Technology and Industrial Arts

Construction Technology

Junior High

Grade 9

Teacher Guide

Standards-Based

Department of Education

'FREE ISSUE
NOT FOR SALE'

Technology and Industrial Arts
Construction Technology

Junior High

Grade 9

Teacher Guide

Standards-Based

Papua New Guinea
Department of Education

Issued free to schools by the Department of Education

Issued free to schools by the Department of Education

Published in 2023 by the Department of Education, Papua New Guinea.

© Copyright 2023 Department of Education, Papua New Guinea.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted by any form or by any means electronic, mechanical, photocopying, recording or otherwise without the prior written permission of the publisher.

Graphic Design and Layout by David Kuki Gerega

ISBN:978-9980-921-12-3

Acknowledgements

The Technology and Industrial Arts –Construction Technology Teacher Guide for Grade 9 was developed by the Curriculum Development Division of the Department of Education and was coordinated by Clemencia Pue Dimain with assistance from the Subject Curriculum Group (SCG).

Writers from schools, tertiary institutions and non-government organisations have contributed to the writing of this teacher guide through specialist writing workshops and consultations. Quality assurance groups and Technology and Industrial Arts Subject Curriculum Group have also contributed to the development of this teacher guide. They are all acknowledged for their support and contributions.

Dr. Arnold Kukari (Late) is also acknowledged for his consultancy and advice to the development of the Junior & Senior High School Standards –Based Curriculum.

Subject Advisory Committee (SAC) and Board of Studies (BOS) are acknowledged for their recommendations and endorsements respectively of this Teacher Guide.

Contents

Acknowledgement..... ii
Acronyms v
Secretary's Message iv
Introduction..... 1
Structure of the Teacher Guide 2
Purpose of the Teacher Guide 3
How to use the Teacher Guide 6
Syllabus and Teacher Guide Alignment..... 9
Learning and Performance Standards 11
Core Curriculum 14
Science, Technology, Engineering, Arts, and Mathematics 15
Essential Knowledge, Skills, Values and Attitudes 24
Curriculum Intergration 32
Teaching and Learning Strategies..... 39
Strands,Units and Topics..... 42
Unit 1: Building Technology..... 48
Unit 2: Electrical Technology..... 101
Unit 3: Plumbing Technology..... 141
Unit 4: Welding Technology..... 166
Unit 5: Engineering Technology..... 202
Planning and Programming..... 266
Standards-Based Lesson Planning..... 314
Standards-Based Assessment, Monitoring and Reporting..... 332
Glossary 375
References 352
Appendices 355

Acronyms

AAL	Assessment as Learning
ARS	Audience Response System.
AFL	Assessment for Learning
AOL	Assessment of Learning
BoS	Board of Studies
CDD	Curriculum Development Division
CP	Curriculum Panel
DA	Diagnostic Assessment
IHD	Integral Human Development
GoPNG	Government of Papua New Guinea
KSVA	Knowledge Skills Values and Attitudes
MTDG	Medium Term Development Goals
NDoE	National Department of Education
OBC	Outcomes-Based Curriculum
OBE	Outcomes-Based Education
PNG	Papua New Guinea
SAC	Subject Advisory Committee
SBC	Standards-Based Assessment
SBC	Standards-Based Curriculum
SBE	Standards-Based Education
SCG	Subject Curriculum Group
STEAM	Science, Technology, Engineering, Arts and Mathematics
SRS	Student Response System
UOW	Unit of Work
TIA	Technology and Industrial Arts

Secretary's Message

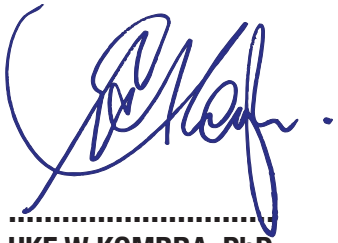
The ultimate aim of Standards-Based Education in Papua New Guinea (PNG) is to prepare students for careers, higher education, and citizenship. This means that education should focus on developing and equipping students with essential knowledge, skills, values, and attitudes that they can use in all aspects of their lives. Education must also aim to motivate and prepare students to pursue Science, Technology, Engineering, Arts, and Mathematics (STEAM) courses in higher education institutions and pursue careers in STEAM related fields.

The Technology and Industrial Arts subject has 5 strands with their own teacher guides developed and this Construction Technology teacher guide is one of them. Construction Technology is a significant curriculum to develop in students' proficiency and competency in the engineering applications, methodology and processes of structures that encompass building, electrical, plumbing and welding. Thus enabling students' knowledge and skills in building through opportunities to design and build various construction projects. However, it is equally important for students to understand technology, its impacts and implications and make decisive and collaborative decisions that will enable themselves to utilise technology more to their advantage.

Technology and Industrial Arts as a subject of which Construction Technology is a strand, is envisioned to benefit students in enabling them to utilise technology knowledge, skills, values and attitudes, and systems and processes to solve problems using the design process in a methodical and precise manner to innovate and invent design solutions. The integration of STEAM in the teaching and learning of Construction Technology will instill in students the abilities and capabilities to be highly proficient and competent end users and possibly creators of technology as STEAM is an integral component of the core curriculum.

Teachers are encouraged to read this teacher guide carefully to become familiar with the content so that they can be confident to use the new concepts and strategies as well as teach the content well. They can also adjust to suit the needs of the students.

I commend and approve this Grade 9 Technology and Industrial Arts: Construction Technology Teacher Guide to be used in all junior high schools throughout Papua New Guinea.



.....

UKE W KOMBRA, PhD
Secretary for Education

Introduction

The strand Construction Technology in the Technology and Industrial Arts (TIA) subject aims to help students become competent and confident in construction technology, who can make efficient, effective and creative use of building, electrical, plumbing, welding skills in their everyday activities. It further encourages them to individually and collaboratively apply processes, systems, techniques and materials to create, monitor, analyse, predict and shape the interactions within and between construction structures and the impact of on individuals, societies, economies and environments. It embraces the development in technology and emerging technologies using software and applications, safely, ethically and with greater responsibility.

The study of Construction Technology will enhance the students' knowledge to create and read technical drawings; become familiar with construction materials, components, processes and perform a variety of building operations using engineering skills and procedures of design. Thus understanding the importance of occupational health and safety, building codes and standards and regulations and further identify the impacts of construction technology in society. It also aims to provide lifelong skills and opportunities for students to live a productive life as well as a career or pursuing further learning. In the 21st Century, it is important to recognise that technology has become part of the educational process for all age levels and should be viewed and taught as a tool for problem solving and decision- making. Students should be encouraged to analyse, synthesise and evaluate situations at home, and school, thereby, apply technology to complete tasks efficiently and effectively and be prepared for the future in the face of a changing construction landscape.

Students' employability will be enhanced through the study and application of STEAM principles. STEAM is an integral component of the core curriculum. It is envisioned that the study of STEAM will motivate students to take up academic programs and careers in STEAM related fields. STEAM has been embedded in the Technology and Industrial Arts: Construction Technology curriculum.

Teachers of Construction Technology strands will plan and program the strand for 13 weeks on a rotational basis with the other 4 strands as they are taught concurrently, hence the total coverage of learning Technology and Industrial Arts as a subject. The learning integration is more relevant including the STEAM approach to teach the essential knowledge, skills, values and attitudes, and processes.

Technology and Industrial Arts: Construction Technology is to be timetabled for 200 minutes (5 periods) per week in junior high school.

Structure of the Teacher Guide

The Construction Technology Strand Teacher Guide comprises four main sections that provide essential information that all teachers should know and do to effectively implement the Construction Technology curriculum.

1. General Information of the Subject/Strand

The general information section of the Teacher Guide informs teachers on the Construction Technology Strand under the following headings below;

- Introduction of the Strand Teacher Guide
- Structure of the Strand Teacher Guide
- Purpose of the Strand Teacher Guide
- How to use the Strand Teacher Guide

2. Teaching and Learning Section

The teaching and learning section of the Teacher Guide informs and guides teachers to apply the teaching and learning theories, principles, pedagogies and practices in planning, programing, teaching and assessing students. They are outlined in the headings bulleted below;

- Syllabus and Teacher Guide Alignment
- Learning and Performance Standards
- Core Curriculum
- Science Technology Engineering Arts Mathematics (STEAM)
- Curriculum Integration
- Essential Knowledge, Skills, Values and Attitudes
- Teaching and Learning Strategies
- Strands, Units and Topics
- Sample SBC Lesson Plans

3. Assessment Section

The assessment section of the Teacher Guide informs and guides teachers to plan and program assessment activities, formulate assessment rubrics and apply assessment strategies to assess studies. This section also guides teachers to monitor and report students' progress of learning and performances of the attainment of standards.

4. Glossary, References and Appendices Sections

These sections guide teachers to refer to terms and definitions of the strand/subject content, references outlined to guide the development of this teacher guide and essential and supplementary information provided to guide teachers on the content and the delivery of this strand/subject.

Purpose of the Teacher Guide

This teacher guide describes what teachers should know and do to effectively plan, program, teach and assess Grade 9 Construction Technology content to enable all students to attain the required learning and proficiency standards.

Ample information with thorough guidelines is provided for the teacher to use to achieve the essential Knowledge, Skills, Attitudes and Values (KSAV) embedded in the set national content standards and grade level benchmarks.

The overarching purpose of this teacher guide is to assist teachers to;

- understand the significance of aligning all the elements of standards-based curriculum (SBC) as the basis of achieving the expected level of education quality,
- effectively align all the components of SBC when planning, programming, teaching, and assessing students learning and levels of proficiency,
- effectively translate and align the Technology and Industrial Arts Syllabi and Construction Technology Strand teacher guides to plan, program, teach and assess different Construction Technology Strand Teacher Guide units and topics, and the essential knowledge, skills, attitudes and values (KSAVs) described in the grade – level benchmarks,
- understand the Construction Technology Strand national content standards, grade-level benchmarks, and evidence outcomes,
- effectively make sense of the content (KSAVs) described in the Communication Technology Strand national content standards and the essential components of the content described in the grade – level benchmarks,
- effectively guide students to progressively learn and demonstrate proficiency on a range of Construction Technology Strand skills, processes, concepts, ideas, principles, practices, values and attitudes,
- confidently interpret, translate and use Construction Technology Strand content standards and benchmarks to determine the learning objectives and performance standards, plan and program appropriately to enable all students to achieve these standards,
- embed the core curriculum in the Construction Technology Strand lesson planning, programming, instruction, and assessment to permit all students to learn and master the core knowledge, skills, values and attitudes required of all students,
- provide opportunities for all students understand how STEAM has and continues to shape the social, political, economic, cultural, and environment contexts and the consequences, and use STEAM principles, skills, processes, ideas and concepts to inquire into and solve problems

relating to both the natural and physical worlds (human –made) as well as problems created by STEAM,

- integrate cognitive skills (critical, creative, reasoning, decision-making, and problem solving skills), high level thinking skills (analysis, synthesis and evaluation skills), values (personal, social, work, health, peace, relationship, sustain values), and attitudes in lesson planning, programming, instruction and assessment,

- meaningfully connect what students learn in Construction Technology Strand with what is learnt in other subjects to add values and enhance students learning so they can integrate what they learn and develop in-depth vertical and horizontal understanding of subject content,

- formulate effective SBC lesson plans using learning objectives identified for each of the topics,

- employ SBC assessment approaches to develop performance assessments to assess students' proficiency on a content standard or a component of the content standard described in the grade –level benchmark,

- effectively score and evaluate students' performance in relation to a core set of learning standards or criteria, and make sense of the data to ascertain status of progress towards meeting grade-level and nationally expected proficiency standards,

- use evidence from the assessment of students' performance to develop effective evidence – based intervention strategies to help students making inadequate or slow progress towards meeting the grade-level and national expectations to improve their learning performances.

- provide opportunities for all students understand how STEAM has and continues to shape the social, political, economic, cultural, and environment contexts and the consequences, and use STEAM principles, skills, processes, ideas and concepts to inquire into and solve problems relating to both the natural and physical worlds (human –made) as well as problems created by STEAM,

- integrate cognitive skills (critical, creative, reasoning, decision-making, and problem solving skills), high level thinking skills (analysis, synthesis and evaluation skills), values (personal, social, work, health, peace, relationship, sustain values), and attitudes in lesson planning, programming, instruction and assessment,

- meaningfully connect what students learn in Food Technology Strand with what is learnt in other subjects to add values and enhance students learning so they can integrate what they learn and develop in-depth vertical and horizontal understanding of subject content,

- formulate effective SBC lesson plans using learning objectives identified for each of the topics,

- employ SBC assessment approaches to develop performance assessments

to assess students' proficiency on a content standard or a component of the content standard described in the grade –level benchmark,

- effectively score and evaluate students' performance in relation to a core set of learning standards or criteria, and make sense of the data to ascertain status of progress towards meeting grade-level and nationally expected proficiency standards, and

- use evidence from the assessment of students' performance to develop effective evidence – based intervention strategies to help students making inadequate or slow progress towards meeting the grade-level and national expectations to improve their learning performances.

How to use the Teacher Guide

The Grade 9 Construction Technology Strand Teacher Guide is an expansion of the content in the Technology and Industrial Art Syllabus. The Syllabus contains the content standards, benchmarks and evidence outcomes which are expanded into teaching and learning Activities in the Teacher Guide. The Teacher Guide provides essential information about what the teacher needs to know and do to effectively plan, teach and assess students' learning and proficiency on learning and performance standards. It should be read in conjunction with the syllabus in order to understand what is expected of teachers and students to achieve the envisaged quality of education outcomes.

The first thing teachers should do is to read and understand each of the sections of the Teacher Guide to help them understand the key SBC concepts and ideas. A thorough understanding of these components will help teachers meet the teacher expectations for implementing the SBC curriculum, and therefore the effective implementation of Grade 10 Construction Technology Strand in TIA Curriculum. Based on this understanding, teachers should be able to effectively use the teacher guide to do the following:

The scope of learning is translated and programmed according to the four terms. The suggested teaching and learning strategies and the key important instructions provided for teachers can be used to design and manage teaching and learning activities for the students in the classroom.

The assessment methods, assessment samples, reporting and recording strategies contained in this guide will assist teachers to plan assessment in Strands for the school year.

The strand teacher guide can be used for developing both classroom learning and professional development activities. The document is a useful resource for developing school and community based in-service programs.

Teachers must thoroughly read the contents of the documents in order to develop an understanding and do the following;

Determine Learning Objectives and Lesson Topics

- The teaching and learning Standards are derived from the Content Standards and Benchmarks in the Syllabus. The Learning Objectives are extracted from the grade-level benchmarks and are used for teaching topics. And lesson objectives are derived from learning objectives and are used for teaching Lessons.

Identify and Teach Grade Appropriate Content

- Grade appropriate content has been identified and scoped and sequenced using appropriate content organisation principles. The content is sequenced using the spiralling sequence principles. The strand, topics and lesson concepts in the Teacher Guide can be spiralled and taught by Strand, by Topics or by lessons using the Benchmarks.

Using the Benchmarks, Content Mapping in Programing will enable teacher to see the content from what the students have already learned in line with current to be taught and link to the next learning content.

Integrate the Core Curriculum in Lesson Planning, Instruction and Assessment

- This sequencing of content will enable students to progressively learn the essential knowledge, skills, values and attitudes as they progress further into their schooling.

Integrate cognitive, high level and 21st century skills in lesson planning, instruction and assessment

- Lesson titles in the teacher guide were drawn out from the benchmarks. From the lesson titles outlined in the planning and programming section, the values, the attitude, the skills and the knowledge are identified.

Integrate Technology and Industrial Arts: Construction Technology Values, and Attitudes in lesson planning, instruction and assessment

- When planning a lesson, it is important that, the values, attitudes, skills and knowledge of the lesson come out clearly in the teaching and learning activities as displayed in the sample guided lessons.

Integrate Science, Technology, Engineering, Arts and Mathematics (STEAM) principles and skills in lesson planning, instruction and assessment

- STEAM principles and skills must be effectively taught and learned by students. Teachers should use the teacher guide to help them make informed decisions when selecting the types of teaching and learning methodologies to use in their teaching of the subject content, including STEAM principles and skills.

Identify and Use Grade and Content Appropriate, Innovative, Differentiated and Creative Teaching and Learning Methodologies

Lesson titles in the teacher guide were drawn out from the benchmarks. From the lesson titles outlined in the planning and programming section, the values, the attitude, the skills and the knowledge are identified.

Plan and address the principles of Inclusive Teaching and Learning'

Teachers are obliged to create an inclusive learning environment to include students with special needs to promote learning for all. These special needs may include students who are gifted or disadvantaged physically, socially, emotionally and intellectually. Students may display combinations of any of these needs and therefore, the teaching and learning activities must have students with special needs in to participate to their fullest abilities. The different types of needs in students include;

- Physical disabilities
- Intellectual disabilities
- Hearing impairment
- Sight-vision impairment
- Speech impairment
- Behavioural and emotional disorders

It is important that the learning activities for TIA: Construction Technology are inclusive and foster the learning needs of all students.

Syllabus and Teacher Guide Alignment

The Grade 9 Construction Technology Strand Teacher Guide is closely aligned and complementary to the Technology and Industrial Art Syllabus.

They are the essential focus points for teaching and learning the essential knowledge, skills, values and attitudes.

Syllabus and Teacher Guide Alignment	
Syllabus Outlines the ultimate aim and goals, and what to teach and why teach it	**Teacher Guide** Describes how to plan, teach, and assess students' performance
• Overarching and SBC principles • Content overview • Core curriculum • Essential knowledge, skills, values and attitudes • Strands and units • Evidence outcomes • Content standards and grade-level benchmarks • Overview of assessment, evaluation, and reporting	• Determine topics for lesson planning, instruction and assessment • Formulate learning objectives • Plan SBC lesson plans • Select teaching and learning strategies • Implement SBC assessment and evaluation • Implement SBC reporting and monitoring

The syllabus outlines the ultimate aim and goals of SBE and SBC, what is to be taught and why it should be learned by students, the underlying principles and articulates the learning and proficiency standards that all students are expected to attain. On the other hand, the teacher guide expands on what is outlined in the syllabus by describing the approaches or the how of planning, teaching, learning, and assessing the content so that the intended learning outcomes are achieved.

This teacher guide should be used in conjunction with the syllabus. Teachers should use these documents when planning, teaching and assessing Grade 9 Construction Technology Strand content.

Teachers will extract information from the syllabus (e.g., content standards and grade-level benchmarks) for lesson planning, instruction and for measuring students' attainment of a content standard as well as progress to the next grade of schooling.

Learning and Performance Standards Alignment

Content Standards, Benchmarks and Evidence Outcomes are linked to Learning Objectives, Lesson Objectives and Performance Standards in the Teacher Guide. (see table). There is a close linear relationship between these standards. Students' performance on a significant aspect of a benchmark (KSVA) is measured against a set of performance standards or criteria to determine their level of proficiency using performance assessment. Using the evidence from the performance assessment, individual student's proficiency

on the aspect of the benchmark assessed and progression towards meeting the benchmark and hence the content standard are then determined.

Standards Alignment	
Standards in Syllabus	**Standards in Teacher Guide**
• SBC Aims and Goals • Content Standard • Benchmarks • Evidence Outcomes	• Learning Objectives • Lesson Objectives • Essential Knowledge, Skills, Values and Attitude • Performance Standard

Standard Alignment

Standard Alignment shows the link between different standards in the Syllabus and Teacher Guide. It begins with SBC Aims and Goals which are National Standards in which the Syllabus Standard are derived from. The Content Standards or Subject Standards are expanded into Benchmarks which are Achievable Benchmarks for particular Grade Levels and are translated into the Teacher Guide as Teaching and Learning Standards and Assessment Standards. And they become the components of Unit of Work.

The Unit of Work (UOW) consists of the Achievable Standards for a particular Grade Level and is translated into Teaching and Learning Activities and Assessment Tasks.

It is essential that teachers know and can do standards alignment when planning, teaching, and assessing students' performance so that they can effectively guide their students towards meeting the grade-level benchmarks (grade expectations) and subsequently the content standards (national expectations).

Below is a diagram to show the relationship between Standards in the Syllabus and the Teacher Guide.

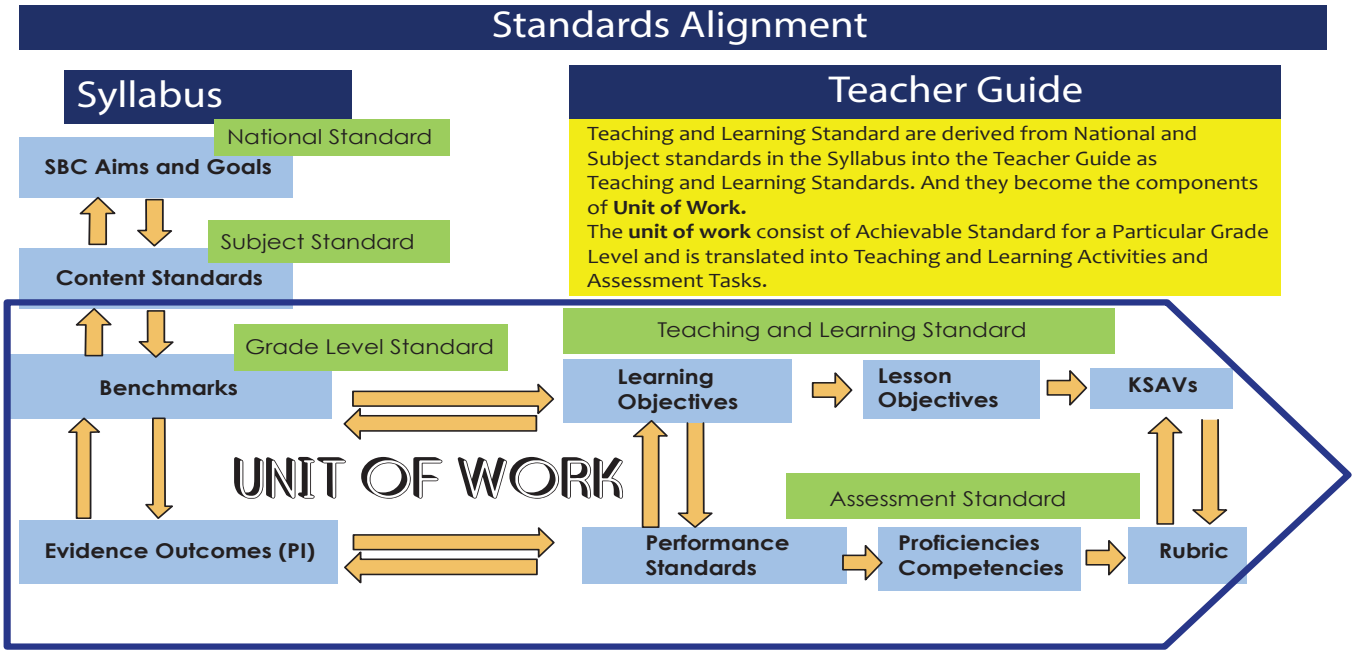


Figure 1 Standards Alignment that shows the alignment of standards in the syllabus and teacher guide

Learning and Performance Standards

Standards define the expected level of education quality that all students should achieve at a particular point in their schooling.

Content standards, benchmarks, and learning objectives are called learning standards while performance and proficiency standards (evidence outcomes) can be categorised as performance standards. These standards are used to measure students' performance, proficiency, progression and achievement of the desired level of education quality. Teachers are expected to understand and use these standards for programming, lesson planning, instruction and assessment.

Student's progression and achievement of education standard(s) are measured using performance standards or criteria to determine their demonstration or performance on significant aspects of the standards and therefore their levels of proficiency and competency. When they are judged to have attained a proficiency on a content standard or benchmark or components of these standards, they are then deemed to have met the standard(s) that is, achieve the intended level of education quality.

Content Standards

Content standards are evidence-based, rigorous and comparable regionally and globally. They have been formulated to target critical social, economic, political, cultural, environment, and employable skills gaps identified from a situational analysis. They were developed using examples and experiences from other countries and best practice, and contextualised to PNG contexts.

Content standards describe what **(content - knowledge, skills, values, and attitudes)** all students are expected to know and do **(how well students must learn and apply what is set out in the content standards)** at each grade-level before proceeding to the next grade. These standards are set at the national level and thus cannot be edited or changed.

Content Standards:

- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the national level;
- state or describe the expected levels of quality or achievement;
- are clear, measurable and attainable;
- are linked to and aligned with the ultimate aim and goals of SBE and SBC and overarching and SBC principles;
- delineate what matters, provide clear expectations of what students should progressively learn and achieve in school, and guide lesson planning, instruction, assessment;
- comprise knowledge, skills, values, and attitudes that are the basis for quality education;
- provide teachers a clear basis for planning, teaching, and assessing lessons;

- provide provinces, districts, and schools with a clear focus on how to develop and organise their instruction and assessment programs as well as the content that they will include in their curriculum.

Benchmarks

Benchmarks are derived from the content standards and benchmarked at the grade-level. Benchmarks are specific statements of what students should know (*i.e.*, essential knowledge, skills, values or attitudes) at a specific grade-level or school level. They provide the basis for measuring students' attainment of a content standard as well as progress to the next grade of schooling.

Grade-level benchmarks:

- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the grade level;
- are linked to the national content standards;
- are clear, measurable, observable and attainable;
- articulate grade level expectations of what students are able to demonstrate to indicate that they are making progress towards attaining the national content standards;
- provide teachers a clear basis for planning, teaching, and assessing lessons;
- state clearly what students should do with what they have learned at the end of each school-level;
- enable students' progress towards the attainment of national content standards to be measured, and
- enable PNG students' performance to be compared with the performance of students in other countries.

Learning Objectives

Learning or instructional Objectives are precise statements of educational intent. They are formulated using a significant aspect or a topic derived from the benchmark, and is aligned with the educational goals, content standards, benchmarks, and performance standards. Learning objectives are stated in outcomes language that describe- the products or behaviours that will be provided by students. They are stated in terms of measurable and observable student behaviour. *For example,* students will be able to identify all the main towns of PNG using a map.

Performance Standards

Performance Standards are concrete statements of how well students must learn what is set out in the content standards, often called the **"be able to do"** of "what students should know and be able to do." Performance standards are the indicators of quality that specify how competent a student's demonstration or performance must be. They are explicit definitions of what students **must do to demonstrate proficiency or competency at a specific level on the**

content standards. Performance standards:

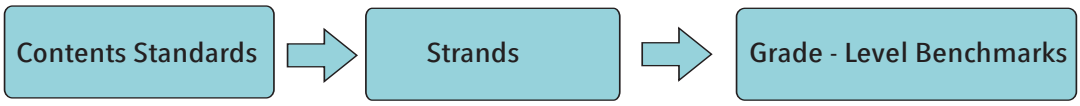
- measure students' performance and proficiency **(using performance indicators)** in the use of a specific knowledge, skill, value, or attitude in real life or related situations.
- provide the basis **(performance indicators)** for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude.
- are used to plan for individual instruction to help students not yet meeting expectations **(desired level of mastery and proficiency)** to make adequate progress towards the full attainment of benchmarks and content standards.
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards.

Proficiency Standards

Proficiency standards describe what all students in a particular grade or school level **can do** at the end of a strand, or unit. These standards are sometimes called evidence outcomes because they indicate if students can actually apply or use what they have learnt in real life or similar situations. They are also categorised as benchmarks because that is what all students are expected to do before exiting a grade or are deemed ready for the next grade.

As per presented above, should teachers wish to develop additional benchmarks to cater for their students learning needs. You are encouraged to follow the process below to develop them.

Approach for Setting National Content Standards and Grade - Level Benchmarks



Development of Additional Benchmarks

Teachers should develop additional benchmarks to meet the learning needs of their students. They should engage their students to learn about local, provincial, national and global issues that have not been catered for in the grade-level benchmarks but are important and can enhance students' understanding and application of the content. However, it is important to note that these benchmarks will not be nationally examined as they are not comparable. Only the benchmarks developed at the national level will be tested. This does not mean that teachers should not develop additional benchmarks. An innovative, reflective, creative and reflexive teacher will continuously reflect on his/her classroom practice and use evidence to provide challenging, relevant, and enjoyable learning opportunities for his/her students to build on the national expectations for students. Teachers should follow the following process when developing additional grade-level benchmarks.

Core Curriculum

Core curriculum refers to a core set of common learnings (knowledge, skills, values, and attitudes) that are integrated into the content standards and grade-level benchmarks for all subjects. The core curriculum includes:

- Cognitive skills (critical and creative thinking);
- Reasoning, problem-solving and decision-making skills;
- High level thinking skills (analysis, evaluation and synthesis);
- 21st Century skills;
- STEAM principles and skills;
- Seven Principles for Teaching Procedural and Technical Skills (Plan ahead, Demonstration, Observation of learner in action, Provide specific feedback, Encourage self-evaluation, Allow learner practice, Prepare to modify approach)
- Working Diagrams (sketching and technical drawing)
- Reading, writing and communication skills, and
- Essential values and attitudes.

Technology and Industrial Arts: Construction Technology teachers are expected to include the core learning's in their lesson planning, teaching and assessment of students in all their lessons. In addition to these are the essential core curriculums; OHS, designing, technical drawing, CAD Software and computer applications, engineering skills, methodology and construction materials, codes, standards and regulations, design process, design solutions and building structures in Construction Technology. Teachers may include other core curriculum concepts in relation to the subject to cater for students learning needs.

A practical example of integrating core curriculum in Teaching and Learning

Teachers can identify a set of core curriculum to teach in one lesson for example; in Technology and Industrial Arts: Construction Technology, students may be posed with an opportunity to find solutions on how technology can be used to utilise one of the core concepts of technology and industry in their area. The core concepts include; design process, design folio, design solutions, materials, processes, techniques, systems and safety.

Students will be required to use what they learnt in Construction Technology about designing, communication, the design process and how technology is engaging in people's livelihood in terms of designing and making products and marketing as a quicker and cheaper way of advertising and selling their products. They can use STEAM principles and skills in finding cause and solutions, use high level thinking skills to analyse and evaluate the effects and how to improve design products, use decision making and critical thinking skills to find the solutions for making and marketing a product.

They can be able to confidently and boldly communicate their findings and present intelligent and convincing arguments, which we can conclude that learning of the core curriculum is evident.

If students can be able to demonstrate mastery, proficiency and competency of core curriculum in such a manner, then the learning of core curriculum has been achieved.

Science, Technology, Engineering, Arts and Mathematics

STEAM education is an integrated, multidisciplinary approach to learning that uses Science, Technology. Engineering, Arts and Mathematics as the basis for inquiring about how STEAM has and continues to change and impact the social, political, economic, cultural and environments contexts and identifying and solving authentic (real life) natural and physical environment problems by nitrating STEAM- based principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

TIA: Construction Technology utilises both the goals of STEAM rather than just the goal of problem- solving. This is to ensure that all students are provided opportunities to learn, integrate and demonstrate proficiency on all essential STEAM principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

Objectives:

Students will be able to:

i. Examine and use evidence to draw conclusions about how STEAM has and continues to change the social, political, economic, cultural and environmental contexts.
ii. Investigate and draw conclusions on the impact of STEAM solutions to problems on the social, political, economic, cultural and environments contexts
iii. Identify and solve problems using STEAM principles, skills, concepts, ideas and process
iv. Identify, analyse and select the best solution to address a problem
v. Build prototypes or model of solutions to problems.
vi. Replicate a problem solution by building models and explaining how the problem was or could be solved.
vii. Test and reflect on the best solution chosen to solve a problem
viii. Collaborate with others on a problem and provide a report on the process of problem solving used to solve the problem.
ix. Use skills and processes learnt from lessons to work on and complete STEAM related projects.
x. Demonstrate STEAM principles, skills, processes, concepts and ideas through simulation and modeling.
xi. Explain the significance of values and attitudes in problem solving.

STEAM Problem -Solving Methods and Approaches

Problem –solving involves the use of problem- solving methods and processes to identify and define a problem, gather information to understand its causes, draw conclusions, and use the evidence to design and implement solutions to address it. Even though, there are many different problem -solving methods

and approaches; they share some of the steps of problem-solving, for example:

- Identifying the problem;
- Understanding the problem by collecting data;
- Analyse and interpret the data;
- Draw conclusions;
- Use data to consider possible solutions;
- Select the best solution;
- Test the effectiveness of the solution by trialing and evaluating it, and
- Review and improve the solution.

STEAM problem-solving processes go from simple and technical to advanced and knowledge- based processes. However, regardless of the type of process used students should be provided opportunities to learn the essential principles and processes of problem solving and more significantly, to design and create a product that addressed a real problem and meets a human need.

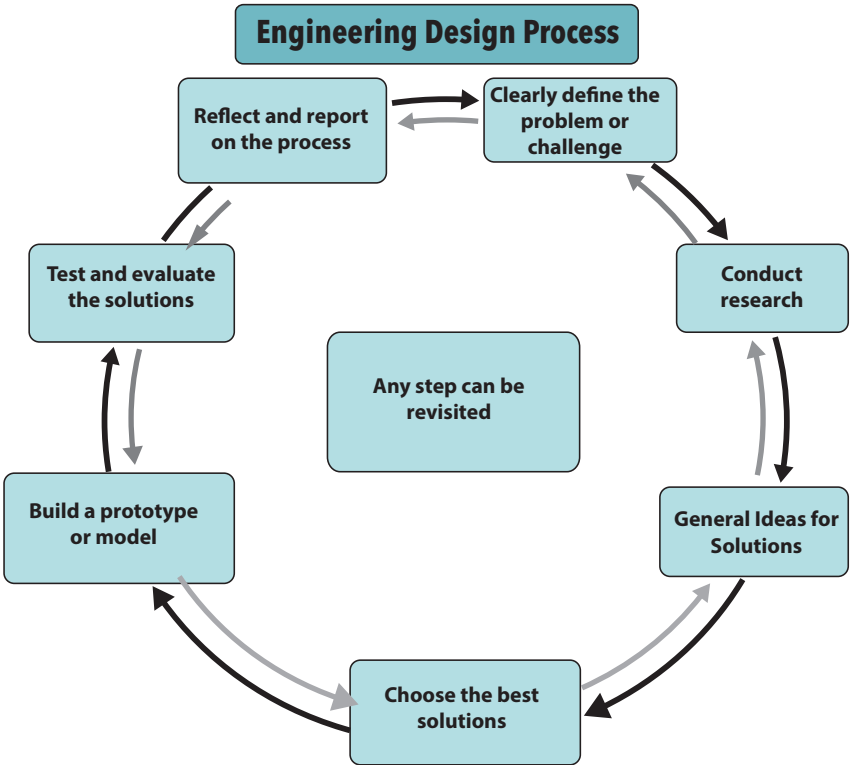
Engineering Design Process

Technological fields used the engineering design process to choose the best solution to solve the problem.

It is an open-ended problem solving process that involves the full planning and development of products or services to meet identified needs. It involves the following sequence of steps:

- Analyse the context and background, and clearly define the problem.
- Conduct research to determine design criteria, financial or other constraints, and availability of materials,
- Generate ideas for potential solutions, using processes such as brainstorming and sketching.
- Choose the best solution.
- Build a prototype or model.
- Test and evaluate the solution.
- Repeat steps as necessary to modify the design or correct faults.
- Reflect and report on the process.

The sequential engineering design process steps described above are illustrated in the diagram below.



Students should be guided through every step of the process so that they can explain it and its importance, and use the steps and the whole process proficiently to identify, investigate and solve problems. They should be provided with opportunities to practice and reflect on each step until they demonstrate the expected level of proficiency before moving on to the next one.
It involves the following sequence of steps;

Step 1: IDEA GENERATION
Step 2: RESEARCH
Step 3: PLANNING (DESIGN BRIEF)
Step 4: PROTOTYPING
Step 5: PRODUCTION
Step 6: COSTING
Step 7: MARKETING

Step 1: Idea Generation

- Ideation, iteration, and brain storming new product ideas

Students should be guided and provided opportunities to identify human made, natural and physical environment problems using their senses and describe what the problem is and its likely causes.

Example: *Residential backyard design that is not pleasing.*

Step 2: Research

- Questionnaires Feedback from a substantial and unbiased audience for product validation

After the problem is identified and described, several questions will be derived from a main issue question. The questionnaire will be formulated and then will be answered in the survey. This questionnaire will guide the researcher in conducting research and investigation for the appropriate solution to the problem.

Example: Main Question 'How can the residential backyard are designed including the elements of design that is aesthetically functional?'

Step 3: Planning (Design Brief)

- Bring the product to life through sketching, illustrations and working diagrams

Creating working sketches, illustrations and working diagrams helps the researcher to better understand his or her research problem, refine the research question and decide on investigation approach before the investigation is conducted.

Example: *Description of an Authentic Situation of an aesthetic and functional residential backyard design.*

The researcher may look into the various designs of backyards in the schools and surrounding residences outside of the school premises take pictures and produce sketches or other subject areas for tips or conduct online search on how to improve the design of residents' backyards from relevant websites. The researchers may even analyse information and past practices or similar but better regarding aesthetic and functional backyard designs.

Step 4: Prototyping

- Construct a scale model of a residential backyard design.

The researcher will make or develop a prototype of the solution and test how it would be used to solve the problem.

Example: Prototype

The illustration of sketches in the planning stage can be created in sketches and technical drafts or use CAD as the basic solution for residential back-yard design. He /she will complete a scale drawing, with annotation and development.

Step 5: Production

- Gather materials and production begins.

This step is the gathering of materials and producing of the product from the best prototype. This involves the identification of lists of materials, procedural steps with their respective tools or equipment to be used to produce the intended product.

It is obviously known during the production that certain procedural steps are needed to be done in certain order before the others because later steps depend on them being prioritized. In addition, concepts of other subjects needed for producing the product maybe gathered, integrated and utilised in the production of the product.

Example: *Producing the product*

Step 6: COSTING

- Total cost of product sold to determine retail price and gross margin

This stage is known as product pricing which involves the calculation of the costs of materials used, labour cost, markup and selling price.

The selling price may be influenced by responses to the questions in the survey due to the interest of the buyers which will determine the cost of the product.

The cost for producing the item are:

1) Material unit cost: K____
2) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____
3) Selling/Marketing cost: K____

A simple formula to calculate a good markup percentage for the project:
Example: Pricing the product

Step 7: MARKETING

- **Launch product into market**

This stage involves the marketing of the finished product. The potential buyers of the product are the targeted audience that were used in the research.

The finished product can be promoted using flyers, put out on public places and market page can be created on social media networks.

STEAM- Based Lesson Planning

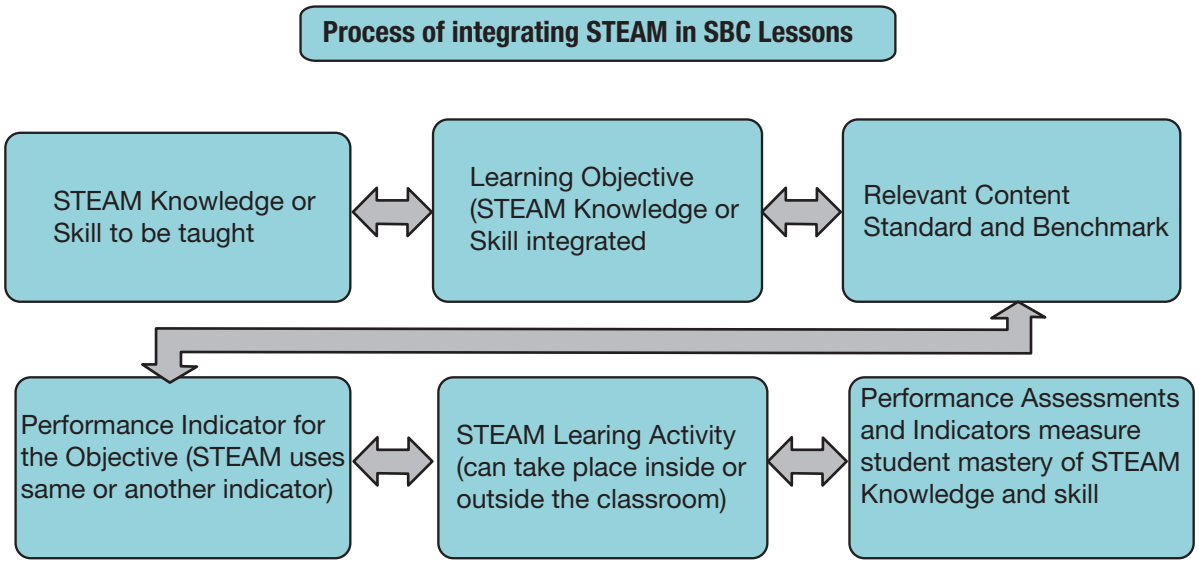
Effective STEAM lesson planning is the key to the achievement of the expected outcomes. STEAM Skills can be planned and taught using separate STEAM-based lesson plans or integrated into the standards- based lesson plans. To effectively do this, teachers should know how to write effective standards and STEAM-based lesson plans.

Developing STEAM-based Lesson Plans

An example of a standards- based lesson is provided below. Teachers should use this to guide them to integrate STEAM content and teaching, learning and assessment strategies into their standards- based lesson plans.

Integration of STEAM problem-solving skills into standards-based lesson plans

Process for Integrating STEAM Principles and Problem-Solving Skills into Standards-Based Lessons



Teachers should follow the steps given below when integrating STEAM problem-solving principles and skills into their standards-based lesson plans. (Refer to Appendices)

Step 1: Identify the STEAM knowledge or skill to be taught (From the table of KSAVs for each content standard and bench mark). **This could be already being captured in the learning objective stated in the standards-based lesson plan.**

Step 2: Develop and include a performance standard or indicator for measuring student mastery of the STEAM knowledge or skill (e.g. level of acceptable competency or proficiency) **if this is different from the one already stated in the lesson plan**

Step 3: Develop student learning activity (An activity that will provide students the opportunity to apply STEAM knowledge or skill specified by the learning objective and appropriate statement of standards). Activity can take place insideor outside the classroom and during or after school hours.

Step 4: Develop and use performance descriptors (standards or indicators) to analyze student STEAM related behaviors or products (results or outcomes), which provide evidence that the student has acquired and mastered the knowledge or skill of the learning objective specified by the indicator(s) of the standard(s).

STEAM- Based Assessment

STEAM-based assessment is closely linked to standards-based assessment where assessment is used to assess student's level of proficiency or competency of a specific knowledge, skill, value or attitude taught using a set of performance standards (indicators or descriptors). The link also includes the main components such as the purpose, the assessment principles and assessment strategies and tools.

In STEAM-based assessment, assessment is designed for what the students should know and be able to do. In STEAM learning students are assessed in a variety of ways including portfolios, project/problem-based assessment, backward designs, authenticity assessment, or other students centered approaches. When planning and designing the assessment, teachers should consider the authenticity of the assessment by designing an assessment that relates to a real world task or discipline specific attributes (such as simulation, role play, placement assessment, live projects, debates) should make the activity meaningful to the student, and therefore be motivating as well as developing employability skills and discipline specific attributes.

Effective STEAM-Based Assessment strategies

The following six sections describe six assessment tools and strategies shown to impact teaching and learning as well as help teachers foster a 21st century learning environment in their classrooms.

1. **Rubrics**
2. **Performance-based assessment (PBAs)**
3. **Portfolios**
4. **Student self-assessment**
5. **Peer-assessment**
6. **Students response system (SRS)**

Although the list does not include all innovative assessment strategies, it includes what we think are the most common strategies, and ones that may be particularly relevant to the educational context of developing countries in this 21st Century. Many of the assessment strategies currently use fit under one or more of the categories discussed. Furthermore, it is important to note that strategies also connect in a variety of ways.

1. Rubrics

Rubrics are both a tool to measure students' knowledge and ability as well as an assessment strategy. A rubric allows teachers to measure certain skills and abilities not measurable by standardized testing systems that assess direct knowledge at a fixed moment in time. Rubrics are also frequently used as part of other assessment strategies (portfolios, performances, projects, peer-review and self-assessment), they will be discussing in those sections as well.

2. Performance- Based Assessments

Performance- Based Assessments (PBA), also known as authentic assessment are generally used as a summative evaluation strategy to capture not only what students know about a topic, but if they have the skills to apply that knowledge in a; 'real-world' situation by asking them to create an end product. PBA pushes students to synthesize their knowledge and apply their skills to a potentially unfamiliar set of circumstances that is likely to occur beyond the confines of a controlled classroom setting. The implementation of performance-based assessment strategies can also impact other instructional strategies in the classroom.

3. Portfolio Assessment

Portfolios are a collection of student work gathered over time that is primary used as a summary evaluation method. The most salient characteristic of the portfolio assessment is that rather than being a snap shot of a student's knowledge at one point in time (like a single standardised test) it highlights student effort, development, and achievement over a period of time; portfolios measure as student's ability to apply knowledge rather than simply regurgitate. They are considered both student-centered and authentic assessment of learning.

4. Self-Assessment

Its main purpose is for students to identify their own strengths and weakness and to work to make improvements to meet specific criteria. Self-assessment occurs when students judge their own work to improve performance as they identify discrepancies between current and desired performance. In this way, self-assessment aligns well with standards-based education because it provides clear targets and specific criteria against which students or teachers can measure learning.

Self-assessment is used to promote self-regulation to help students reflect on their progress and to inform revisions and improvements on a project or paper. In order for self-assessment to be truly effective, four conditions must be in place, the self-assessment criteria, criteria is negotiated between the teachers and students, students are taught how to apply the criteria, students receive feedback on their self-assessments. Teachers then help students use assessment data to develop an action plan.

5. Peer Assessment

Peer assessment, much like self-assessment, is a formative assessment strategy that gives students a key role in evaluating learning. Peer assessment approaches can vary greatly but, essentially it is a process for learners to consider and give feedback to other learners about the quality or value of their work. Peer assessments can be used for a variety of products like papers, presentations, projects and or other skills behaviors. Peers assessment is understood as more than only a grading procedure and is also envisioned as teaching strategy since engaging in the process develops both the assessor and the assessees skills and knowledge. The primary goal for using peer assessment is to provide feedback to the learners. This strategy may be particularly relevant in the classrooms with many students per teacher since student time will be more plentiful than teacher time, although any single student's feedback may not be rich or in-depth as teachers feedback, the research suggests that peer assessment can improve learning.

6. Students Response system

Students response system (SRS), also known as classroom response (CRS), audience response system (ARS) is a general term that refers to a variety of technology-based formative assessment tools that can be used to gather student- level data instantly in the classroom through the combination of hardware, (voice recorders, PC, internet connection, projector and screen) and software.

Teachers can ask students a wide range of questions (both closed and open ended), where students can respond quickly and anonymously, and the teacher can display the data immediately and graphically. The use of technology also includes a use of video which examines how a range of strategies can be used to assess students understanding. The value of SRS comes from the teachers analysing information quickly and then devising real-time instructional solutions to maximise students learning. This includes a suggested approach to help teachers and trainers assess learning.

Essential Knowledge, Skills, Values, and Attitudes

Students' level of proficiency and progression towards the attainment of content standards for Technology and Industrial Arts subject will depend on their mastery and application of essential knowledge, skills, values, and attitudes in real life or related learning experiences and situations across the secondary curriculum.

Examples of the different types of knowledge, skills, values and attitudes, including processes, that all students are expected to learn and master as they progress through the grades are provided in;

- Technology and Industrial Arts syllabuses for grades 9&10 page 24-27

These knowledge, skills, values and attitudes have been integrated into the content standards, benchmarks and performance standards developed for Technology and Industrial Arts subject

Teachers are expected to plan and teach these in their lessons, and assess students' performance and proficiency, and progression towards the attainment of content standards.

Construction and Industrial Arts

Technology and Industrial Arts provides and instills in students the confidence to use a range of specific knowledge, skills, values and attitudes in various technologies. These are scoped and embedded within the strands curriculum content in the subject, with the intension to create related career pathways. The content in each strand encourage students to be proactive, competent, creative, responsible and reflective learners, enabling them to pursue career opportunities in respective fields of technology studied in this subject.

Provided herein are recognised knowledge for the subject which are applicable across the strands.

Types of common knowledge for Technology and Industrial Arts

These are specific content knowledge for the subject. They include;	
• Creativity • Branding • Communication skills • Technical expertise • Industry expertise • Critical thinking- • Information Technology skills • Innovation	• Building and Engineering Knowledge. • Physical Strength and Stamina. • Mathematical formulas in technology • **Technology and Industrial** Language Coordination. • Technology Skills. • Problem Solving Skills. • Prototype

skills oriented subject, therefore embraces all the commonly recognised skills which can be used across the strands scoped in the content. Listed here for teacher's convenience are commonly recognised skills across the strands.

Types of Skills for Technology and Industrial Arts

These are specific content Skills for the strand. They include;	
• Creativity • Critical thinking • Technical knowledge • Commercial awareness of food industries/catering services • Research and data handling capacity • Critical analysis and interpretation of materials • Management skills • Organisational Skills. • Problem solving skills • Mathematical skills • Language Literacy skills • Leadership • Innovative skills • trans formational skills	• Food Server Skills • Focus Communication skills (approachability, circumstantial awareness, diligence, efficiency, thoroughness • Multitasking skills • Attention to detail skills (multitasking , approachability, • Technical Skills • Decision making skills • Coding • information technology soft skills • logical thinking • collaboration • teamwork • software engineering • software quality assurance • customer Service • Modeling

Types of Values

Personal engagement and civic engagement strategies help young people to acquire and apply skills and dispositions that will prepare them to become competent and responsible citizens.

1. Personal Values (importance, worth, usefulness, etc

Core values	Sustaining values
• Sanctity of life • Truth • Aesthetics • Honesty • Human • Dignity • Rationality • Creativity • Courage • Liberty • Affectivity • Individuality	• Self-esteem • Self-reflection • Self-discipline • Self-cultivation • Principal morality • Self-determination • Openness • Independence • Simplicity • Integrity • Enterprise • Sensitivity • Modesty • Perseverance

2. Social Values

Core Values	Sustaining Values
• Equality • Kindness • Benevolence • Love • Freedom • Common good • Mutuality • Justice • Trust • Interdependence • Sustainability • Betterment of human kind • Empowerment	• Plurality • Due process of law • Democracy • Freedom and liberty • Common will • Patriotism • Tolerance • Gender equity and social inclusion • Equal opportunities • Culture and civilization • Heritage • Human rights and responsibilities • Rationality • Sense of belonging • Solidarity • Peace and harmony • Safe and peaceful communities

Types of Attitudes

Attitudes - Ways of thinking and behaving, points of view	
• Optimistic • Participatory • Critical • Creative • Appreciative • Empathetic • Caring and concern • Positive • Confident • Cooperative	• Responsible • Adaptable to change • Open-minded • Diligent • With a desire to learn • With respect for self, life, equality and excellence, evidence, fair play, rule of law, different ways of life, beliefs and opinions, and the environment.

Construction Technology strand

The **Construction technology** strand encourages students to “think out of the box”. This simply means to think openly and freely beyond the learning situation to bring about fresh creative ideas into the classroom lessons. This gives opportunity to the students to apply creativity and critical thinking to participate .Teachers must ensure that even students with rudimentary creativity skills end up improvising their designs, models of prototypes and products.

Types of knowledge for Construction Technology

These are specific content knowledge for the Strand. They include;	
• Technical drawing • Print and layout reading • Design • Construction Materials specifications • Constructions Systems • Constructions Processes • Construction techniques • Prototype • Constructions materials estimates and costs‘	• Designs of structures • Construction tools • Construction equipment • Construction tools, equipment and correct functions • OHS • Maintenance skills, • Storage skills • Construction supervisory skills • Project management Skills

Processes in Technology & Industrial Arts

Technology and Industrial Arts expounds on the classroom practices using processes for effective and evidence based lesson deliveries. The commended/ suggested processes are for teachers to use as the starting points planning skills or practice based lessons in any of the strands as presented in the subject syllabus.

Types of Processes- Inquiry processes for Technology & Industrial Arts subject

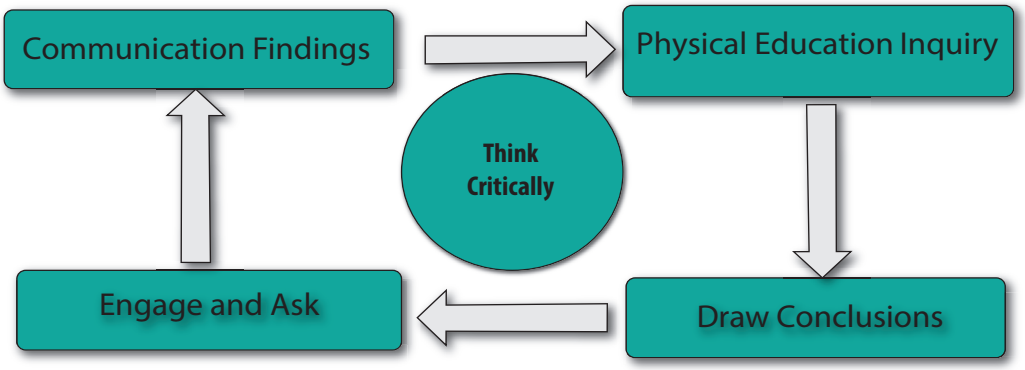
Technology & Industrial Arts Inquiry processes include:

- Gathering information
- Analysing information
- Evaluating information
- Making judgements
- Taking actions
- Instructional technology
- Integration process
- Project planning process
- Organization of learning experiences

Technology & Industrial Arts Inquiry Processes

Engage and Ask	How will I engage my students in the topic and prompt them to ask questions? • Determine the enduring understandings about the topic being studied. • Engage your students with the topic by grabbing their interest with a hook connected to the enduring understandings. • Allow students to generate questions based upon the topic and hook. • Determine what questions will be essential to achieving the enduring understandings. (Student generated or teacher determined • With students, determine what other information is needed in order to fully answer the questions.
Think Critically	How will students access and analyse information about this topic? • Have students think about where they can find answers to the questions posed about the topic. • Gather and organize multiple primary and secondary sources. • Ensure that sources used expose students to different perspectives and viewpoints about the topic. • Students should use sources to collect, analyse, and interpret data. • Ensure students are analysing sources for credibility, bias, and perspective in order to identify gaps in the research.
Draw Conclusion	How will students synthesize ideas to answer the questions posed based on sources used? • Students should engage in civic discussion to answer the questions posed while respecting diverse opinions. • Engage students in evaluating possible courses of action and their consequences. • Students should make and justify an informed decision or choice and/or design an action plan supported by evidence from sources. • Have students evaluate the consequences of a decision or choice. • Allow students to make revisions based on feedback and further study.
Communi-cate Findings	How will students demonstrate what they have learned and take action on that learning? • Determine how students will apply what they have learned and share their findings with others. • Explore appropriate audiences for students to present conclusions. • Determine if there is an opportunity for students to take action and influence others to make more informed decisions. • Have students develop strategies to persuade others, including policy makers when applicable. • Prepare students to defend their analysis against alternative.

Below is how the Technology & Industrial Arts Inquiry Process will be taught in the classroom. Be specific as you make notes of the activities or prompts you will use to ensure students will have the opportunity to practice these skills as a requirement in the Grade 10 content standards.



Technology & Industrial Arts Enquiry

1. **Developing Questions and Planning Inquiries**
   a. *Constructing Essential Questions*
   - Address essential questions that reflect an enduring issue in the field
   b. *Constructing Supporting Questions*
   - Explain how supporting questions contribute to an enquiry.
   c. *Determining Helpful Sources*
   - Develop new supporting and essential questions through investigations, collaboration and using diverse sources.

2. **Evaluating Sources and Using Evidence**

   a. *Gathering and Evaluating Sources*
   - Gather and evaluate information from multiple sources while considering the origin, credibility, point of view, authority, structure, context and corroborative value of the sources.
   b. *Developing Claims and Using Evidence*
   Identify evidence that draws information from multiple sources to revise or strengthen claims.
   - Communicating Conclusions and Taking Informed Action
   c. *Communicating Conclusions*
   - Construct and evaluate explanations and arguments using multiple sources and relevant, verified information.
   d. *Critiquing Conclusions*
   - Articulate explanations and arguments to a targeted audience in diverse setting.
   e. *Taking Informed Action*
   - Use interdisciplinary lenses to analyse the causes and effects of and identify solutions to local, regional or global concerns.
   - Use deliberative processes and apply democratic strategies and procedures to address local, regional or concerns and take action in or out of school.

5. Literacy Skills

A strong emphasis must be placed on various types of literacy, from financial to technological, from media to mathematical, from content to cultural. Literacy may be defined as the ability of an individual to use information to function in society, to achieve goals and to develop her or his knowledge and potential. Teachers emphasise certain aspects of literacy over others, depending on the nature of the content and skills they want students to learn.

The following literacy skills are intended to be exemplary rather than definitive;

Types of Literacy Skills – Skills in basic literacy, digital literacy and financial literacy
• Define and apply discipline-based conceptual vocabulary • Describe people, places, and events, and the connections between and among them • Arrange events in chronological sequence • Differentiate fact from opinion • Determine an author's purpose • Determine and analyse similarities and differences • Analyse cause and effect relationships • Explore complex patterns, interactions and relationships • Differentiate between and among various options • he ability to locate, evaluate and use digital information. • The ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills • The ability to effectively and critically navigate, evaluate and create information using a range of digital technologies. • Making choices about personal finances and having the skills to make decisions that will have positive outcomes. • Effectively use financial skills • Improve personal financial management skills • Improve budgeting and investing skills • Create a savvy relationship with money application skills • Create a lifelong journey of learning for education is the key to success when it comes to money • Effective use financial skills • Improve personal financial management skills • Improve budgeting and investing skills • Create a savvy relationship with money application skills • Create a lifelong journey of learning for education is the key to success when it comes to money

6. Numeracy Skills

Numeracy skills refer to the ability to use, interpret and communicate mathematical information to solve real-world problems. These include the ability to understand basic math like addition, subtraction, division and multiplication. More advanced numeracy skills incorporate the use of graphical, spatial, statistical and algebraic concepts and the ability to interpret that data and apply it to real-world situations.

Types of Numeracy Skills – skills that are driven by the basic mathematical aspects
• Basic knowledge of numbers • Calculation skills • Budgeting • Interpreting mathematical information • Understanding the relationships between numbers • Understanding trends • Measurement and data analysis

7. High Level Thinking Skills

These skills include analysis, synthesis, and evaluation skills.

i. Analysis Skills – Analysis skills involve examining in detail and breaking information into parts by identifying motives or causes, underlying assumptions, hidden messages; making inferences and finding evidence to support generalisations, claims, and conclusions.

ii. Synthesis Skills – Synthesis skills involve changing or creating something new, compiling information together in a different way by combining elements in a new pattern proposing alternative solutions.

iii. Evaluation Skills – Evaluation skills involve justifying and presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on set criteria.

Key Words				
Analyse	Differences	Find	Reproduce	Similar to
Appraise	Discover	Focus	Motivate	Simplify
Arrange	Discriminate	Function	Omit	Take part in
Assumption	Discussion	Group	Order	Test for
Breakdown	Distinction	Highlight	Organise	Themewebbing
Categorise	Distinguish	In-depth	Point out	Create
Cause & effect	Dissect	Inference	Research	Innovate
Choose	Divide	Inspect	See	Design
Classify	Establish	Isolate	Select	collaborate
Comparing	Examine	Investigate	Separate	recreate
				networking

Curriculum Integration

An integrated curriculum is described as one that connects different areas of study by cutting across subject-matter lines and emphasising unifying concepts. Integration focuses on making connections and linkages in content for students, allowing them to see the importance of all subjects in the curriculum. When students are able to see and understand the linkages between different subject matter, they engage in relevant, meaningful activities that can be connected to real life.

Curriculum integration is a holistic approach to learning thus curriculum integration in SBC will equip students with the essential 21st Century knowledge, skills, values and attitudes. Teachers must develop intriguing curriculum by going beyond the traditional teaching of content based or fragmented teaching to the teacher who is knowledge based and who should be perceived as a 21st Century innovative educator.

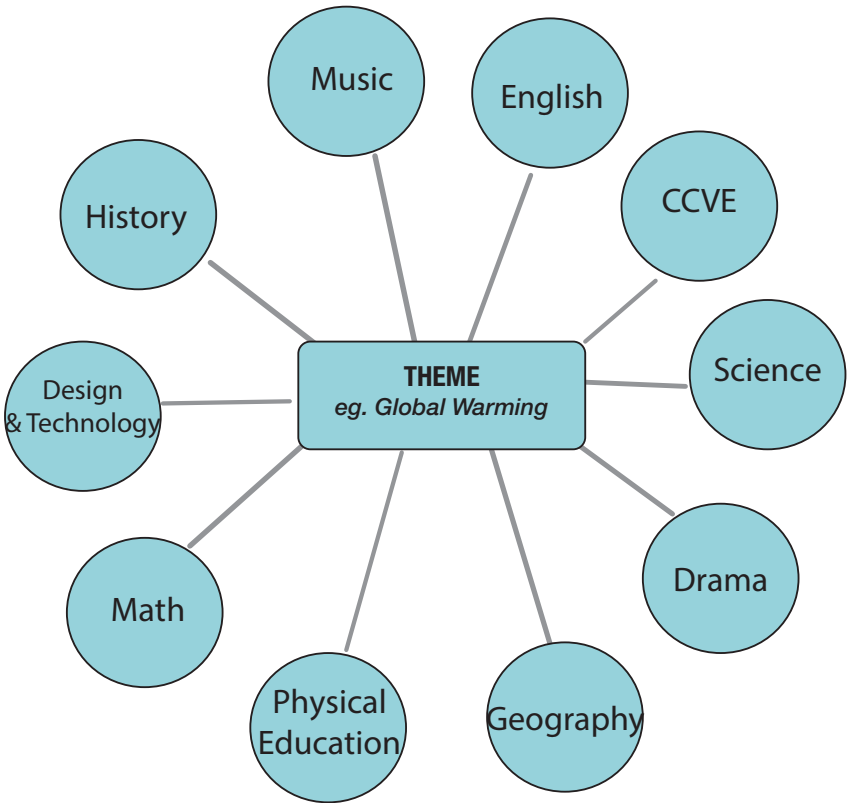
There are three approaches that SBC will engage to foster conducive learning for all children whereby they all can demonstrate proficiency at any point of exit. Adapting these approaches will have an immense impact on the lives of these children as they will not only see themselves as catalyst of change for a competitive PNG but also, comparable to the world standards as global citizens.

Engaging these three approaches in our curriculum will surely sharpen the knowledge and ability of each child, allowing them to see themselves as assets through their achievements and as agents of change contributing meaningfully to their country.

Integrated learning will bear a generation of knowledge-based populace who can solve problems and make proper decisions based on evidence. Thus, PNG can achieve its goals like the Medium Term Development Goals (MTDG) and aims such as the Vision 2050 for a happy, healthy and wealthy society whereby, all its citizens should have access and fair distribution to income, shelter, health, education and general good and services improving the general standard of living for PNG in the long run.

(i) Multidisciplinary Approach

In this approach, learning involves a theme or concept that will be taught right across all subject area of study by students. For instance, if the theme is “Advocacy for active Citizenship and Participation”, all subject areas create lessons or project-based learning and assessment as per their subjects around this theme. The content of the theme ““Advocacy for active Citizenship and Participation” will be taught right across all the different subjects through the different Benchmarks as shown in the diagram and table below.


Music
English
History
CCVE
THEME
eg. Global Warming
Science
Design
& Technology
Drama
Math
Physical
Education
Geography

Sample Curriculum Integration Outline of Linkages

THEME: "ADVOCACY FOR ACTIVE CITIZENSHIP AND PARTICIPATION"		
SUBJECT: CHRISTIAN AND CITIZENSHIP VALUES EDUCATION		**GRADE: 12**
STRAND 3: CHRISTIAN CITIZENSHIP AND SOCIETY		
UNIT 1: Christian Civics Systems		
TOPIC: Christian civic organizations use technology to advocate for good health, better education and for protection of the natural environment and its sustainability.		
Subject	**Benchmark**	**Concept of focus to learn and assessed for the Theme**
CCVE	**12.3.1.4** Inquire and discuss how Christian civic Organizations use technology to advocate for good health, better education and for protection of the natural environment and its sustainability.	How Civic Organizations use technology to advocate for protection of the natural environment and its sustainability
Agriculture	**12.3.1.4.3** Suggest ways for improving problems that a□ect conservation in Papua New Guinea	Improving Conservation problems in PNG as Citizens
Arts	**12.3.3.2** Conduct research and create artworks to advocate for social change. **12.1.2.2** Use a range of techniques and technological tools in a variety of applications relating to music to communicate a theme.	Use data from research to create artwork to advocate for active Citizenship Use Music Technological Tools to communicate active Citizenship
Business Studies	**12.4.2.9**. Establish the e-business by creating a website or using a mobile application (apps) using the Apple operating system (App Store) or Google Android operating system (Google Play).	Create a website or a mobile application to as a platform to advocate for active Citizenship[p
Character and Social Development		
English	**12.2.6.2:** Take advantage of technology's capacity to link to other information and to display information flexibly and dynamically. **12.5.4.2:** Give a clearly articulated, well-structured presentation on a complex topic.	How to display Citizenship information flexibly and dynamically with use of technology. Do a clearly articulated, well-structured presentation on active Citizenship

Mathematics	**12.4.4.3** Use appropriate technology to aid concept development as a tool for problem solving. (General Maths) **12.1.1.5** Apply quadratic equations to solve real-world situations and complex number problems. (Advance Math)	Application of quadratic equations to solve real-world situations as part of active citizenship Use appropriate technology as a tool for problem solving when they engage as active citizens in real life situations
Physical Education	**12.2.2.2** Distinguish and illustrate sporting greats of PNG in respect to their contribution in the country	How they can actively participate as sporting greats to model active citizenship participation
Science	**12.2.1.6** Investigate human population growth by comparing recent and future population growth in developed and developing countries (Biology)	Use of data from investigations to compare human population growth and use the information to participate in informed decision making
Social Science	**12.1.4.6**. Critique various national and global strategies, agenda, and actions for addressing climate change. (Geography) **12.2.4.2.** Examine the different ways the United Nations promote change and maintain stability in different regions of the world. (Political Science) **12.3.3.1** Identify and appraise the different ways people from different cultures, religions, and ethnic and ideological backgrounds relate to each other (History)	Use of strategies to actively participate in addressing climate change Understanding of how UN maintains stability to be able to actively advocate for understanding of world peace Learn how common grounds of understanding and relationships minimizes differences in cultures, religions, and ethnic and ideological backgrounds and advocate for tolerance
TIA	**12.5.2.4;** Describe the characteristics of client site scripting and creating interactive menus (Computer Tech)	The use of site scripting to create interactive menus for advocacy on issues of national and global interest as part of active citizenship participation

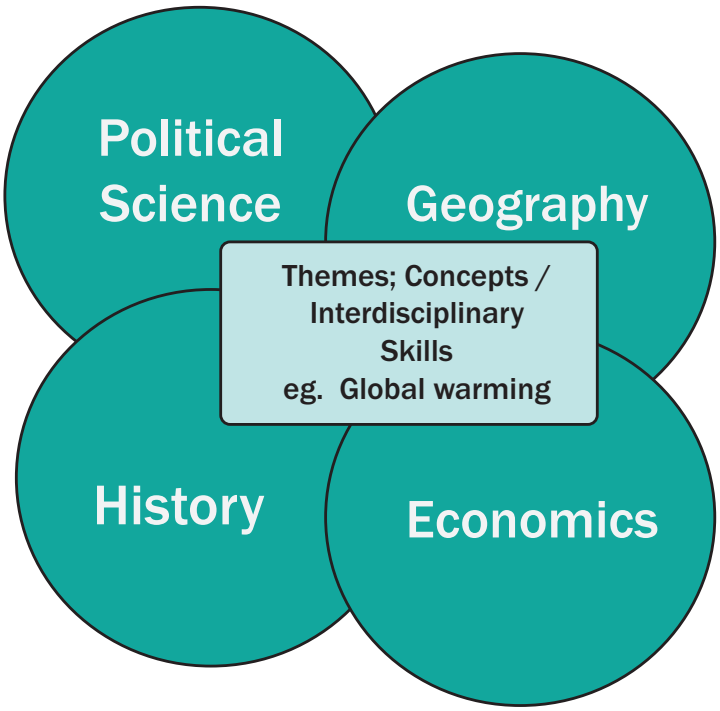
Planning for assessment will be a collaborative effort of all the subject teachers who wish their students to be part of the project with the CCVE subject Teacher as the overall coordinator of the Project and leading the Team.

See the process of this assessment in the Assessment Section.

(ii) Interdisciplinary Approach

This approach addresses learning similarly to the multidisciplinary approach of integrated learning whereby learning takes place within the subject area. It is termed interdisciplinary as the core curriculum of learning is interwoven into each subject under study by the students. For instance; in CCVE, under the strand "Governance and Leadership" students will learn the different types of leadership and common governance principles cut across the different leadership styles they will learn. Apart from learning these, students learning in CCVE are expected to use the application of writing, speaking and communication presentation skills in writing text types in their essay, such as argumentative essay, informative, explanatory, descriptive, expository and narrative essay, oral presentations and speech delivery in debates, advocacies and awareness campaigns. They must be able to capture the mechanics of English skills such as grammar, punctuation etc... Though these skills are studied under English, they are considered as core skills that cut across all subjects under study.

Therefore, essential knowledge, skills, values and attitudes comprising the core curriculum are interwoven and provide an essential and holistic framework for preparing all students for careers, higher education and citizenship in this learning.



(iii) Intra-disciplinary approach

This approach involves teachers integrating sub-disciplines within a subject area. For instance, within the subject CCVE, the four different strands will all be captured studying a particular content for CCVE. For example, under the Civic Systems and Principles, students will learn about civic different identities of different contexts and their participation likewise in the other 3 strands. Thus, children are well aware of their responsibility in active civic participation.

(iv) Trans-disciplinary Approach

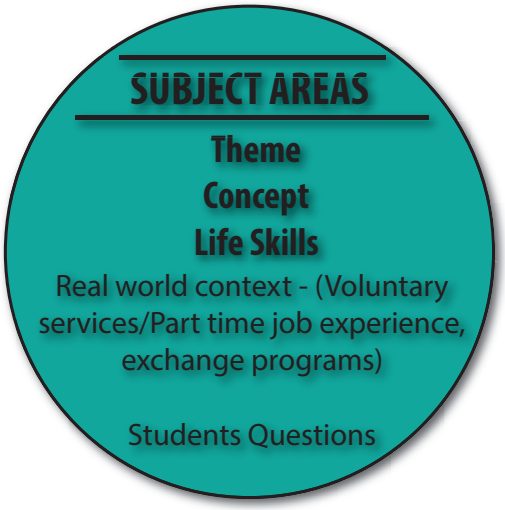
In this approach learning goes beyond the subject area of study. Learning is organised around students' questions and concerns. That is, where there is a need for change to improve lives, students develop their own curriculum to effect these needs. The Trans-disciplinary approach addresses real-life situations thus gives the opportunity to students to attain real life skills. This learning approach is more to do with Project–Based Learning also referred to as problem-based learning or place- based learning.

The three steps to planning project-based curriculum (Chard 1998).

1. Teachers and students select a topic of study based on student interests, curriculum standards, and local resources.
2. The teacher finds out what the students already know and helps them generate questions to explore. The teachers will also provide resources for students and opportunities to work in the field.
3. Students share their work with others in a culminating activity. Students display the results of their exploration and review and evaluate the project.

For instance; students may come up with slogans for school programs such as 'Our culture – clean city for a healthier PNG'. The main aim could be to curb betel nut chewing in public areas especially around bus stops and local markets. Here, students draw up their own instructions and criteria for assessment which is they have to clean the nearest bus stop or local market once a week throughout the year. They also design and create posters to educate the general public as their program continues. They can also involve the town council and media to assist them especially to carry out awareness. Studies (Susan M. Drake and Rebecca C. Burns) have proven that Project based-programs achievements have led to the following:

- Students go far beyond the minimum effort.
- Make connections among different subject areas to answer open-ended questions.
- Retain what they have learnt.
- Apply learning to real-life problems.
- Have fewer discipline problems.
- Lower absenteeism (Curtis, 2002).



These integrated learning approaches will demand for teachers to be more proactive in order to improve students learning and achievements. In order for SBC to serve its purpose fully; these three approaches must be engaged for better learning for the children of Papua New Guinea now and in the future.

Teaching and Learning Strategies

Technology & Industrial Arts emphasises and embraces the use of cognitive, reasoning, decision-making, problem solving and higher level thinking skills to teach to enhance students' understanding of inter-disciplinary concepts and issues in relation to environment, geography, history, politics and economic within PNG and globally.

It aims to provide a meaningful pedagogical framework for teaching and learning essential and in demand knowledge, skills, values, and attitudes that are required for the preparation of students for careers, higher education and citizenship in the 21st Century.

Students must be prepared to gather and understand information, analyse issues critically, learn independently or collaboratively, organise and communicate information, draw and justify conclusions, create new knowledge, and act ethically.

Teaching and learning is a two-way interactive interaction between teacher and a student , a student to a student/students and occurs in any learning environment in or outdoors depending on the nature of teaching strategies learning activities and performance assessments teachers plan to use in the delivering of the lesson.

Technology and Industrial Arts teaching and learning takes on a **blended perception and practices** of its content delivering with envisioning intentions to reinforce evidence based learning. It embraces these in the classrooms whereby each technology strand content in the form of content standards, benchmarks and performance standards direct or determine the planning of the types of learning situations and activities, assessments throughout the school year.

These standards, including the specific knowledge skills and attitudes ,how they are planned for students learning and performance attainment purposes in the respective grade levels are through highly commended teaching, learning and assessing strategies. For example; using blended learning strategies. This is where/when the traditionally recognised strategies(teacher centred) is blended with using e-teaching/learning strategies(online using smart phones) to learn about properties of fabrics, in a Textile Technology strand lesson.

Teaching strategies

Find listed for your convenience are identified teaching strategies commended for TIA subject lesson deliveries lessons However teachers can blend these in with the existing or current teaching practices using technology.

- Use of multimedia for content research.
- Utilisation of social media for fact finding on particular technology .
- Using variety of resources for meaningful teaching .
- Making most of games in electronic devices for learning.
- Use technology to empower students and reach out.

Learning Strategies

These are suggested learning strategies that can be used across the learning of all the five content strands in TIA subject.

- Using multiple types of instructional materials for learning
- Incorporate technology for reinforcement and motivation for learning
- Try new learning techniques for
- Keep your traditional teaching methods
- Vary your assessments
- Mix up group work styles
- Try a digital curriculum

Classroom assessment strategies

- Find for your convenience suggested assessment strategies to assess technology curriculum content.
- Clarifying learning intentions and criteria for success.
- Engineer effective classroom-based questioning and discussions on performance tasks that provoke or draw out evidence of learning.
- Constantly provide feedback that move learners forward.
- Present or address students as instructional resources for each other,
- Computer assisted video-based test

All Teachers teaching TIA from grades 9-10 and Construction Technology in Grade 11 and 12 are encouraged to also add to this list for the good of their student's learning.

TIA Classroom

This classroom will be a learning environment prepared especially for the teaching and learning of TIA subject. As we are moving through the 21st century technology era, TIA classrooms must reflect shadow image to encourage the teaching and learning of all the strands in the subject content.

It is suggested that teachers and students could work together to ensure that this technology classroom tips could be accommodated. These are:

- Regularly keep updates on new advancements in technology.
- Ongoing Effective Evaluation on an Ongoing Basis.
- Make Technology a Treat & Not an Expectation.
- Monitor closely usage of electronic devices .
- Set ground rules for all.
- Share knowledge on how to get technical support.
- Communicate with parents.
- Familiarise yourself with the Technology First aid.
- Use of Technology by students.

These teaching and learning strategies will help teachers to;

- familiarise themselves with different methods of teaching in the classroom,
- develop an understanding of the role of a teacher for application of various methods in the classroom.

Successful teachers always keep in view that teaching must "be dynamic, challenging and in accordance with the learner's comprehension. He/she does not depend on any single method for making his/her teaching interesting, inspirational and effective".

Please find a list of the different teaching and learning strategies in the Appendix.

These strategies;

- make learning more engaging,
- make learning more effective,
- make learning fun,
- encourage higher motivational level,
- improve attention spans,
- develop higher order thinking and reflective skills,
- improve communication skills,
- develop the spirit of teamwork /collaboration,
- develop leadership skills and qualities, and
- encourage discovery learning.

Therefore, teachers are encouraged to utilise the suggested strategies as well as others.

Strands, Units and Topics

This section of the teacher guide contains the Technology and Industrial Arts: Construction Technology content to be taught in grade 9. It consists of;

- a brief explanation of how the topics, learning objectives and lesson topics are derived.
- an overview of the content distributed according to the four terms in an academic year;
- the unit of work per strand

Technology and Industrial Arts is organized around five main strands – Textiles, Food, Construction, Communication, and Computer of which Construction Technology is one strand. These strands embed the content that students are expected to learn and master at each grade and school level. National content standards are benchmarked at each grade level, which allows for essential KSAVs to be reinforced and expanded throughout the grades.

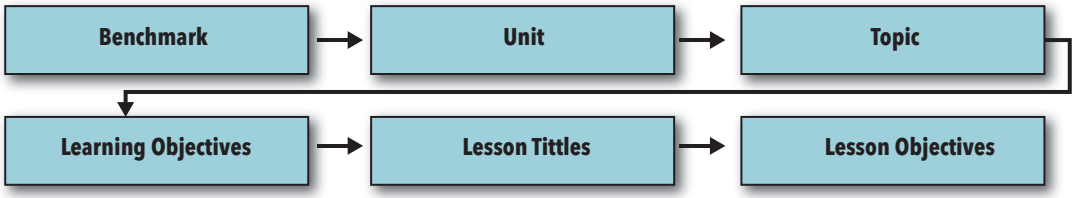
Benchmarks show grade level expectations of what students are able do to demonstrate that they are making progress towards attaining the content standard.

These grade-level benchmarks were then unpacked to identify the topics, learning objectives and the lesson topics. Below is a description of how topics were derived from the grade-level benchmarks.

Identifying topics from benchmarks

In order to identify the topic from the benchmark, we need to unpack the benchmark. When we unpack a benchmark, we are identifying what students will know and be able to do when they have mastered the benchmark.

1. Write out the benchmark that you want to unpack.
2. Write the verbs (skills/actions) – Higher order thinking skills
3. Underline or highlight the big idea (content) in the benchmark. The big idea (content) is the topic derived from the benchmark.
4. Write essential questions that would be engaging for students
5. Develop sub-topics from the big idea (topic)
6. Write learning objectives according to the sub-topics
7. Write lesson Topics from the learning objectives



Content Overview

The teaching and learning of Construction Technology in Grades 10 will follow the outline of content for the four terms in a year as a strand within the Technology and Industrial Arts.

This is only a sample to guide teachers as to how they are going to plan and teach the five strands in Technology and Industrial Arts in a school year.

TERM	STRAND	UNIT	CONTENT STANDARD
1	**Textiles Technology**	Fibres and Fabrics	**CS1.1** Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.
		Textiles and Clothing	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions.
	Food Technology	Food and Nutrition	**CS2.1** Examine and analyse the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on their production and compliance with ethical principles and standards.
		Food Science	**CS2.2** Investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (eg, health, occasions, lifestyle, business).
2	**Construction Technology**	Building Technology	**CS3.1** Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.
		Electrical Technology	**CS3.2** Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

		Plumbing Technology	**CS3.3** Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.
		Welding Technology	**CS3.4** Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.
		Engineering Technology	**CS3.5** Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.
3	**Communication Technology**	Data Communication and Network	**CS4.1** Investigate and analyse communication technology utilising multi-media and the practices and systems in designing, installing, configuring and managing networks.
		Computer Security and Safety	**CS4.2** Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society.
4	**Computer Technology**	Computer Architecture	**CS5.1** Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.
		Computer Software	**CS5.2** Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.

Strand 3: Construction Technology

This strand consists of five (5) units. They are;

- Building Technology
- Electrical Technology
- Plumbing Technology
- Welding Technology
- Engineering Technology

UNITS	TOPICS
Unit 1. Building Technology	Topic 1:The history and theory of buildings Topic 2: Building construction materials Topic 3: Trade drawing Topic 4: The Elements of Occupational Health and Safety Topic 5: Building Standards and regulations Topic 6: Mathematics and Science in Building Structures
Unit 2: Electrical Technology	Topic 1: History of Electricity Topic 2: Workplace and Electrical safety Topic 3: Electrical or Electronic processes and products Topic 4: Fundamentals of electricity Topic 5: Components and devices used on circuit diagrams Topic 6: Circuits Topic 7: Electrical Fundamentals
Unit 3: Plumbing Technology	Topic 1: Fundamentals of plumbing Topic 2: Occupational Health and Safety Topic 3: Plumbing tools and equipment Topic 4: Trade Drawing In Plumbing
Unit 4: Welding Technology	Topic 1: Topic 1: Workshop organisation Topic 2: Welding principles, codes and standards. Topic 3: Measurement techniques Topic 4: Properties of Metal Topic 5: Cutting & Welding
Unit 5: Engineering Technology	Topic 1: Historical aspects of Engineering Topic 2: Introduction to Engineering Topic 3: Engineering Fields Topic 4: Engineering Principles and practices Topic 5: Occupational Health & safety Topic 6:Engineering Design Process Topic 7: Engineering Communication

Unit 1: Building Technology

Unit	Benchmark	Topics	Lesson Titles
1. Building Technology	**9.3.1.1**	Topic 1: The history and theory of buildings	1.Introduction to Building 2.Theory of Buildings 3. Types of Buildings 4. Importance of building and career paths.
	9.3.1.2	Topic 2: Building construction materials	1. Introduction to Building materials 2. Variety of materials used 3. Timber 4. Bricks and Concrete 5. Metal and steel
	9.3.1.3	Topic 3: Trade drawing	1. Trade drawing 2.Types of trade drawing 3.Isometric drawing 4.Pictorial drawing 5.Orthographic drawing 6.Types of lines use
	9.3.1.4	Topic 4: The Elements of Occupational Health and Safety	1. Occupational Health and safety 2.The regulations and standards of OHS
	9.3.1.5	Topic 5: Building Standards and regulations	1. Building legislations and regulations 2.Types of building codes 3.Types of building regulations
	9.3.1.6	Topic 6: Mathematics and Science in Building Structures	1. Science in Math in Foundation 2. Science in Math Substructure 3. Super -structure 4. Applied Math 5. Building Defects

Grade 9

Construction Technology

Teaching Content

UNIT 1. Building Technology

Content Standard 3.1. Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 9.3.1.1 Investigate the history and theory of Building

Topic 1: The history and theory of buildings

Learning Objectives

By the end of this topic, the students will be able to;

1. Describe technological and cultural contexts and the history of building.
2. Describe the theory of building and the craft of old and new technologies, and the good practices.
3. Discuss the principles of building with illustrations of the old and new processes

Essential Questions:

1. What are the principles of building?
2. How does technology exist in a cultural context with deeper connections to building?
3. What is the holistic understanding of building that paves the way for designs?
4. What is invention in building technology?
5. How have the theory of building evolved in history?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skill	Value	Attitudes
The principles, history and theory of building	inquiry and research	Craft of New and Old Technologies: good practice and new processes	Appreciate history and design of buildings

Technology and Industrial Arts Application: Construction Technology, Building Construction

Content Background

Introduction to Building

Introduction

When designing a building, an architect plans for spatial, environmental and visual requirements. Once these requirements are satisfied, it is necessary to detail the fabric of the building. The choice of materials and
the manner in which they are put together to form building elements, such as the foundation, walls, floor and roof, depend largely upon their properties relative to environmental requirements and their strength. The process of building construction thus involves an understanding of: the nature and characteristics of a number of materials; the methods to process them and form them into building units and components; structural principles; stability and behaviour under load; building production operations; and building economics. Different socio-economic conditions and cultural beliefs are reflected in varying local building traditions.

http://www.fao.org/3/i2433e/i2433e05.pdf

Different types of building

What Is Building?

Any enclosed or open space with a roof, sidewall, foundation, W.C. & bath, etc., is called a Building.

In these, tents, tarpaulin shelters and slums without foundations, walls and rigid roof erected for temporary and ceremonial occasions shall not be considered as buildings, even when they are used for longer periods

1. **History of building**

The history and theory of buildings- The history and theory of building is basically refers to as the history of building from the ancient times to modern building concepts. There are two concepts to discuss on the building history; modern concept, traditional concept and the Importance of career pathways of the building trade.

2. Theory of building

2.1. Principles of Building

I. Cultural Context: Technology exists within a cultural context. Therefore, contemporary building technology derives of a rich historical and cultural evolution of technique and form that enlarges the ability to design intelligently.

II. Holistic Building: Understanding individual building components and the details demands understanding the guiding architectural intentions, performance requirements, process of manufacture and assembly, and systematic organisation of various building assemblies.

III. Invention: Architectural invention is the medium for the determination of form at all scales and permeates the physical architectural result. The making of details is *not a deterministic* process that seeks to optimise a singular solution.

iv. Importance of building and career pathways: The Building Construction is vital Trade that needs to be taught basic knowledge and skills to students in schools to bring development to a community and society in terms of infrastructure to improve the living standards of people both rural and urban areas.

.**Types of Buildings**

Building Structures types are as follows,

1. Residential buildings
2. Educational buildings
3. Institutional buildings
4. Assembly buildings
5. Business buildings
6. Mercantile buildings
7. Industrial buildings
8. Storage buildings
9. Hazardous building

1. Residential Buildings

Residential buildings are those in which at least sleeping facility is provided for normal residential purposes, with or without cooking and dining facilities (except institutional buildings). It includes single or multi-family dwellings, apartment houses (flats), lodgings or rooming houses, restaurants, hostels, dormitories and residential hotels.

2. Educational Building:

These include any building used for school, college or day-care purposes involving assembly for instruction, education or recreation and which is not covered by assembly buildings.

3. Institutional Buildings:

Institutional buildings are used for various purposes such as medical treatment other treatment or care of persons suffering from physical or mental illness, disease or infirmity, care of infants or old age persons care, and for penal or correctional detention in which the liberty of the inmates is restricted.

The institutional buildings are major includes sleeping accommodation for the occupants. They include hospitals, sanitoria, custodial institutions, or penal institutions like jails, prisons, and mental asylums.

4. Assembly Buildings:

These are the buildings where groups of people meet or gather for amusement, recreation, social, religious, political, civil, travel and similar purposes; as theatres, motion picture houses, marriage halts, town halls, auditoriums, exhibition halls, assembly halls museums, skating rinks, city halls gymnasiums, restaurants (also used as assembly halls), places of worship, dance halts, dub rooms, passenger stations and terminals of air, surface and other public transportation services, recreation places and stadia etc.

5. Business Buildings

These buildings are used for the transaction of business (other than that covered by mercantile buildings), for the keeping of accounts and records, and for similar purposes; offices, banks, professional establishments, courthouses, and libraries. The major activities in this type of building are the transaction of public business and the keeping of books and records.

6. Mercantile Buildings

This type of building used for selling a small product in which small shops, stores, market, for display and sale of merchandise either wholesale or retail, office, shops, and storage service facilities incidental to the sale of merchandise and located is known as Mercantile building.

7. Industrial Buildings

Type of building in which raw material process and material fabrication, processing or assembly plants, laboratories, dry cleaning plants, and power plants, pumping stations, smokehouses, laundries, gas plants, refineries, dairies, and sawmills.

8. Storage Buildings

Storage buildings are those in which material is stored or sheltering facilities are provided for goods like wares or merchandise. This building also being used for handling highly combustible material in warehouses, cold storage plants, freight depots, transit sheds, storehouses, truck and marine terminals, garages, hangars (other than aircraft repair hangars), grain elevators, barns and stables.

9. Hazardous Building

The hazardous building used for storage of such material or chemical which are highly dangerous to human or it may pollute the environment.

They have majorly used storage, processing of highly combustible material handling, manufacture or explosive materials or products which are liable to burn with extreme rapidity and poisonous elements, manufacturing or processing of highly corrosive, toxic or noxious alkalies, acids or other liquids or chemicals producing flame, Poisonous, irritant or corrosive gases.

These buildings also used for material processing which produces explosive mixtures of dust.

https://civiconcepts.com/blog/types-of-buildingparticles subjected to spontaneous ignition.

The Career Pathways of Building construction

The career pathways of building construction are really broad from a simple carpenter to engineer. For example, students who have acquired these skills can find employment in building construction firms, cabinet & joinery firms, drafting/ Architecture, building estimator, building engineer/structural engineer. All these trade professions come from a simple trade carpentry, as they proceed to higher education level they will specialize to various streams and the name changes.

Construction Engineering Technology is a broad field that has many rewarding careers in several different areas of concentration. Construction Engineering Technologists work with engineers to turn ideas into workable plans used to create: roads, tunnels, bridges, airports, railroads, buildings, dams and other facilities. The technologist will learn aspects of civil engineering, architectural engineering and project/construction management. This makes the technologist unique as they carry selected knowledge of both the engineer and a construction manager.

This industry is an exciting and ever-changing field. In a career as a Construction Technologist, you will combine your creativity with the elements of technical knowledge and management skills to bring a layout or drawing to life, turning this information into a physical structure.

Construction technology has come a long way, in the past it meant things like building a cabin from logs, then daubing mud on to seal out drafts. Today, the term “construction

technology" has taken on a whole new meaning. With constantly evolving technology available, today's technologists have an ever changing selection materials for private homes and commercial projects and can use more advanced methods to ensure the strength and life of the project. Recent years have also seen an increased use of prefabricated buildings that are designed to be built in a factory, then delivered and assembled on the construction site.

There are many careers available to someone with a construction technology degree in areas such as: design, project management, land surveying, cost estimates, site supervision, inspection, and construction safety to name a few.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the history and theory of building. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Introduction to Building

Lesson Objective: Students will be able to:

1. research the history of building and outline the technologies that existed in varying cultures in PNG and abroad;
2. research and analyse the practices, processes and systems in the history of building;
3. analyse the principles of building and compare the old and the new crafts.
4. Analyse the importance of Building construction and the career pathways

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
• History of building • Technology in building in cultural contexts	Research and analysis	Appreciate history of building, structures, principles and technology	Respect the evolution of building throughout history

Teaching Strategies

Students engage in brainstorming exercise to discover the history of buildings

They then are allowed to design guiding questions that will enable them to conduct research on the history of buildings and types of buildings.

Learning Strategies

Be involved in brainstorming exercise to discover the history of buildings

Teacher	Students
Introduction	
1. Show pictures of buildings from different eras from different countries. 2. Introduce key questions What is the history of building? What are the principles of building?	1. Look through the pictures to understand building in theory and the principles of building. 2. Think about the key questions to lead into the lesson.
Body	
Activity 1 Brainstorming Activity **Activity 2** Research activity **Activity 3** Group Presentation	Do brainstorming activity Conduct research Group presentation
Conclusion	
Conclude lesson with main concepts being explained	Take lesson notes
Assessment	
Assess the research and presentation activity	Complete assessment task.

Resources

1. pictures of buildings from different eras from PNG and abroad
2. Library resources
3. Google website. Building construction text books.

Note: the internet can be used to source information for learning

---

Lesson 2: Theory of Building

Teaching Strategies

Engage students in brainstorming exercise on the definitions of building
Engage students in the discussion of different terminologies used in building

Learning Strategies

Discover different terminologies used on Building

Activity 1 Brainstorming activity on the different terminologies used on building
Activity 2 Conduct research on definitions of types of building
Activity 3 Discussions and presentation of research findings on the different types of building

Resources

Library books, building construction books
Google e-books building construction

Note: the internet can be used to source information for learning

---

Lesson 3: Types of Buildings

Teaching Strategies

Engage students in brainstorming exercise on the different types of building
Engage students in the discussion of different types of building

Learning Strategies

Discover different types of Building

Activity 1 Brainstorming activity on the different types of building
Activity 2 Conduct research on different types of building

Activity 3 Discussions and presentation of research findings on the different types of building

Resources
Ebook building construction-google.com
Library books, construction project management books
Note: the internet can be used to source information for learning

---

Lesson 4: Importance of building and career pathways.

Teaching Strategies
Engage students in brainstorming exercise on the Importance of building and career pathways
Engage students in the discussion of Importance of building and career pathways

Learning Strategies
Discover the Importance of building and career pathways
Activity 1 Brainstorming activity on the Importance of building and career pathways
Activity 2 Conduct research on four types of career pathways of building
Activity 3 Discussions and presentation of research findings on Importance of building and career pathways

Resources
Library books, construction books
E-book building construction-Google
Note: the internet can be used to source information for learning

---

STEAM Activity

Learning Objective: By the end of the topic, students will able to;

- *Create models of a building incorporating old and new crafts(STEAM).*

Making a building model

Students work in groups of 5 to create models of building. Review what students learned about the history and theory of building. Explain to students the aspects that are considered in building and how they are important. They build a building model that will stand the elements of weather. They will determine the materials to be used to have the expected outcome. Students will work in groups.

Materials Needed
Strong and sturdy pieces of timber, small nails, glue, sturdy plastics that are wavy or flat, hammer, cutter, tape measure

Steps
1. Provide the materials with those that students have been asked to provide.
2. Allow students to observe safety when building their models.
3. Students will critically decide the elements and the reasons why their models are designed in particular way.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to analyse the Introduction to Building and the types of materials used and importance of building and the career pathways. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1.Analyse the practices, processes and systems in the history of building;

a. identify the practices, processes and systems in the history of buildings.

b. analyse notes on the practices, processes and systems in the history of buildings

c. Present analysis relating to the evolution of buildings.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify the practices, processes and systems in the history of buildings.	Identify all of the practices, processes and systems in the history of buildings.	Identify most of the practices, processes and systems in the history of buildings.	Identify some of the practices, processes and systems in the history of buildings.	Identify few of the practices, processes and systems in the history of buildings.
2. Analyse the practices, processes and systems in the history of buildings	Clear and precise analysis of the practices, processes and systems in the history of buildings	Clear analysis of the practices, processes and systems in the history of buildings	Poor analysis of the practices, processes and systems in the history of buildings	Very poor analysis of the practices, processes and systems in the history of buildings
3. Present analysis relating to the evolution of buildings.	Excellent and precise presentation of analysis and well related to the evolution of buildings.	Excellent presentation of analysis relating to the evolution of buildings.	Good presentation analysis relating to the evolution of buildings.	Poor presentation of analysis and poor relation to the evolution of buildings.

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 9.3.1.2 Identify and describe a variety of construction materials, components, and processes.

Topic 2: Building construction materials

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss and examine building materials used in construction.

Essential Questions:

1. What is building materials?
2. What are the types of Timber Building materials?
3. What are the Bricks (masonry) and Concrete materials?
4. What are the Metal and Steel materials?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skill	Value	Attitudes
Building Construction materials, components and processes.	identify and describe	Appreciate	Keep up with technology changes.

Technology and Industrial Arts Application: Construction Technology, Building Technology

Content Background

Introduction to Building Materials

Building material is any material used for construction purpose such as materials for house building. Wood, cement, aggregates, metals, bricks, concrete, clay are the most common type of material used in construction. The choice of these is based on their cost effectiveness for building projects.

Many naturally occurring substances such as clay, sand, wood and rocks, even twigs and leaves have been used to construct buildings. Apart from naturally occurring materials, many man-made products are in use, some more and some less synthetic. The manufacture of building materials is an established industry in so many countries and the use of these materials is typically segmented into specific specialty trades, such as carpentry, plumbing, roofing and insulation work.

Building construction materials are materials that are used to build structures, e.g. buildings, furniture, stools, timber scaffolds etc. Most of the building material varies according to the type and the purpose of design used or being drafted for construction. The common types of

materials used such as, Timber building materials, bricks and concrete materials, metal or steel materials. They have different types, designs, sizes (specifications) that are used in particular task in building in terms of their positions or locations applied/ used.

Building materials are materials specifically the meaning of different terminology used in building construction. The specific technical terms used in building example, stumps, bearers, floor joist, framing, roof framing, rafters, purlins, fascia boards, barge boards, ridge cap, barge mold etc.

1. Timber Building materials- Timber building materials are buildings materials that are made of timbers from raw wood to a finished products (DAR/UNDAR) . The methods that are used to process timbers from wood to finished product (DAR/UNDAR) would be summarized later. They are different types of timbers, sizes, shapes that serves a certain task in construction.

2. Brick and Concrete materials-Bricks and concrete materials are building material made from masonry and concrete (cement powder, gravels, water). They are two different building materials; Bricks are masonry materials, made from cement powder and gravels, mortar powder that made a finished product. They come in different shapes, sizes and designs. The concrete materials are building materials that are made from cement powder and gravels in different sizes e.g., less than 10mm, 12mm, 25mm etc.

3. Metal and Steel materials- Building materials that are made of steel alloys, metals, by mixing with different chemicals to form a compound called Alloy steel. For example, Galvanized steel pipes, Brass pipes, fittings, etc. that are used to construct building or steel structures. They are different types, sizes, shapes of steel used in different locations or positions in building.

Building Materials				
Wood Material Timbers (DAR/UNDAR)	Stones Stone wall/clay	Concrete materials, Cement powder	Steel materials Galv. Pipes, brass	Fibre (PVC) Materials-PVC pipes ,conduit

What Is Building Materials?
"Building material is the material which is used for the construction purpose."
Each building material possess different properties like weight, strength, durability, and cost which makes it suitable for certain types of applications. The selection of material types is based on cost and effectiveness to resisting the loads and stresses acting on the structure.

The following are the building materials in construction.

1. Mud and Clay
2. Clay bricks and Blocks
3. Sand
4. Aggregates
5. Stone and Rock
6. Thatch
7. Wood and Timber
8. Fired Bricks and Clay Blocks
9. Cement
10. Fabric
11. Foam
12. Glass

13. Gypcrete
14. Metal
15. Plastics

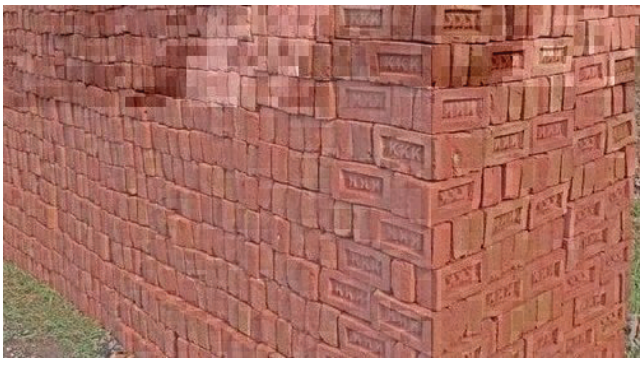
Types of Building Materials
The following are the list of building materials with pictures.

1. Mud and Clay
Mud is defined as the mixture of soil, loam, silt, or clay with the water. It generally naturally form after the rainfall near to the river or water sources. After some time the mud hardens and makes a mudstone.
As a building material mud is a semi-fluid material that can be used to coat, seal, and adhere materials. Mud referred to as with many different names by its different components like slurry, mortar, plaster, stucco, and concrete.

Mud Bricks
Generally, a mixture of subsoil and water with the addition of the stone, gravel, straw, lime, and bitumen is usually used to build walls, floors, and even roofs. In the past, the mud is usually used to plaster the building wall, construction of building walls, and use to make mud bricks.
Mud mixture with some binder like bitumen or cement called stabilized mud. It is also is known as the mudcreate, landcrete, and soil cement.

Applications
- Mud bricks
- Mud plaster
- Mud mortar
- Mud concrete

2. Clay Bricks and Blocks Types of Building Materials
The mud bricks are known as the Clay bricks. It also called as the adobe.



Clay Bricks

The mud or clay is a mixture with water and placing into the moulds and then allowing dry in the open air. As a binder straw is sometime within the bricks, it makes them a composite, if the straw does not use the bricks are easy to break, due to the straw the bricks are redistributed the force throughout the bricks and reduce the chances of breakage.
The building used this type of bricks are generally protected from the ground water.

Applications

- Mud or clay bricks are commonly used to build homes or other necessary structures.

3. Sand

Sand is a generally granular material composed of the finely divided rock and mineral particles. It also defines based on the size, being finer than gravel and coarser than silt. It one of the essential types of building materials.

Construction Sand

The most common content of the sand is silica (sio2). It is usually in the form of quartz. The second most common content is calcium carbonate.
Sand is a **NON RENEWABLE RESOURCE**, usually sand is used to making concrete.

Sources

- River sand
- Desert sand
- Beach sand
- Marine or ocean sand

Applications

1. Bricks
2. Concrete
3. Mortar
4. Paint
5. To protect against the flood the sandbags are used.
6. It also used as an abrasive in cleaning, preparing, and polishing.

4. Aggregates

Aggregates are the most commonly used material in construction. Also, the aggregates are the most mining material in the world.
Aggregate is the main component of the composite material such as the concrete and asphalt concrete. It gives the strength to the overall composite material.

Aggregate

The aggregates have high hydraulic conductivity value compare to the soil. So it widely use in the drainage application such as foundation, septic drain fields, retaining wall drains, and road side drainage.
The aggregates are commonly used for a stable foundation or a road/rail base because it have uniform properties or a low cost extender that binds with more expensive cement or asphalt to form concrete.
Generally aggregates are classified in to 2 types:-
Coarse aggregates:- >4.75 mm
Fine aggregates:- <4.75 mm

Sources
Stone quarry

Application
- Concrete:-
    - Asphalt concrete
    - Cement concrete
- Road and Rail base foundation
- Retaining wall drainage
- Roadside drainage

5. Stone or Rock
Rock is a naturally available material. It is use in construction at different places. The stone or rock which is been use in construction is hard, durable, tough and free from the weathered soft patches of materials, cracks, and other defects which reduce the strength and durability of a rock.

Types of Stone

The rocks or stone use for construction has various different application based on their properties.

Some different types of rock or stone listed below:-

- Ballast
- Granite
- Sandstone
- Slate
- Laterite
- Limestone
- Marble

Sources

- Stone quarry

Application

Ballast

- Road construction
- Concrete
- Rubble masonry
- Bridge piers
- Retaining walls
- Dams
- Base for rails

Granite

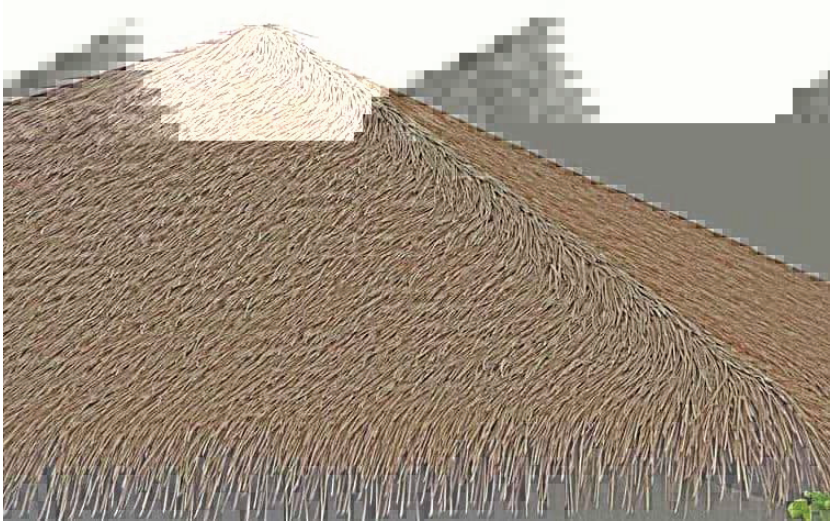
- Bridges and dams
- Retaining walls
- Curbs and stone columns
- As a kitchen platform
- Riser and trade-in staircase
- Flooring
- Door and windows framing

Marble

Ornamental works like columns, flooring, steps.

6. Thatch

With the help of dry vegetation such as straw, water reed, sedge, rushes, heather, or palm branches roof of the building is crafted is known as the thatching. Due to thatching, the shaded water does not come to the inner roof. Due to densely packed vegetation is used for the thatching it works as insulation also.



Thatch

This is a very old method which we been used for roofing. In developing countries, thatch is used in nowadays because low-cost dry vegetation is used. In developed countries, they use thatch for the elevation purpose or to gives the rustic look to their house.

The serviceability of the thatching is depends on the roof shape and design, pitch of the roof, position of roof, the quality of material used for the thatching and skill of thatcher.

Thatch is a naturally water resistance if properly maintain it does not absorb the water. On roof the slope is made up to 50* so the water is not penetrate in it and quickly drain off.

Thatch is had one property is insulation. With the help of the straw the roof gives a good performance in both the cold and warm season. It also good resistant the wind damage.

Application

Thatch is usually used for the roofing material with properties like good isolation, good water-resistant, good wind resistance.

7. Wood and Timber

Wood

- Timber is the one type of wood which is been used for the construction or carpentry purpose.
- Timber is a material which is been used from the thousands of the year.
- Wood has unique characteristics in which it builds a variety of structures.
- Wood is naturally available material.
- Wood is a good isolation material.
- Wood fabricated in all kinds of shapes and sizes.
- 30% of the total construction work timber is used.
- Timber provided good strength, toughness, durability
- Application of Timber
- Formwork
- Door/windows frame and shutters
- Cabinets
- Cupboard
- Tables and railings
- Furniture of house
- On-wall as isolation material
- Flooring
- Construction of earthquake-proof buildings

8. Fired Brick and Clay Blocks

- Generally Fired bricks made from the fire clay and is used for the high temperature construction likes kilns, lining furnaces.
- Fired bricks are manufacture similar to the normal bricks but in a burning process fired bricks are exposed to a very high temperatures.
- Fired bricks weighs about 30 to 35 N.
- The compressive strength of 200 to 220 kg/cm2.

- Water absorption is varies from 5 to 10%
- Fires bricks have good chemical resistance properties.

Fire Bricks

Mainly there are 3 types of fired bricks:-

- Acidic fire bricks
- Basic fire bricks
- Neutral fire bricks

Applications

- The inner surface of kilns, furnaces, and chimneys.
- Fire resistance structure
- The lining of wood-fired ovens.

9. Cement

The cement is a fine powder material, which is been use for a binder the substance and set and harden them or bind the other adheres to other material together. It old extensively used and oldest types of building material.

Cement

Generally, cement is use to bind sand and aggregates together.
In construction the cement is used for the many purpose like:-
Cement + sand = Mortar (used for the plastering or brick work)
Cement + sand + aggregates = Concrete (used for slab, columns, footing, beam)

Cement slurry (for tile works)
Cement paste (for repairing purpose)

The good cement has following physical properties

- Fineness
- Soundness
- Consistency
- Strength
- Setting time
- Heat of hydration
- Loss of ignition
- Bulk density
- Specific gravity

Cement is in the form of powder when mixed with water it sets to a hard mass. Setting and hardening result is based on the hydration, which is chemically a combination of the cement and water.
There are many types of the cement available in the market. All the cement have their own properties and own uses. Generally for the building construction the Portland cement is used.

Following are the types of the cement

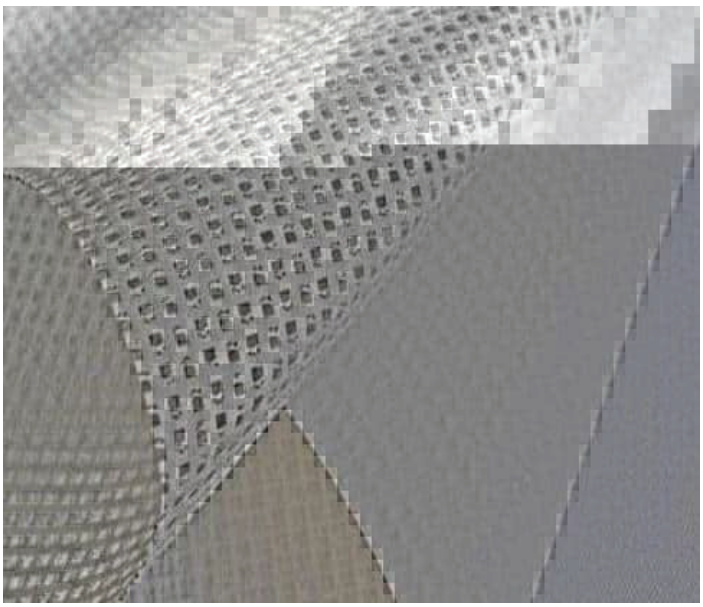
- Repaid hardening cement
- Low heat cement
- Sulphate resisting cement
- High alumina cement
- Blast furnace slag cement
- Coloured cement
- Pozzolana cement
- Air entraining cement
- Expansive cement
- White cement

Application:-

- Cement concrete for the footing, beams, columns, slab, lintels etc.
- Cement mortar for brickwork and plastering.
- Cement is use for the making joints of drain and pipes.
- For watertight structures
- Cement is use for precast structures like pipes, piles.
- Cement is use for the important structure like bridges, pipe culverts, dams, tunnels.
- Cement is use for RCC roads.

10. Fabric

In civil engineering, the use of the fabric is in many places, but nowadays fabric is used for a fabric structure which provides end users a variety of aesthetic free form building designs. Fabric structures are flame retardant, weather resistant and meet natural forces requirements.
Fabric structure is a one type of a tensile structure.
In the fabric structure the fabric used is coated and laminated with synthetic materials for increased strength, durability, and environmentally resistance.



Fiberglass Fabric
Fabric used for the structure is the following below:

- Polyesters
- Polyvinyl chloride
- Woven fiberglass coated with polytetrafluoroethylene.

Fabric have the following strength

- Tensile strength
- Tear strength
- Adhesion strength
- Flame retardancy

Fabric structure is used in traditional building in certain scenarios. No lighting is required because the fabric is translucent, which makes it an energy efficient solution.
For determining a material's suitability for the structure consider the following things:

- Shading coefficients
- General solar, optical, thermal performance data
- Acoustical data
- Colorfastness
- Cleanability

Application:

1. Awnings, tents and low tension frames structure
2. Walkways and tent halls and smaller air supported structures
3. Stadium domes

11. Foam
Nowadays, the synthetic polystyrene or polyurethane foam is used with a combination of structural materials like concrete.

Foam Insulation

- Foam is a lightweight material.
- Foam easily shaped in any form.
- Foam is a good insulator material.
- Foam is used in the house as an insulator sandwiched between the wood or cement or insulating concrete foam.

Types of Foam
1. Rigid foam
2. Spray foam

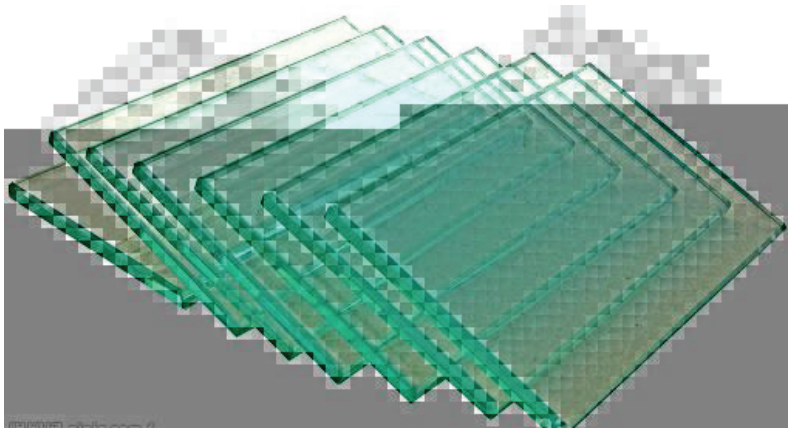
The spray foam is a chemical reaction product between the two materials isocyanate and polyresin. The reaction between these two materials can expand 30 – 60 times its liquid volume after it is sprayed in place. Expansion of the foam is generally used in the packing material which is to shape the product being packaged and produces a high thermal insulating value with virtually no air infiltration.

The following are 3 thermal properties of foam:
1. Conductive heat transfer
2. Radiant heat transfer
3. Convective heat transfer

Applications
1. Packaging application:
This type of foam is a good packing material which is used in shipping valuable fragile items and also for the protection of the sculptures, vases, large fossils, lamp bases, busts, computer or furniture.

2. Building application:
Spray foam insulation or spray polyurethane foam is used as an insulator material in the houses or buildings.

12. Glass
Glass is a product which is been made with a mixture of sand and silicates, in a very hot fire stove called a kiln and is very brittle. It is one of the widely used types of building materials. Glass is generally used in windows to cover the panel of the window with the ability to both let light into the room, at the same time keeping inclement weather outside.



Glass

Glass is nowadays used for architectural purposes in the building or the elevation of modern buildings. Curtains walls made from the glass are used to cover the entire façade of the building or also used for the span over a wide roof structure in the space frame.
The new invention of GLASS BRICK is used in a building for an elevation purpose.

The types of glass used in construction are;

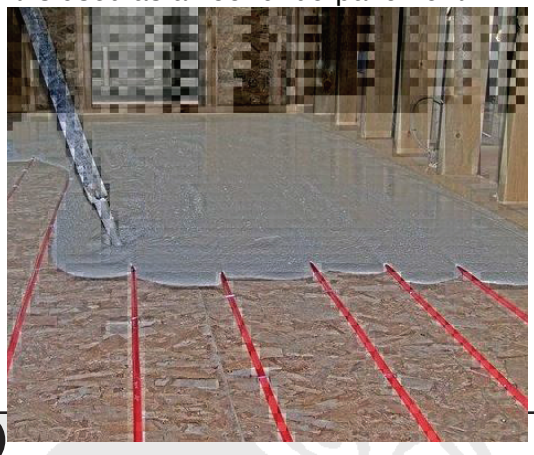
1. Float glass
2. Tinted glass
3. Toughened glass
4. Laminated glass
5. Shatterproof glass
6. Extra clean glass
7. Double glazed glass
8. Chromatic glass
9. Glass wool
10. Glass blocks

Applications of Glass in Construction

- Float glass is used as shop fronts, glass blocks, railing partitions.
- Laminated glasses are used in glass facades, bridges, staircases, floor slab, etc.
- Shatterproof glass is used in skylight, window, and in flooring.
- Extra clean glass is used for the elevation purpose.
- Double glazed glass use for an insulation purpose.
- Chromatic glass is used in meeting rooms and ICUs.
- Glass wool is used in filler or insulator in building, it is also used as a soundproof.

13. Gypcrete

As a new building material gypcrete or the gypsum concrete is a mixture of gypsum plaster and fiberglass roving.
It is used as a floor underpavement.



Gypcrete

Gypcrete is generally used in the building in a wood frame and concrete construction with properties of fire ratings, sound reduction, radiant heating, and floor leveling.
The architects and designers have suggested the gypcrete as a flooring material nowadays because it has many good properties and benefits than the other building materials.
Some benefits of the gypcrete are listed below:

- Lightweight
- Easy to install
- Affordable
- Partially fire resistant

Applications

1. Flooring
2. Ceilings
3. Rapid wall

14. Metal and Steel

Metal or steel is the second most common building material after concrete. It is one of the most useful and strong types of building materials.
There are many types of metal present in the market. The following is list of types of metals:

- Iron
- Cast iron
- Steel
- Stainless steel
- Wrought iron
- Aluminum
- Bronze
- Brass
- Lead

Steel Roof Shed

In the construction field the steel is a commonly used material. The primary purpose of the steel is to form a skeleton for the building or structure essentially the part of the structure that holds everything up and together.
There are many advantages of the steel; malleability, ductility, elasticity, hardness, brittleness, conductivity.
Steel is also used as reinforcement in the concrete. It gives the tensile strength to the component. Concrete is poor in tensile strength so the steel reinforcement is used.

There are 2 types of steel used in construction:
1. Structural steel (mild steel)
2. High yielding strength Deformed steel

Structural steel is generally use in a construction of steel structure like roofing truss, sky scrapers, industrial buildings, cold storages, etc.
High yield strength deformed steel is used generally to make a bar, which is been used in structural members like beams, columns, footings, etc.

Applications of Steel in Construction

- Concrete Reinforcement
- Pipe fittings, manhole covers
- Floor and wall brackets for railings
- Circular stairs
- Door window Grills
- Ceiling frame or wall framing
- Roofing and accessories
- High strength bolts
- Cables for elevators
- Wall tiles
- Kitchen platforms
- Stair

15. Plastic

Today the use of plastic is more than any other material. Plastic is very light in weight and easiest for work and maintenance. It is an important type of building material.
There are many different types of plastics that are available in the market and they all have their own properties and own uses.

Plastic Pipes

The following are the properties of the plastic;

- Appearance
- Chemical resistance
- Dimensional stability
- Ductility
- Durability
- Electric insulation
- Finishing
- Fire resistance
- Fixing
- Humidity
- Maintenance

- Melting point
- Recycling
- Strength
- Thermal properties

Applications of Plastic

- Façade panels, exterior covering, carpentry
- Weather boarding
- Windows
- Rolling shutters
- Wall lining
- Floor covering
- Roof covering
- Roof tightness
- Sanitary equipment
- Insulation

For **civil construction work**, the main **building materials** are **cement, sand, aggregate, and steel**. The cement is used to make concrete and **plasterwork**. Sand used for **plastering work and concrete** making.
https://civiconcepts.com/blog/types-of-building-materials

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building construction materials. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Introduction to Building materials

Teaching Strategies
Engage students in brainstorming exercise to define building materials
Engage students in the discussion of different terminologies on building materials and building members used in building

Learning Strategies
Discover the terminologies of Building materials used

Activity 1 Brainstorming activity on the different terminologies used in building materials
Activity 2 Discover the types of building materials and their terminologies as used in the building trade
Activity 3 Discussions and presentation of findings on the different types of building materials and their terminologies as used in construction.

Resources
Use the internet to find these information
E-book building construction- google.com
Library books, construction project management books
Note: the internet can be used to source information for learning

Lesson 2: Variety of building materials

Teaching Strategies
Engage students in brainstorming exercise on the types of materials used in building
Engage students in the discussion of different types of building materials used

Learning Strategies
Discover types of Building materials used
Activity 1 Brainstorming activity on the types of building materials used
Activity 2 Conduct research on types of building materials used
Activity 3 Discussions and presentation of research findings on the different types of building materials used in construction.

Resources
EBook building construction- google.com
Library books, construction project management books
Note: the internet can be used to source information for learning

Lesson 3: Timber

Teaching Strategies
Engage students in brainstorming exercise on timber building materials used in building
Engage students in the discussion of different types of timber building materials used in building.

Learning Strategies
Discover types of Timber and their specification used
Activity 1 Brainstorming activity on the types Timbers used
Activity 2 Conduct research on different sizes and specification of timber building materials used
Activity 3 Discussions and presentation of research findings on the different types of Timbers processed for building materials used in construction.

Resources
Ebook building construction- google.com
Library books, construction project management books
Note: the internet can be used to source information for learning

Lesson 4: Bricks and Concrete

Teaching Strategies
Engage students in brainstorming exercise on Bricks and concrete material.
Engage students in the discussion of different types Bricks and concrete materials

Learning Strategies
Discover types of Bricks and concrete materials
Activity 1 Brainstorming activity on the types bricks and how they are made
Activity 2 Conduct research on types of concrete materials and type of ratio used in mixing concrete
Activity 3 Discussions and presentation of research findings on the different types bricks and concrete materials and practical applications.

Resources
E-book brick, masonry, concrete- google.com
Library books, Building construction books
Note: the internet can be used to source information for learning

Lesson 5: Metal and steel

Teaching Strategies
Engage students in brainstorming exercise on metal and steel materials.
Engage students in the discussion of different types of metals and steel materials

Learning Strategies
Discover types of metal and steel materials
Activity 1 Brainstorming activity on the types metal and how they are made
Activity 2 Conduct research on types of steel materials and their specifications
Activity 3 Discussions and presentation of research findings on the different types metal and steel materials.

Resources
EBook metal and steel metal- google.com
Library books, Building Construction books
Note: the internet can be used to source information for learning

---

STEAM Activity: Students work in groups to create building materials used in building, e.g. processing timbers from raw wood/materials. How to make bricks or blocks of 300mmx 300mm sizes.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to analyse the Building materials and the types of materials used in construction. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define building materials
2. Describe and analyse timber building materials
3. Describe and analyse Brick and Concrete materials
4. Describe and analyse Metal and Steel materials

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define building materials	Correctly define and explain all building materials	define and explain all building materials	Define and explain some building material	Do not define and explain building materials
2. Analyse and describe timber building materials	Correctly analyse and describe timber building materials	Describe timber building materials	Few describe timber building materials	Hard to describe timber building materials
3. Analyse and describe Brick and Concrete materials	Correctly analyse and describe Brick and Concrete materials	Analyse and describe Brick and Concrete materials	Poorly Analyse and describe Brick and Concrete materials	Do not analyse and describe concrete materials
4. Analyse and describe Metal and Steel materials	Correctly Analyse and describe Metal and Steel materials	describe Metal and Steel materials	Few Analyse and describe Metal and Steel materials	Hard to Analyse and describe Metal and Steel materials

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 9.3.1.3 Describe the elements of drawings, and their application in technical drawings.

Topic 3: Trade drawing

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss, identify and construct the different types of drawings in Trade drawing.

Essential Questions:

1. What is trade drawing?
2. What are the types of trade drawings?
3. What is isometric drawings?
4. What is pictorial drawing?
5. What is orthographic drawing?
6. What are the types of line used?
7. How are the elements of design related to technical drawing?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skill	Value	Attitudes
The elements of Trade drawings and their application	Accurate drawing Describe drawing	Appreciate the importance of technical drawing	Responsibility and diligence

Technology and Industrial Arts Application: Construction Technology: Building Technology

Content Background

Elements of design

- basic drawing skills
- size, shape, colour and texture
- function
- utility
- aesthetics

Technical Drawing

Technical drawings are graphic and technical communication tools. Early humans felt a need to represent the world to their peers. The appearance of technology gradually led humans to develop another use for drawing. It became a way to convey technical thought (Archimedes, Leonardo da Vinci). The industrial revolution gave rise to graphic and communication tools, which facilitated the exchange of technical information between individuals. An international organization codified some of these graphic tools so that everyone could understand them. Trade drawing or Technical drawing is sometimes referred to as the act and discipline of

composing drawings that visually communicate how something functions or is constructed. Different trades have different technical drawings to visualise something in their specific trade.

The Basics of Technical Drawing (Drafting)
Creating technical drawings is a time honored art form which is used in all fields of Engineering (Mechanical, Civil, Architectural, Electrical, Aerospace, etc.). The main purpose of technical drawings is to communicate specific information to other technical people (i.e. engineers, machinists, etc). Technical drawings give all of the information needed to make the product and being accurate in that information is the main goal. Engineers are very particular with their drawings and must pay attention to detail.

- Trade drawing is the technical drawing; drafting or drawing is the act and discipline of composing drawings that visually communicate how something functions or is constructed.
- Types of trade drawings/building plans are many including; 3D drawings (Isometric, perspective), Exploded-view 3D complete working drawing, Details drawings (2D orthogonal projections).
- Isometric projection is a method for visually representing three dimensional objects in two dimensions in technical and engineering drawings.
- Pictorial drawing is a view of an object as it would be seen by an observer who looks at the object either in a chosen direction or from selected point of view. Pictorial drawings often are more readily made and more clearly understood than are front, top, and side view of an object.
- Orthographic drawing is a clear, detailed way to represent the image of an object. It may be used by engineers, designers, architecture and technical artists to help a manufacturer understand the specifics of a product that needs to be created.

Above all, the main aim of technical drawings is to be practiced specifically on different Types of Building Plans.

- Site Plan. Site plan is comprehensive detailed drawing of the building or an apartment 00representing whole plan of a building. ...
- Floor Plan. A plan means, top view of any building or object. ...
- Cross Section. Architectural drawings that are orthographic projections of structures with a cut transecting them. This is a three dimensional view in a two dimensional view.
- Elevation. A drawing that helps the architect understands the facing of the building. The facing of the elevation includes the direction of the sunlight and wind. It also includes the height of the building as well as doors and windows.
- Landscape Plans. A floor plan for an outdoor area. It creates a visual representation of a site using scaled dimensions.

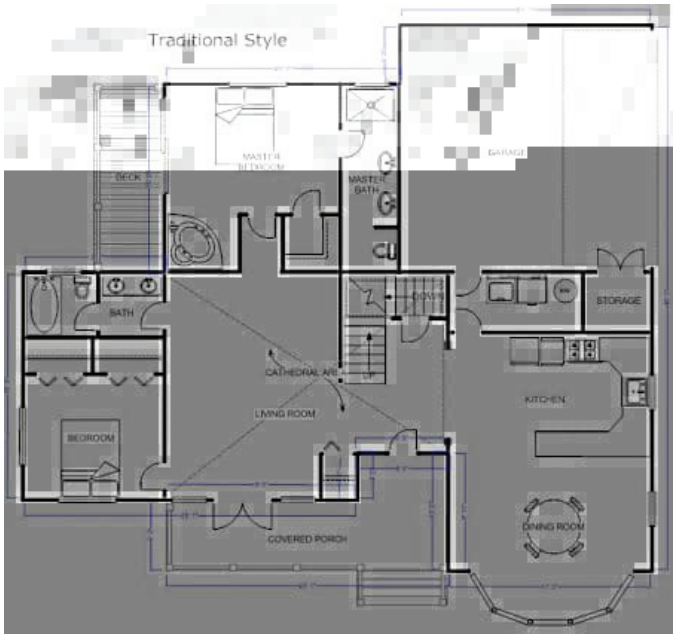
Types of Building Plan Drawings

Considering the detailing and complexity of a project, different types of drawings are issued by an architect for the easy understanding and smooth working of construction process. Some the types of drawings are discussed in depth below,

1. Site Plan

Site plan is comprehensive detailed drawing of the building or an apartment representing whole plan of a building. It shows property boundaries and means of access to the site and nearby structures if they are relevant to the design.

For a construction project, the site plan also needs to show all the services connections like drainage and sewer lines, water supply, electrical and communications cables, exterior lighting etc.



Site Plan of a house.

It's a first design that is made for any project before going into detailing process. Drawing up a site plan is a tool for deciding both the site layout and the size and orientation of proposed new buildings.

These drawings should comply with the local development codes, including restrictions on historical sites. It acts as a legal agreement for the permission of construction from the government body. For this, it is required that the site plan is made by a licensed professional like architect, engineer, landscape architect or land surveyor.

2. Floor Plan

A plan means, top view of any building or object. Floor plan is the most fundamental architectural diagram, a view from above showing the arrangement of spaces in building in the same way as a map, but showing the arrangement at a particular level of a building.

Floor plan view is defined as a vertical orthographic projection of an object on to a horizontal plane cutting through the building. This shows the walls, windows, door and other features such as stairs, fittings and even furniture too.

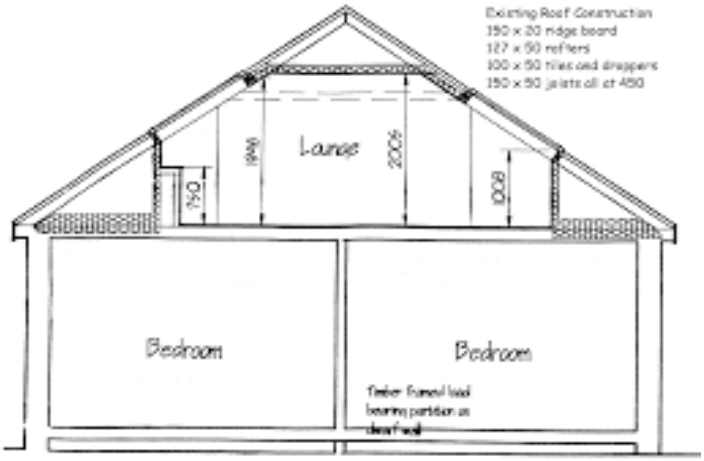
2D Floor Plan.

Floor plan is usually given in 2D form, which has all the measurements and detailing. Now a days for a better understanding and conceptualize the plan prior to the construction, floor plans are made in 3D where one can see how the entire apartment looks with furniture from above, giving you a way to see not only how objects fit in the space, but how specific furniture pieces look together.

3D Floor Plan.

3. Cross Section

Geometrically, a cross section is a horizontal orthographic projection of a building on to a vertical plane cutting through the building. Cross section is vertical cut section of any building which shows the details of dimension, thickness of any component of a building. It also represents the sill height, lintel height, floor height and other minute details of a structure.



Cross Section.

The section plane where the plan is vertically cut is represented in the 2d floor plan by a bold dotted straight line.

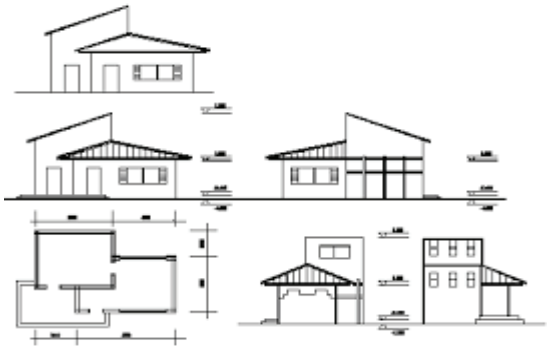
4. Elevation

An elevation drawing is an orthographic projection drawing that shows one side of the house. The purpose of an elevation drawing is to show the finished appearance of a given side of the house and furnish vertical height dimensions. Majorly it is divided into 3 types,

1. External Elevation

Exterior elevations are as- built drawings that show the exterior sides of the building, from the ground level up to the top of the structure. Together with the floor plan and roof plan, the exterior elevations round out the typical set of as-built that is mostly requested for projects. As it is the outside representation of a building, it consists of details of type of finish, floor height and projections if any.

Exterior elevations can be 2D or 3D drawings. 2D drawings typically have measurements on them, showing where the relationships between exterior elements like doors and lights. 2D elevations also can have callouts to different kinds of bricks, stones, and paints, to show exactly where each material needs to go.



Exterior Elevation

- **Landscape Plan**

A landscape design is like a floor plan for an outdoor area. Like a floor plan, a landscape design creates a visual representation of a site using scaled dimensions. Landscape

plans include natural elements like flowers, trees, and grass as well as man-made elements like lawn furniture, fountains and sheds. Landscape designs may also include overlays for irrigation and lighting.

Landscape Plan

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand the types of technical drawings. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Trade drawing

Teaching Strategies
Engage students in brainstorming exercise on trade drawing/technical drawing used in building
Engage students in the discussion of different types of trade drawing and technical drawing used in building

Learning Strategies
Discover the different definitions/meaning of trade drawing/technical drawing used in building used

Activity 1 Brainstorming activity on the types trade/technical drawing in building
Activity 2 Conduct research on different trade/technical drawing
Activity 3 Discussions and presentation of research findings on the different types of trade/technical drawing, isometric, orthographic, pictorial drawing in building construction.

Resources
E-book building Architectural books- google.com
Library books, construction Architecture, drafting books
Note: the internet can be used to source information for learning

Lesson 2: Types of trade drawing

Teaching Strategies
Students engage in brainstorming exercise to discover Types of Trade/technical drawing
They then are allowed to design guiding questions that will enable them to conduct research on the types of trade drawing
Discussions in groups on the research findings on different types of trade/technical drawing
Engage students in the discussion

Learning Strategies
Activity 1 Brainstorming activity on types trade/technical drawings
Activity 2 Conduct research on different Types of trade drawing
Activity 3 Discussions and presentation of research findings on different Types of trade drawing

Resources
Building and architecture books
Library building and drafting books

Note: the internet can be used to source information for learning

---

Lesson 3: Isometric drawing

Teaching Strategies
Students engage in brainstorming exercise to discover Isometric drawing
They then are allowed to design guiding questions that will enable them to conduct research on the Isometric drawing
Discussions in groups on the research findings on different Techniques on sketching Isometric drawing

Learning Strategies
Activity 1 Brainstorming activity on Isometric drawing
Activity 2 Conduct research on different techniques of sketching geometric drawings using Isometric drawings
Activity 3 Discussions and presentation of research findings on different isometric drawing

Resources
Building and architecture books
Library building and drafting books
Note: the internet can be used to source information for learning

Lesson 4: Orthographic drawing

Teaching Strategies
Students engage in brainstorming exercise to discover Orthographic drawing
They then are allowed to design guiding questions that will enable them to conduct research on the Orthographic drawing
Discussions in groups on the research findings on different Techniques on sketching Orthographic drawing

Learning Strategies
Activity 1 Brainstorming activity on Orthographic drawing
Activity 2 Conduct research on different techniques of sketching Orthographic drawing
Activity 3 Discussions and presentation of research findings on different Orthographic

Resources
Building and architecture books
Library building and drafting books
Note: the internet can be used to source information for learning

---

Lesson 5: Types of lines used

Teaching Strategies
Students engage in brainstorming exercise to discover types of lines use
They then are allowed to design guiding questions that will enable them to conduct research on the Types of lines use
Discussions in groups on the research findings on different Techniques on sketching drawings by using different Types of lines

Learning Strategies
Activity 1 Brainstorming activity on Types of lines
Activity 2 Conduct research on different techniques of sketching drawing using different types of lines
Activity 3 Discussions and presentation of research findings on different techniques of sketching drawing using different types of lines

Resources
Building and architecture books
Library building and drafting books
Note: the internet can be used to source information for learning

---

STEAM Activity Students work in groups to construct a different dimension of building plan and use different lines to sketch the three elevations of a gable roof house.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Trade drawing. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. define trade drawing
2. Identify types of trade drawings
3. Construct isometric drawings
4. Construct orthographic drawing
5. Construct types of line used

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define trade drawing	Exceptional description of trade drawing with examples given	Clear description of trade drawings	Unclear description of trade drawings .	No description of trade drawings
2.Identify types of trade drawings	Excellent description and illustrations of types of trade drawings	Clear description of types of trade drawings	Unclear description of types of trade drawings	No description of types of trade drawings
3.Construct isometric drawings	Excellent construction of isometric drawings with precision	Clear construction of isometric drawings with accuracy.	Unclear and inaccurate construction of isometric drawings	No construction of isometric drawings with accuracy
4.Construct orthographic drawing	Excellent construction of orthographic drawings with precision	Clear construction of orthographic drawings with accuracy.	Unclear and inaccurate construction of orthographic drawings	No construction of orthographic drawings with accuracy.

UNIT1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 9.3.1.4 Identify and describe the elements of safety

Topic 4: The Elements of Occupational Health and Safety

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss and examine OHS regulations, standards and practices in Building Technology

Essential Questions:

1. What are common elements of Occupational Health and safety
2. What are the OHS regulations?
3. What are the OHS standards?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Essential Skill:	Value:	Attitudes
OHS Regulations and Standards	Discuss and examine	Appreciate the importance of safety	Cautious and be aware

Technology and Industrial Arts Application: Construction Technology: Building Technology

Content Background

Occupational Health and Safety (OHS)

The OHS Act seeks to protect the health, safety and welfare of employees and other people at work. It also aims to ensure that the health and safety of the public is not put at risk by work activities.

SMS Safety Management System is composed of four functional components:

- Safety Policy
- Safety Risk Management
- Safety Assurance
- Safety Promotion

The Four SMS Functional Components

The essential idea of any SMS — be it a product/service provider's SMS or the SMS of the regulator responsible for safety oversight — is to provide for a systematic approach to achieving acceptable levels of safety risk. SMS is comprised of four functional components, including an intangible, but always critical, aspect called safety culture.

- Safety Policy
- Safety Risk Management
- Safety Assurance
- Safety Promotion (Safety Culture)

The four components of a SMS are:

1. **Safety Policy** — Establishes senior management's commitment to continually improve safety; defines the methods, processes, and organizational structure needed to meet safety goals
- Establishes management commitment to safety performance through SMS
- Establishes clear safety objectives and commitment to manage to those objectives
- Defines methods, processes, and organizational structure needed to meet safety goals
- Establishes transparency in management of safety
  - Fully documented policy and processes
  - Employee reporting and resolution system
  - Accountability of management and employees
- Builds upon the processes and procedures that already exist
- Facilitates cross-organizational communication and cooperation
2. **Safety Risk Management (SRM)** — Determines the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risk
- A formal process within the SMS composed of:
  - Describing the system
  - Identifying the hazards
  - Assessing the risk
  - Analyzing the risk
  - Controlling the risk
- The SRM process may be embedded in the processes used to provide the product/service
3. **Safety Assurance (SA)** — Evaluates the continued effectiveness of implemented risk control strategies; supports the identification of new hazards
- SMS process management functions that systematically provide confidence that organizational outputs meet or exceed safety requirements
- AVS SMS has a dual safety assurance focus:
  - AVS organizations
  - Product/service providers
- Ensures compliance with SMS requirements and FAA orders, standards, policies, and directives
  - Information Acquisition
  - Audits and evaluations
  - Employee reporting
  - Data Analysis
  - System Assessment
- Provides insight and analysis regarding methods/opportunities for improving safety and minimizing risk
- Existing assurance functions will continue to evaluate and improve service
4. **Safety Promotion** — Includes training, communication, and other actions to create a positive safety culture within all levels of the workforce
- Safety promotion activities within the SMS framework include:
  - Providing SMS training
  - Advocating/strengthening a positive safety culture
  - System and safety communication and awareness
  - Matching competency requirements to system requirements
  - Disseminating safety lessons learned

OHS Legislation

OHS Legislation sets out the laws about health and safety requirements affecting most work places, work activities and specified high risk plant or equipment. It defines the pathway forward to assist workplaces provide a safe working environment. The purpose of OHS legislation is to protect the worker against the hazards on the job. It outlines the general rights and responsibilities of the employer, the supervisor and the worker. The law makes both the worker and the employer jointly responsible for workplace health and safety.

OHS Regulation and Standards

OHS Legislation means all legislative requirements relating to work health and safety including as is applicable to the Vendor and/or the Goods, applicable in the place where the Delivery Location is located and any other occupational health and safety statutes enacted.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand the elements of occupational health and safety. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Occupational Health and Safety

Teaching Strategies
Students engage in brainstorming exercise to define occupational health & safety
They then are allowed to design guiding questions that will enable them to conduct research on different terms used on OHS
Discussions in groups on the research findings on the OHS terminologies.

Learning Strategies
Activity 1 Brainstorming activity on how to design guiding questions for their research on terminologies of OHS
Activity 2 Conduct research on OHS used in Building construction
Activity 3 Discussions and presentation of research findings of OHS terminology used in construction

Resource
OSHA Field
Safety and Health Manual

Lesson 2: The regulations and standards of OHS

They then are allowed to design guiding questions that will enable them to conduct research on different regulations of OHS.
Discuss in groups on the research findings of the regulations of OHS.

Learning Strategies

Activity 1 Brainstorming activity on how to design guiding questions for their research on the regulations of OHS
Activity 2 Conduct research on different regulations of OHS
Activity 3 Discussions and presentation of research findings on the different regulations of OHS

Resources

OSHA Field
Safety and Health Manual

STEAM Activity Students work in create STEAM activity that incorporates OHS in buildings.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to comply the elements of OHS. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

Define occupational health and safety
Define regulations of OHS
Explain the standards of OHS

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define occupational health and safety	Clear and precise explanation of occupational health and safety with examples of situations given from the building industry.	Clear explanation of occupational health and safety	Unclear explanation of occupational health and safety	No explanation of occupational health and safety
2.Define regulations of OHS	Clear and succinct description of regulations of OHS with examples from the building industry given.	Clear and succinct description of regulations of OHS	Unclear description of regulations of OHS	No description of regulations of OHS
3.Explain the standards of OHS	Clear and succinct explanation of standards of OHS with examples from the building industry given.	Clear and succinct explanation of standards of OHS	Unclear explanation of standards of OHS	No explanation of standards of OHS

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 9.3.1.5 Describe the scope and purpose of building codes, and identify other regulations and standards that apply to construction projects

Topic 5: Building Standards and Regulations

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse legislations, codes and regulation used in building technology.

Essential Questions:

1. What is the scope and purpose of building
2. What is the definition of Building legislations and regulations
3. What are the common types of building codes?
4. What are the types of building regulations?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skill:	Value:	Attitudes
Building scope and purpose of building codes, legislations and regulations	Implement and comply the building legislations and regulations	Importance of building legislations and regulations	Awareness and diligence

Technology and Industrial Arts Application: Construction Technology: Building Technology

Content Background

Building Standards and regulations

Building standards and building regulation are set of laws/rules, and guidelines set by the building Boards for all the construction Industries to adhere to and comply with before any structure is erected. They ensure that all the construction processes have to be followed to meet the standards of building structures regulations, durability of structure with approved designs and specifications before construction commence. The types of building Codes, building regulations, specifications have to be approved by the Building board before project commence.

A building code is a set of regulations written by city or county officials with the help of construction professionals that govern the design, construction and modification of commercial buildings, homes and other structures in the jurisdiction. Violating these regulations can result in fines and/or penalties.

Safety is a top priority of cities and other jurisdictions. Building codes tackle a variety of safety concerns such as materials that are banned or the number of fire escapes needed in a single structure. In addition, cities and counties that are prone to a certain type of natural disaster also may establish codes directly to counter that type of event. To be sure, older buildings must be brought up to current code. If they fail to be updated, a building inspector could deem them unfit to live or work in. In the case of new buildings, they must be

What are building regulations in construction?
Building regulations set standards for the design and construction of buildings to ensure the safety and health for people in or about those buildings.

Difference between building regulations and planning permission

It is generally realised that a form of permission is required for building work or alterations of properties. However, it may not always be clear how the planning and building regulations approval authorities differ.

There may also be responsibilities under the construction health and safety regulations.
Building regulations set standards for the design and construction of buildings to ensure the safety and health for people in or about those buildings. They also include requirements to ensure that fuel and power is conserved and facilities are provided for people, including those with disabilities, to access and move around inside buildings.

Planning seeks to guide the way our towns, cities and countryside develop. This includes the use of land and buildings, the appearance of buildings, landscaping considerations, highway access and the impact that the development will have on the general environment.

For many types of building work, separate permission under both authorities (separate processes) will be required. For other building work, such as internal alterations, buildings regulations approval will probably be needed, but planning permission may not be. If you are in any doubt you should contact your local planning authority or a building control body.

The building regulations help ensure that new buildings, conversions, renovations and extensions (domestic or commercial) are going to be safe, healthy and high performing. Detailed regulations cover specific topics including; structural integrity, fire protection, accessibility, energy performance, acoustic performance, protection against falls, electrical and gas safety. They also lay standards for drains, ventilation, protection against the ingress of water and protection against contamination.
Building standards means standards contained in the building code, mechanical code, plumbing code, and electrical code in effect in a city or town where a home is located.
Building standards means the quality and quantities of materials shown for a given project.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building standards and regulations. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Building legislations and regulations

Discussions in groups on the research findings on definitions of building legislations and regulations in Papua New Guinea

Learning Strategies
Activity 1 Brainstorming activity on how to design guiding questions for their research on different terms used in building regulations in Papua New Guinea
Activity 2 Conduct research on legislations of building in Papua New Guinea
Activity 3 Discussions and presentation of research findings definitions of building legislations and regulations in Papua New Guinea

Resources
Building Board manual book

Lesson 2: Types of building codes

Teaching Strategies
Students engage in brainstorming exercise to discover the Types of building codes
They then are allowed to design guiding questions that will enable them to conduct research on Types of building codes
Discussions in groups on the research findings on Types of building codes

Learning Strategies
Activity 1 Brainstorming activity on how to design guiding questions for their research on different Types of building codes
Activity 2 Conduct research on Types of building codes
Activity 3 Discussions and presentation of research findings Types of building codes

Resources
Building Board manual book

Lesson 3: Types of building regulations

Teaching Strategies
Students engage in brainstorming exercise to discover the Types of building regulations
They then are allowed to design guiding questions that will enable them to conduct research on Types of building regulations
Discussions in groups on the research findings on Types of building regulations

Learning Strategies
Activity 1 Brainstorming activity on how to design guiding questions for their research on different Types of building regulations
Activity 2 Conduct research on Types of building regulations
Activity 3 Discussions and presentation of research findings Types of building regulations

Resources
Building Board manual book

STEAM Activity Students work in groups to create a steam activity that incorporates building standards.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Building Standards and regulations. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

1.Define building legislations and regulations
2.Analyse and describe the types of building codes
3.Analyse and describe the types of building regulations

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define building legislations and regulations	Clear and precise definition of building legislations and regulations with examples	Clear definition of building legislations and regulations	Incomplete definition of building legislations and regulations	No definition of building legislations and regulations
2.Analyse and describe the types of building codes	Correctly and clearly analyse and describe types of building codes with examples from different countries	Correctly analyse and describe types of building codes with few examples from different countries	Does not correctly analyse and describe types of building codes with no examples	Does not analyse and describe types of building codes
3.Analyse and describe the types of building regulations	Correctly and clearly analyse and describe the types of building regulations used in country	Correctly analyse and describe the types of building regulations used in country	Does not Correctly analyse and describe the types of building regulations used in country	Does not analyse and describe the types of building regulations used in country

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 9.3.1.6 Apply mathematical skills and scientific concepts in the planning and building of a variety of construction projects

Topic 6: Mathematics and Science in Building Structures

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss and distinguish between the different components of a building structure
2. Define building trade math and scientific concepts used in planning and building of structures.
3. Analyse and discuss what mathematical skills and science concepts are involved in building structures.

Essential Questions:

1. What are the different components of a simple building structure?
2. What is trade Math and how is math and science applied in the planning and building structures?
3. What is the STEAM application in buildings?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skill:	Value:	Attitudes
Maths and Science in Building structures	Apply	Appreciate structure and patterns, and style and aesthetics.	Awareness of importance science and math in building structures

Technology and Industrial Arts Application: Construction Technology: Building Technology

Content Background

Humans have been building shelters for thousands of years, so why is so much attention put to the whole topic of building science? After so many years of practice the right way to build houses may still be challenging. After all, many of the most popular building principles and strategies used today in today's homes and commercial buildings were originally developed by some primitive and ancient civilizations long ago including:

a. Oriental buildings to capitalise on the suns pathway through the sky for light and heat
b. selection and installation of materials that would shed water away from the structure, and storage of solar energy using high mass materials for use when needed.

Some Romans even had indoor plumbing and hot baths 2000 years ago, that so many of the ideas thought of as new have actually been around since the earliest civilisations. Building scientists must understand the complex nature of airflow within and across the building envelope; heat and moisture transfer to and from indoors, how these will affect the occupant, and how machines will impact the space and occupants.

Creating an indoor environment that is healthy, comfortable, and durable and energy efficient requires an understanding of the complex relationships between occupant, building, machines, and nature. Properly building a structure is indeed a science that deserves the attention it is getting today.

Before construction workers can build a habitable structure, an architect has to design it. Geometry, algebra, and trigonometry all play a crucial role in architectural design. Architects apply these math forms to plan their blueprints or initial sketch designs. They also calculate the probability of issues the construction team could run into as they bring the design vision to life in three dimensions.

Since ancient times, architects have used geometric principles to plan the shapes and spatial forms of buildings. In 300 B.C., the Greek mathematician Euclid defined a mathematical law of nature called the Golden Ratio. For more than two thousand years, architects have used this formula to design proportions in buildings that look pleasing to the human eye and feel balanced. It is also known as the Golden Constant because it manifests literally everywhere.

The Golden Ratio still serves as a basic geometric principle in architecture. You could even call it a timeless archetype, as it evokes in human beings a universal sense of harmony when they see or stand in a building designed with this principle. And perhaps not surprisingly, we see the Golden Ratio demonstrated throughout “architectures” of the natural world.

Calculating ratio is essential, as well, when it’s time to construct a building from the architectural blueprints. For example, it’s important to get the proportions right between the height and length of a roof. To do that, building professionals divide the length by the height to get the correct ratio.

The Pythagorean theorem, formulated in the 6th century B.C., has also come into play for centuries to calculate the size and shape of a structure. This theorem enables builders to accurately measure right angles. It states that in a triangle the square of the hypotenuse (the long side opposite the right angle) is equal to the sum of the squares of the other two sides.

The most remarkable ancient architecture of all may be the pyramids of Egypt, constructed between 2700 B.C. and 1700 B.C. Most of them were built and scaled at about a 51-degree angle. The Egyptians clearly and mysteriously possessed knowledge of geometry, as evidenced by the accuracy of pyramid construction.

In the modern world, builders use math every day to do their work. Construction workers add, subtract, divide, multiply, and work with fractions. They measure the area, volume, length, and width. How much steel do they need for an office building? How much weight in books and furniture will the library floors need to bear? Even building a small single-family home calls for careful calculations of square footage, wall angles, roofs, and room sizes. How many square yards of carpet?

Dreambox Learning, (2019)https://www.dreambox.com/resources/blogs/architecture-and-construction-through-mathematics

Nevertheless, there is some form of maths that underpins much of the work that happens in the construction industry. From setting out a building on site to calculating quantities and costs, from determining floor space ratios to ordering materials, there is a lot of everyday practical arithmetic and mathematics. Architects use geometry to study and divide space as well as draft detailed building plans. Builders and engineers rely on geometric principles to create structures safely. Designers apply geometry (along with color and scale) to make the aesthetically pleasing spaces inside. Geometry is used to design with the best angles to make structures as strong as possible, using shape, size, position and other properties. Civil

engineers use geometry to design and assemble shapes to construct freeways, tunnels, bridges and more.

One of the practical purpose of building science is to provide predictive capability to optimize the building performance and sustainability of new and existing buildings, understand or prevent building failures, and guide the design of new techniques and technologies.
What are the elements of building science?

Building science is the science and technology driven collection of knowledge in order to provide better indoor environmental quality, energy efficient built environments and occupant comfort and satisfaction. Building science is a field of knowledge that draws upon physics, chemistry, engineering, architecture, and the life sciences.

Neenu S K,(nd)https://theconstructor.org/building/12-basic-components-building-structure/34024/#:~:text=The%20basic%20components%20of%20a,and%20protecting%20the%20building%20structure.

Generally, there are two major components of a building project which are substructure and superstructure. The substructure is the part of the building that is built below the ground level whereas superstructure is the part of the structure that is constructed above the ground level.

Superstructure
The superstructure is the portion of a building which is constructed above the ground level and it serves the purpose of the structure's intended use. It includes columns, beams, slab upwards including all finishes, door and window schedules, flooring, roofing, lintels, and parapets.

https://theconstructor.org/building/superstructure-substructure-building-construction/1651/

Substructure
The substructure is the lower part of a building which is constructed below the ground level. The function of substructure is the transfer of loads from the superstructure to the underlying soil. So, the substructure is in direct contact with supporting soil. Substructure involves footing and plinth of a building.

The purpose of the substructure of a building is to transfer loads of the superstructure to the soil that is underneath. This is why the substructure is right against the soil that supports it. Now, it is important that you spend time working with structural engineers to ensure that all support beams, columns, and foundations are incorporated properly to ensure that nothing will collapse within the substructure.
Most of the time, the substructure is made from plain cement concrete or reinforced cement concrete. Once that is in place, stones, bricks, or additional concrete is added until it all reaches the plinth level. It is necessary for a damp-proof course to be laid on top, so that moisture doesn't penetrate any part of the substructure.

Mishra M ( ) What is substructure and superstructure in building construction? Retrieved may 2023 from https://theconstructor.org/building/superstructure-substructure-building-construction/1651/

Superstructure
The superstructure of a building is where people will spend most of their time. This area includes the first and second floors inside a home and any number of floors in larger buildings. The superstructure includes beams, columns, finishes, windows, doors, the roof, floors, and anything else.
The parts of the superstructure are much lengthier than the parts of the substructure. This shouldn't be surprising since the superstructure is much larger than the substructure.

Differences between the Substructure and Superstructure of a Building

Substructure

- The structure that is below the damp proof course that includes the ground floor and foundation
- The structure that is below the plinth
- This structure transfers the loads that are received from the superstructure and transfers it to the foundation
- Includes the foundation, pier, and abutment

Superstructure

- The internal and external elements of a building that is over the substructure
- The structure from the top of the plinth to the top of the building
- This structure transfers the loads from the upper part of the building to the substructure
- The structures above the baring and the wearing surface
- Includes walls, beams, columns, windows, doors

Both the substructure and the superstructure are important parts of buildings and one cannot successfully have a building, or a home, without both of them in place. If one tries to build just a superstructure without a substructure underneath, the entire superstructure will eventually collapse under the weight of the very top.
Therefore, the substructure must always be very stable before adding an even sturdier superstructure on top. That is the only way one will have a home, or a building, withstanding the elements and everything else that Mother Nature and humans bring their way.

Letsbuild (2019),What is substructure and superstructure in building, retrieved May 2023 fromhttps://www.letsbuild.com/blog/substructure-superstructure

Building Defects
Due to ageing and natural deterioration of the building fabric, many common types of defects are found on buildings. Some of the defects may affect the structural safety of the buildings while most of them are localised and non-structural in nature.
Building owners or occupants should always be aware of the condition of their buildings. To avoid unnecessary panic, building owners should:

- identify the symptoms,
- understand the possible causes of the defects,
- carry out timely repair and maintenance works to keep their buildings in good structural condition.

Common types of Building Defects
1. Non-structural cracks

- Hair-line cracks
- Cracks that stretch to many directions
- Cracks that appear between non-structural walls and structural members

2. Spalling of concrete

- Stains of water or rust are found on the surface or there is seepage of water
- Cracks appear
- Spalling of rendering/tiles
- The surface bulges and large pieces of concrete peel off, exposing the rusty steel bars

3. Structural cracks

- Cracks that penetrate the surface rendering into the structural concrete or load-bearing brick wall
- Cracks that appear on structural elements of buildings such as beams
- Long cracks that run across the wall
- Rusty stains that appear on the cracks
- Diagonal cracks that appear on the corners of window frames or door frames

4. Defective external wall finishes

- Debonding of finishes / tiles from the wall resulting in hollow sound when tapped with a hammer
- Cracking of the wall surface
- Bulging with a hollow base
- Falling off
- Loosening of finishing

Repair and Maintenance of Building Defects

Building owners have full and ultimate responsibility to maintain not only their own premises but also the common parts of the building. Such responsibility is NOT released by just reporting the issues to the relevant government departments.

Type of Defect	Actions Required
Non-structural cracks	• Building owners should keep in view the conditions of the defects. • Unless the circumstances have changed, owners may carry out repair as necessary.
Spalling of concrete / structural cracks / defective external wall	• Building owners should arrange for timely repair and maintenance works to upkeep the building in good condition.
Defects are found within own premises	• Respective building owners should arrange themselves for the appointment of building professionals to coordinate repair of the defects.
Defects are noted in the common parts of the building	• Building owners should alert the owners' corporation/ management company for arranging the appointment of building professionals to coordinate the necessary repair works. • The cost should be borne by concerned building owners normally according to the shares stipulated in the deed of mutual covenant.

Building owners who intend to carry out building repair works should consult building professionals.

Building Department (2022), Building Defects, Retrieved May 2023 from,https://www.bd.gov.hk/en/safety-inspection/building-safety/index_bsi_defects.html

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge

prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the mathematical and scientific aspects of building. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Science and Math in Building Foundation

Teaching Strategies

Students engage in brainstorming exercise to discover building foundation and its components

They then are allowed to design guiding questions that will enable them to conduct research on building foundation and its components and the application of Math and Science Concepts.

Discuss in groups and do presentations on the findings on building foundation and components and the application of Math and Science concepts.

.

Learning Strategies

Activity 1 Brainstorming activity on how to design guiding questions for their research on building foundation and components and the application of Math and Science

Activity 2 Conduct research on building foundation and components and the application of Math and Science.

Activity 3 Present research findings on building foundation and components and the application of Math and Science.

Resources

Mathematics for Carpentry and the construction trade

Lesson 2: Science and Math in Substructure

Teaching Strategies

Students engage in brainstorming exercise to define sub- structure member (footings, post, and bearers)

They then are allowed to design guiding questions that will enable them to conduct research on the definition of substructure members (footings, post, and bearers)

Discussions in groups on the research findings of definition of sub- structure members (footings, post, and bearers)

Learning Strategies

Activity 1 Brainstorming activity on how to design guiding questions for their research on definition of sub- structure member (footings, post, and bearers)

Activity 2 Conduct research on different formulae to calculate sub- structure member (footings, post, and bearers)

Activity 3 Discussions and presentation of research findings on the correct formulae to calculate sub- structure members (footings, post, and bearers)

Resources

Mathematics for Carpentry and the construction trade

Lesson 3: Science and Math in Superstructure

Teaching Strategies

Students engage in brainstorming exercise to define super -structure members (Floor joist, studs, roofing frame)

They then are allowed to design guiding questions that will enable them to conduct research on the definition of super -structure members (Floor joist, studs, roofing frame)
Discussions in groups on the research findings of the definition of super -structure members (Floor joist, studs, roofing frame)

Learning Strategies

Activity 1 Brainstorming activity on how to design guiding questions for their research on the definition of super -structure members (Floor joist, studs, roofing frame) and the formulae for calculation.

Activity 2 Conduct research on the formula to calculate super -structure members (Floor joist, studs, roofing frame)

Activity 3 Discussions and presentation of research findings of formulae to calculate super – structure members (Floor joist, studs, roofing frame)

Resources

Mathematics for Carpentry and the construction trade

Lesson 4: Applied Math

Teaching Strategies

Students engage in brainstorming exercise to discover building trade math
They then are allowed to design guiding questions that will enable them to conduct research on building trade math terminologies and applications.
Discussions in groups on the research findings on building trade math terminologies and applications.
Engage students in the calculations of sections of the substructure and superstructure.

Learning Strategies

Activity 1 Brainstorm activity on how to design guiding questions for their research on Building trade math and applied math in building structure.

Activity 2 Conduct research on building trade math and applied math in building structure

Activity 3 Discussions and presentation of research findings of the definition building trade math terminologies and what applied Math is in building structure

Activity 4 Allow students to work in groups to calculate sections of the substructure and superstructure.

Resources

Mathematics for Carpentry and the construction trade

Lesson 5: Building Defects

Teaching Strategies

Students engage in brainstorming exercise to discover identifying and classifying the types of building defects.
They then are allowed to design guiding questions that will enable them to conduct research on identifying and classifying the types of building defects.
They are allowed to study buildings in the school and identify the building defects and compile a poster of building defects.
Discuss in groups and present on findings of research on identifying and classifying the types of building defects.

Learning Strategies

Activity 1 Brainstorming activity on how to design guiding questions for their research on identifying and classifying the types of building defects.

Activity 2 Conduct research on identifying and classifying the types of building defects.

Activity 3 Discussions and presentation of research findings of identifying and classifying the types of building defects.

Resources
Mathematics for Carpentry and the construction trade

STEAM Activity Students work in groups to create a model of a building with 5 stories in a limited land area.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis in trade applied math. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Explain the principles of super structure design
2. Describe the techniques to construct and finish component elements of the superstructure
3. Explain superstructure
4. Define building trade math in PNG Iconic buildings and house designs that are prominent in each province. The National Parliament House, APEC House; traditional houses in each province

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1 Explain the principles of super structure design	Clearly and correctly explain principles of super structure design with examples	Correctly explain principles of super structure design with examples	Does not correctly explain principles of super structure design with few examples	No explanation of principles of super structure design with no examples
2. Explain substructure	Clearly explain substructure with clear explanation of members with examples	Clearly explain substructure with clear explanation of members	Does not Clearly explain substructure with clear explanation of members	Does not explain substructure with clear explanation of members
3. Explain superstructure	Clearly explain substructure with clear explanation of members with examples	Clearly explain substructure with clear explanation of members	Does not clearly explain substructure with clear explanation of members	Does not explain substructure with clear explanation of members
4. Define building trade math in PNG Iconic buildings and PNG provincially designed houses.	Clearly defines building trade math in PNG Iconic buildings and PNG provincially designed houses. with examples	Clearly defines building trade math in PNG Iconic buildings and PNG provincially designed houses. with examples	Does not clearly define building trade math in PNG Iconic buildings and PNG provincially designed houses. with examples	Does not define building trade math in PNG Iconic buildings and PNG provincially designed houses. with examples

Unit 2: Electrical Technology

Units	Benchmarks	Topics	Lesson Titles
2. Electrical Technology	**9.3.2.1.** Describe the historical development of Electricity	Topic 1: History of Electricity	1. Electrical Energy Production & Supply 2. Modern Power Generation methods 3. Renewable and sustainable energy practices. 4. Career Pathway in Electrical Technology
	9.3.2.2. Investigate and communicate OHS legislations and regulations, assess and employ emergency procedures whilst observing safety.	Topic 2: Workplace and Electrical safety	1. OHS legislation & Regulation 2. Personal Safety 3. Emergency procedures.
	9.3.2.3. Identify, design, develop and evaluate processes and products related to electrical technology and communicate the findings through the use of appropriate electrical and electronic terminologies.	Topic 3: Electrical or Electronic processes and products	1. Electrical or Electronic processes 2. Electrical or Electronic products
	9.3.2.4. Define electricity, conductivity and differentiate insulators from conductors.	Topic 4: Fundamentals of electricity	1. Electricity 2. Conductivity 3. Conductors and Insulators 4. Semiconductors
	9.3.2.5. Identify symbols and explain the functions of components and devices used in electrical circuit diagrams.	Topic 5: Components and devices used on circuit diagrams	1. Electrical components & devices 2. Electrical symbols used in circuit diagrams
	9.3.2.6. Identify different types of circuits and explain parts and operation of a simple practical circuit.	Topic 6: Circuits	1. Types of Circuits 2. Parts of each circuit 3. Operations of a practical circuit
	9.3.2.7. Investigate the concepts, principles and practices related to electrical.	Topic 7: Electrical Fundamentals	1. OHMs LAW 2. Kirchhoff's Law 3. Circuit Calculations

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 9.3.2.1 Describe the historical development of electricity

Topic 1: History of Electricity

Learning Objectives

By the end of this topic, the students will be able to;

1. Explain the historical development of electricity and the modern methods of the electrical energy generation
2. Explain the principles for generating electricity from renewable energy sources
3. Discover and discuss the career pathways for electrical Technology

Essential Questions:

1. Why was Electricity invented and advanced to this stage?
2. What are the Modern Power Generation Methods?
3. What are the practices for Renewable and Sustainable Energy?
4. What are the career pathways in Electrical technology?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skill	Value	Attitudes
Development of Electricity	Inquiry, describe (with examples)	Appreciate, Responsible and Value	inquisitive

Technology and industrial Arts Application: Construction Technology, Electrical Technology

---

Content Background

Electrical and magnetic occurrences in the past have been discovered as natural events. The Electrical Technology we have today has been the outcome of the practically of human curiosity and research over thousands of years.
Electricity then was sold to consumers as the stages and branches so as the careers of its technology advancement seem wide in range. Nowadays, a community's advancement is assessed through the amount of electricity it uses or consumes.

History of Electrical energy production and supply
Electrical energy cannot be stored in large quantities. Therefore bulk supplies of electrical energy must be fed directly from generating station through transmission and distribution

Time-line of Electricity Invention

YEAR	INVENTOR	INVENTION DESCRIPTION
16th Century	Dr. Willam Gilbert	Proves that many substances are electric and magnetic not just amber

1752	Benjamin Franklin	Flies a kite in a thunderstorm and discovers lightning is electricity
1769	James Watt	Invests the steam engine. The watt was named after him.
1792	Allessandro Volta	Discovered an electric current when two metals touch. He also invented batteries & volt was named after him.
1820s	Andre Marie Ampere	Is the first to explain how an electric circuit works. The term 'amp' was named after him.
1831	Michael Faraday	Invents the first electric generator.
1879	Thomas Edison	Invented the first light bulb. He also invented a type of generator that works with Watt's steam engine.
1887 - 1943	Nicola Tesla	Invented alternating current (AC) motor which introduced the practice of transmitting power by using two or three phase current.

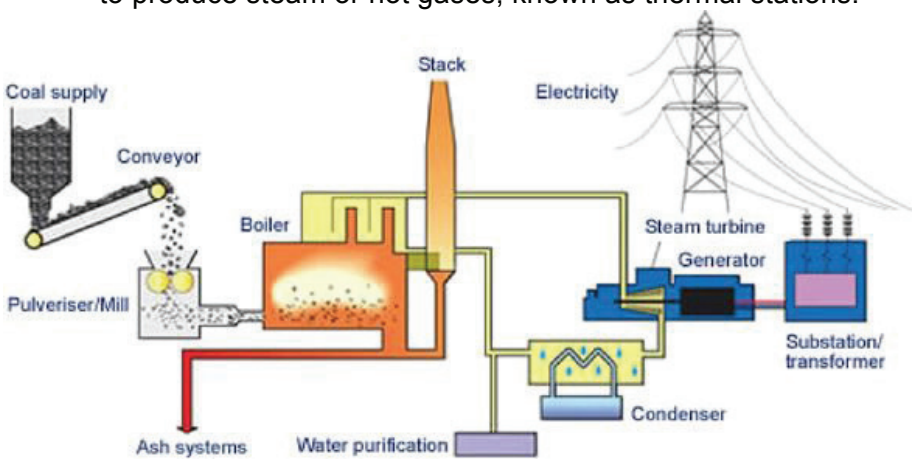
Modern Power Generation Methods
Electrical generators with rotating turbines are used nowadays to obtain bulk of electrical energy. Energy used to drive turbines is extracted from steam, flowing water, hot gases and wind.

Modern Generating systems fall in the following groups;
1. Power stations using thermal energy released from burning coals, oil or natural gas system to the consumer. This need led to the development of the electricity supply industry.

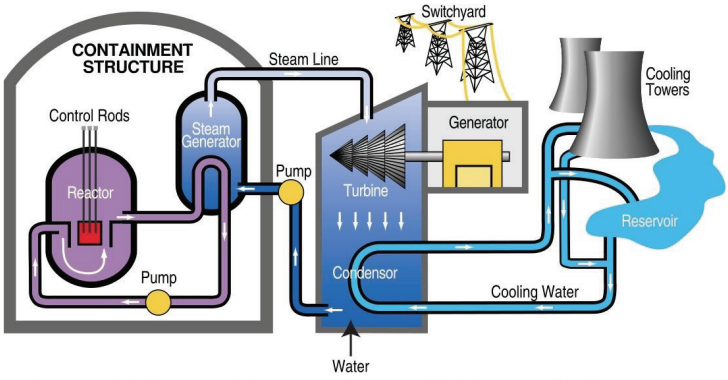
Modern Power Generation Methods
The bulk of electrical energy produced today is obtained from rotating turbines attached to an electrical generator. Energy used to drive turbines is extracted from steam, flowing water, hot gases and wind.

Modern Generating systems fall in the following groups;

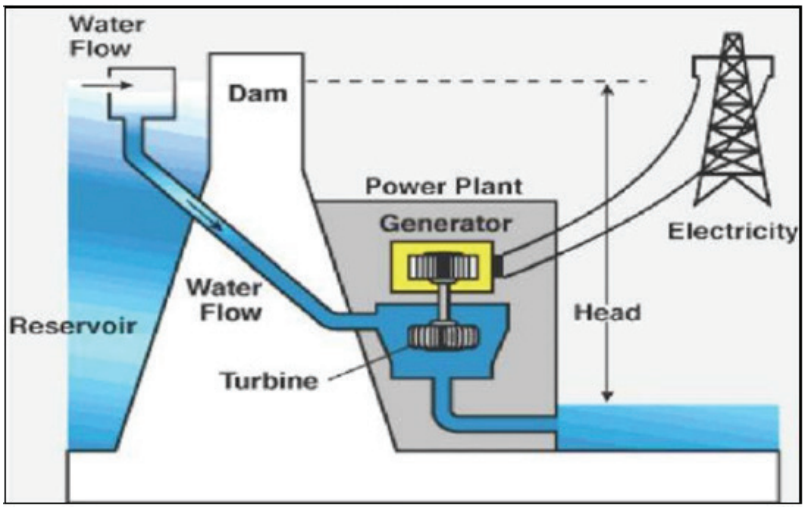
1. Power stations using thermal energy released from burning coals, oil or natural gas to produce steam or hot gases, known as thermal stations.



2. Power stations using thermal energy released by nuclear reaction, known as nuclear power stations.



3. Power stations using the kinetic energy of moving water known as hydropower stations (the most common form of renewable energy)



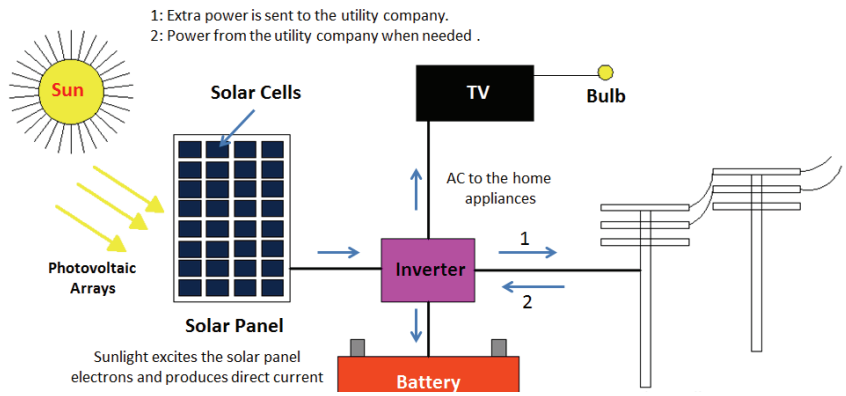
4. Other renewable energy sources such as biogas from landfill, geothermal, solar energy or kinetic energy from wind and wave movement.

Renewable and Sustainable energy practices

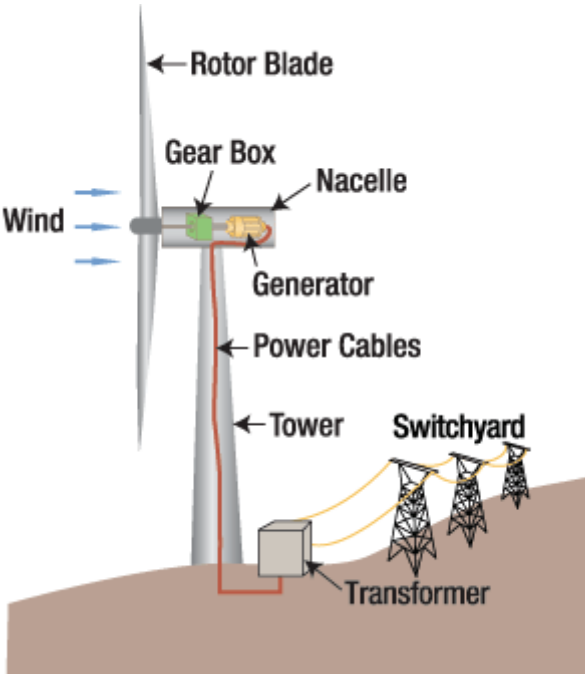
Sustainable energy is a form of energy that meet our today's demand of energy without putting them in danger of getting expired or depleted and can be used over and over again. Sustainable energy should be widely encouraged as it does not cause any harm to the environment and is available widely free of cost. All renewable energy sources are sustainable as they are stable and available in abundance.

Generally renewable energy is taken to mean any of the following:

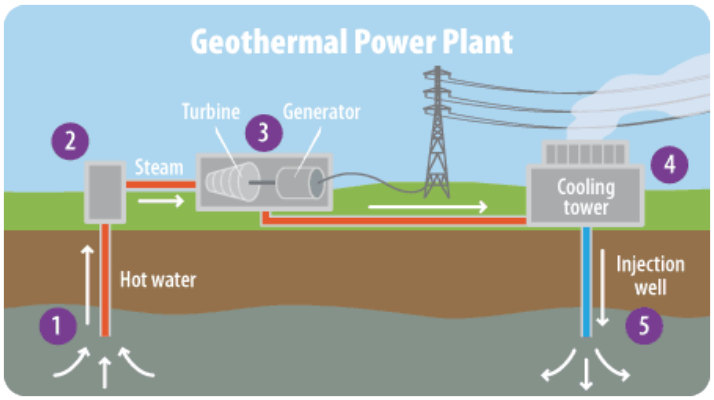
- Solar power



- Wind power



- Hydropower
- Tidal power
- Geothermal power



Resources are considered non-renewable if they take a very long time to be created (e.g. fossil fuels) or if their creation happened long ago and is not likely to happen again (e.g. uranium). Flows are almost always renewable. On the other hand, biofuels are renewable and definitely count as fuels.

(James Jenden, Ellen Lloyd, Kailyn Stenhouse, Brodie Yyelland, Jason Donev (January 4 2019 edition)

Electrical career pathways

Careers

1. Electrical Engineering

   Electrical engineers are more than just system designers and developers. Engineers are involved in projects from conceptualisation to maintenance. Engineers handle practicalities by conducting feasibility studies and cost analyses. Because of their multifaceted duties, electrical engineers sometimes specialise in project management, research and development or consultancy. Because of the wide range of industries using electrical engineers, many engineers specialise in sub-discipline of electrical engineering. Common sub-disciplines include: Power, Control, Electronics, and Microelectronics, Signal processing, Communication, Instrumentation and Computers

Electrical Technology Associate in Applied Sciences Degree may fall in the following areas; Electrical project managers, Electrical project estimators, Electrical generating plant operators, Building and code compliance inspectors and Electrical contractors

2. Electrical Technology Certificate may include careers such as; Apprentice electricians, Code compliance inspectors, Electrical construction estimators and Electrical project field supervisors

3. Electrical Construction Certificate may include career such as Journeyman electricians.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the history of electricity, the modern power generations, renewable and sustainable energy and engage experience and invite the job personnel to talk about the career opportunities in Electrical technology itself.

The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: History of Electrical energy production and supply

Lesson Objective: Students will be able to:

1. Describe the history of the development of electricity.
2. Explain electrical energy production and supply.

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
• History of the development of electricity • Electrical energy production and supply	Research describe and explain	Appreciate history of the development of electricity structures, principles and technology	Appreciate and value the history of the development of electricity and take care of structures and be responsible in using them

Teaching Strategies

- Students engage in brainstorming exercise to discover the supply and production of Electrical Energy.
- They then are allowed to design guiding questions that will enable them to conduct research on the history of electricity
- Discussions in groups on the research findings and facilitate students' research findings as a class discussion.

Learning Strategies

Activity 1 Brainstorming activity on the development of electricity and its advancement. Design guiding questions for their research.

Activity 2 Conduct research on the invention and advancement of electricity into the

modern power generation.

Activity 3 Discussions and presentation of research findings on the Invention and advancement of Electricity generations, and the modern power generation.

Teacher	Students
Introduction	
3. Tell a story of ancient times of how people survived without power comparing it in today's electricity world to capture students' attention that will lead students to the topic discovery. 4. Present pictures of sources of electricity then and today 5. Introduce key questions (What is the electricity? Who invented Electricity? How far have we gone in the electrical energy supply and production?)	1. Students listen attentively and work out where the story is leading. 2. Look through the pictures to understand how electricity has come about. 3. Brainstorm on the key questions to lead into the lesson.
Body	
Introductory to Body: Teachers present a timeline video on the history of the development of electricity ***Guided Practice of the body*** **Activity 1:** Present video review questions for group discussions ***Independent practice of the body*** **Activity 2:** Assign one or two question to each group to answer **Activity 3:** Group Presentation	Watch and take notes of important timelines Group discussion on the video review questions Focus discussions on the assigned questions and prepare presentation. Present and share the group answers of the video review questions on the timeline of electricity development.
Conclusion	
Conclude lesson with main concepts being explained and recapped	Take lesson notes
Assessment	
Task: Students individually create a history of electricity development chart using A3 paper, markers, Strip Card boards and glue. Allow 20 minutes for students to create the chart that has the timeline in correct order of the development and history of Electricity. Then assess them by marking the chart to see if the timeline is correct.	Complete assessment task using the steps below below 1. Draw a timeline on the chart 2. Write year and events on small cardboards and stick them on the timeline on the chart. 3. The completed timeline chart should tell the history of electricity from then to now. 4. Submit after 20 minutes **Criteria** **Area of assessment** / **Tick off or put x** Timeline created tells the history of electricity learnt Content of the timeline is accurate Task is completed on time Chart is neat and presentable

History of electricity notes. Video of the production of electricity, video review questions, A3 chart, markers or ink biros

Lesson 2: Modern Power Generation Methods

Teaching Strategies
Engage students in presentation of Modern Power Generation Methods.
Engage students in the discussion on building models of the different methods Modern Power Generations.

Learning Strategies
Activity 1 Discover the methods of Modern Power Generation methods
Activity 2 Discuss and prepare charts of the methods of Modern Power Generation Methods.
Activity 3 design and create a simulated model of a method of the Modern Power Generation.

Resources
Modern Power generations video Tutorials on the different methods
Modern Power generations notes

Lesson 3: Renewable and sustainable energy practices

Teaching Strategies
Guided Discovery of what Renewable and sustainable energies are. Teacher presents information on the lesson and students discuss as a class.

Learning Strategies
Activity 1 In groups discuss and define Renewable and sustainable energy and practices.
Activity 2 Group presentation of activity 1

Resources
Renewable and Sustainable Energy notes

Lesson 4: Electrical career pathways

Teaching Strategies
Guided Discovery of the career pathways in Electrical Technology. Teacher facilitates the construction of interview questions for students to carry out interview on an Electrical personnel engaged in the Industry.

Learning Strategies
Activity 1 In groups discuss the career paths in Electrical Technology.
Activity 2 Conduct a case study in groups on interviewing a tradesperson currently involve in the Electrical Industry on the nature of job, responsibilities, salary and challenges.
Activity 3 Present case study findings of activity 2

Resources
Electrical career notes.

STEAM Activity:
Students work in groups to create a simulated model of a method of Power Generation with the use of card boards, wood and metals pieces, and other materials (materials safe for anyone or the environment) and present the model dressed as an Electrical Industry personnel presenting the project and employing correct electrical terminologies.

The main purpose of assessment is to find out if students can use the skill of synthesis to describe the development of Electricity. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Explain the historical development of electricity
2. Identify and explain the modern methods of the electrical energy generation
3. Explain the principles for generating electricity from renewable energy sources
4. Discover the career pathways for electrical Technology

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Explain the historical development of electricity	Explains confidently the development of electricity stating the stages of invention into the modern power generation in the 21st century using STEAM or STEM terms and context	Explains the development of electricity by stating a few stages of invention into the modern power generation in the 21st century	Explains very briefly the development of electricity but have used irrelevant terms and context	Very poor description of the development of electricity or no explanation at all.
2. Identify and explain the modern methods of the electrical energy generation	Identifies and explains the modern power generation methods using correct language and providing pictorial examples	Identifies and explains the modern power generation methods using satisfactory language with minimal pictorial examples	Identifies but briefly explains the modern power generation methods using incorrect language with no examples	Very poorly explanation of the modern power generation methods with no examples
3. Explain the principles for generating electricity from renewable energy sources	Correctly explains the principles of generating electricity from renewable energy using Electrical terms and context with correct examples	Explains the principles of generating electricity from renewable energy with one example	Very brief explanation on the principles of generating electricity from renewable energy with no examples	Very poor and irrelevant explanations and with no examples
4. Discover the career pathways for electrical Technology	Correctly identifies and describes the career pathway for electrical technology with appropriate Electrical terminologies	Identify and describe the career pathway for electrical technology	Incorrectly Identifies and describes the career pathway for electrical technology	Very poor description and identification of the career pathways on electrical technology

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 9.3.2.2 Investigate and communicate OHS legislation and regulation and assess and employ emergency procedures whilst observing safety

Topic 2: Workplace and Electrical Safety

Learning Objectives

By the end of this topic, the students will be able to;

1. Explore and interpret OHS Legislation and regulations
2. Discuss personal safety practices and correct application of electrical technology
3. Use emergency procedures in emergency situations

Essential Questions:

1. What are the Occupational Health and Safety legislations and regulations for PNG?
2. How do you observe personal safety?
3. Why do we have emergency procedures and how do we administer them?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Occupational health and Safety legislation, emergency procedures	Investigate, communicate, assess, employ and observe	Vigilant, taking precautions	Safety conscious

Technology and Industrial Arts Application: Construction Technology, Electrical Technology

---

Content Background

Workplace safety is very important for each and every employee in the industry because all the workers desire to work in a safe and protected atmosphere. Health and safety is the key factor for all the industries in order to promote the wellness of both employees and employers. Almost everything in a workplace setting today operates on electricity. This passage of electricity can cause great pain, burns, and even fatalities. To protect workers, you should properly educate them and ensure that your work environment is safe and free of electrical hazards.

Occupational Health and Safety Legislations or regulations

The purpose of the Work Health and Safety laws (WHS laws) is to protect the health, safety and welfare of employees, volunteers and other persons who are at, or come in to contact with a workplace. Different laws exist in each state and territory.

The following is a list of legislations and regulations for PNG

- Industrial Safety, Health and Welfare Act 1961
- Industrial Safety, Health and Welfare Regulation 1965 Industrial Safety, This reprint of this Statutory Instrument incorporates all amendments, if any, made before25 November 2006 and in force at 11 February 1965 of Health and Welfare Act 1961.

Personal Safety

Personal safety refers not only to physical safety (freedom from physical harm) but also to psychological safety, which involves freedom from worry about physical safety as well as being victimized by hostility, aggression, and harassment. Personal safety in the workplace depends on your own awareness of potential threats and risks**.** Our Personal Safety focuses on overcoming the two key challenges to achieving sustained improvements in Personal Safety:

- Perceiving and assessing risks
- Taking personal responsibility to manage and mitigate those risks

We achieve this through working with others to help;

- Improve their perception of risk
- Raise their capability to assess risk
- Ensure they take personal ownership to address the risks they have identified
- Increase their skills to manage and mitigate risk

Key areas to focus on are those areas that present the greatest risks to personal safety:

- Complacency or over-familiarity with the task
- Underestimating the complexity or possible outcomes of the task
- Entering into risk because the level of risk perceived is underestimated.

Personal protective equipment

Personal protective equipment refers to any clothing or accessories used to protect workers from hazards. Goggles protect the eyes from vapors, chemical splashes, mists and fumes. Face shields protect the entire face from chemical exposure. Clothing made from durable fabrics or coated with chemical-resistant film protects the torso and skin from chemical splashes and spills. When handling chemicals, workers should wear gloves. These gloves should be selected based on their chemical resistance and other properties. Protective footwear and foot coverings help protect the feet and lower legs from chemical exposure. When selecting this type of footwear, be aware of other hazards in the workplace. If workers use heavy objects and handle hazardous chemicals, steel-toed footwear made of chemical-resistant materials will help protect them against both types of hazards.

<table>
<tr>
<td>HEAD PROTECTION
</td>
<td>EYE PROTECTION
</td>
<td>BODY PROTECTION
</td>
<td rowspan="2">PROTECTION FROM HARMFUL SMELL
 </td>
</tr>
<tr>
<td>HAND PROTECTION
</td>
<td>FEET PROTECTION
</td>
<td>EAR PROTECTION
 </td>
</tr>
</table>

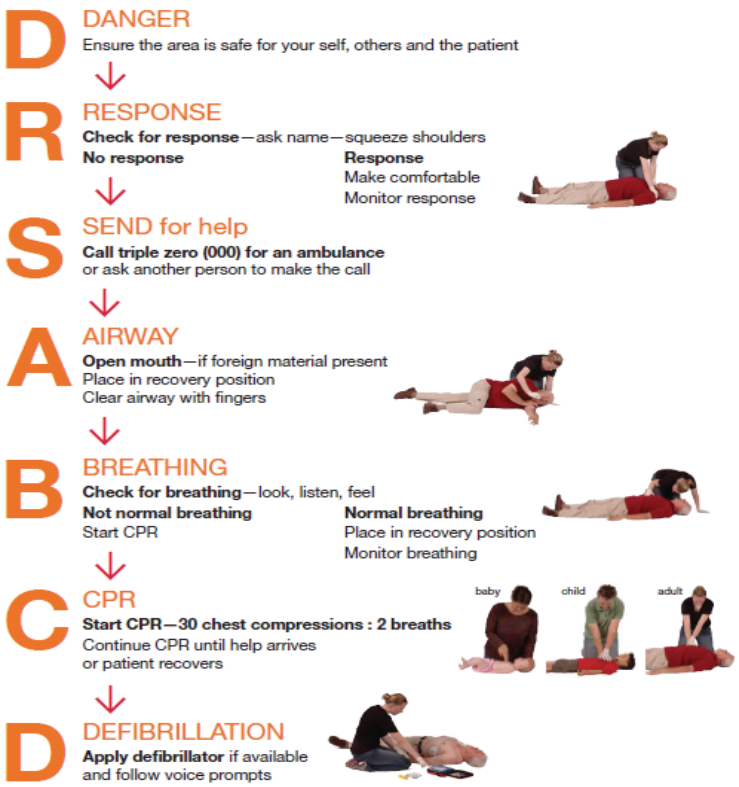
One set of goals of first aid is called the "Three P's":

- Preserve life – stop the person from dying.
- Prevent further injury – stop the person from being injured even more. If possible, an injured person should not be moved. ...
- Promote recovery – try to help the person heal their injuries.

Cardio Pulmonary Resuscitation

Cardiopulmonary resuscitation is an emergency procedure that combines chest compressions often with artificial ventilation in an effort to manually preserve intact brain function until further measures are taken to restore spontaneous blood circulation and breathing in a person who is in cardiac arrest.

CPR alone is unlikely to restart the heart. Its main purpose is to restore partial flow of oxygenated blood to the brain and heart. The objective is to delay tissue death and to extend the brief window of opportunity for a successful resuscitation without permanent brain damage.



Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge and skill prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand the importance of Workplace and Electrical Safety. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: OHS legislations & Regulations

Teaching Strategies

Guided discovery of OHS Legislation and regulations. Students are guided to understudy the parts of the legislation and present discussions. Teachers provide research points for students to carry out.

Learning Strategies

Students are given case study of incidents and how the legislation was applied to it. Students present case study finding of incidents and referencing the legislations.

Activity 1: Read and analyse case study in groups to identify incidents and legislation applications.

Activity 2: Present findings in a class discussion

Activity 3: students identify common incidents in electrical that may result in using legislation to charge an individual.

Resources

Industrial and safety ACT 1961

Lesson 2: Personal Safety

Teaching Strategies
Engage students to brainstorm on Personal Safety and Personal Protective Equipment. A notes a given and students are facilitated to prepare chats for each PPE for Personal safety.

Learning Strategies
Group discussions are conducted for students to present ideas on personal safety and Personal Protective Equipment. Student identifies a PPE and prepares a chat for presentation

Activity 1: Brainstorm ideas on Personal Safety and PPE
Activity 2: Prepare chats on a PPE in pairs and present by naming the PPE and state how it is important for personal safety.

Resources
Notes on Personal Safety and PPE, Safety videos

Lesson 3: Emergency Procedures

Teaching Strategies
Students are lead through a guided discovery of the emergency procedures and how to apply or demonstrate them in an emergency situation. A demonstration is done on Basic first Aid and Cardiopulmonary resuscitation.

Learning Strategies
Students discuss emergency procedures after the teacher's lesson presentation and demonstration. They then apply basic first aid and demonstrate CPR on a mannequin

Activity 1: Discuss emergency procedures in class after the teacher's lesson presentation.
Activity 2: Students apply basic first aid on a class mate
Activity 3. Students demonstrate CPR on a mannequin

Resources
Emergency procedures Tutorial

STEAM Activity Students work in groups to create an activity incorporating Workplace and Electrical Safety

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to observe workplace and Electrical safety. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Explore and interpret OHS Legislation and regulations
2. Observe personal safety practices
3. Use emergency procedures in emergency situations

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Explore and interpret OHS Legislation and regulations	Confidently Identifies and interprets the OHS Legislations and regulations correctly and reference it where appropriate	Identifies and interprets the OHS legislation	Only identifies the OHS legislation but does not interpret it.	Cannot identify or interpret the OHS legislation or regulation
2. Observe personal safety practices	Confidently observes Personal Safety practices at all times	Observes personal safety practices at times	Observes personal safety practices once in a while	Very poor attitude towards personal safety practices
3. Use emergency procedures in emergency situations	Confidently demonstrates emergency procedures in emergency situations	Demonstrates emergency procedures in emergency situations	Not too confident in demonstrating emergency procedures in emergency situations	Very poor demonstration of emergency procedures.

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 9.3.2.3 Identify, design, develop and evaluate processes and products related to electrical technology and communicate the findings through the use of appropriate electrical and electronic terminology.

Topic 3: Electrical/ Electronic Design processes and products

Learning Objectives

By the end of this topic, the students will be able to;

1. Identify and explain electrical or electronic design processes using appropriate terminologies
2. Design and develop electrical or electronic products
3. Evaluate electrical or electronic processes and products and communicate findings through correct terminologies

Essential Questions:

1. What is the design process?
2. How is the design process important in designing electrical or electronic products?
3. How important is the evaluation process?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Electrical and Electronic processes, products and terminologies	Identify, design, develop, evaluate, use	Appreciate with awareness	Responsible and being aware

Technology and Industrial Arts Application: Construction Technology, Electrical Technology

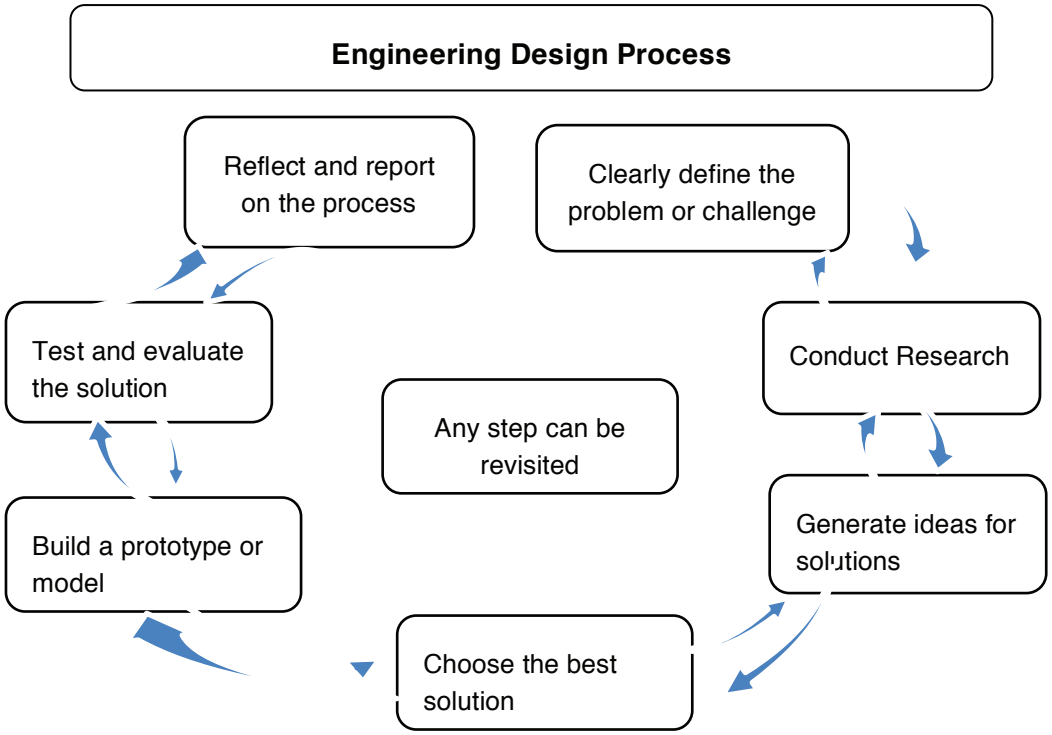
---

Content Background

Electrical or Electronic Design process uses the engineering design process to design and develop products

Engineering Design Process

Technological fields use the engineering design process to identify and define the problem or challenge, investigate the problem, collect and analyse data, and use the data to formulate potential solutions to the problem, analyse each of the solutions in terms of its strengths and weaknesses, and choose the best solution to solve the problem. It is an open-ended problem-solving process that involves the full planning and development of products or services to meet identified needs. It involves a sequence of steps such as the following:



Electrical or Electronic products

The following is a list of electrical and electronic products/ appliances

- Stoves
- Washing machines
- Dishwashers
- Electric jug and cookers
- Refrigerators
- Air conditioners
- Ceiling fan
- TV Screen
- Mixers
- Blenders

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand electrical or electronics processes taken to design, develop and evaluate products and even present finding of the evaluation with correct electrical terminologies. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Electrical/ Electronic Design Processes

Teaching Strategies

A guided discovery of the topic is done for students to read through and identify the electrical or electronic processes. A class discussion is facilitated to presentation of ideas.

Students work together in groups to identify electrical and electronic process. They also define electrical terminologies and use them to describe the processes discovered.
Activity 1: Work in groups to identify electronic or electrical processes and define terminologies used in describing the processes.
Activity 2: Present ideas on the processes discovered using correct terminologies

Resources
Handouts on engineering design process

Lesson 2: Electrical/ Electronic products

Teaching Strategies
Teachers are encouraged to produce a list of electrical and electronic products to guide the students in selecting a product for presentation.

Learning Strategies
Students pick out an electronic or electrical product and explain the process of design for the product and explain the its purpose and can use the process to trouble shoot.

Activity 1: Students discuss and choose a product and prepare a chat identifying and explain in the product and its functions.
Activity 2: Conduct research on the designing process of the product
Activity 3: Present the chart in class discussion.

Resources
Product manuals and charts, markers

STEAM Activity Students work in groups to create and design a hidden alarm circuit.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to identify, design and evaluate electrical/electronic products and processes. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Identify and explain electrical or electronic design processes using appropriate terminologies
2. Design and develop electrical or electronic products
3. Evaluate electrical or electronic processes and products and communicate findings through correct terminologies

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Identify and explain electrical or electronic design process using appropriate terminologies	Confidently Identifies and explains the electrical and electronic process thoroughly step by step with appropriate terminologies	Identifies and explain the electrical and electronic design process with few steps	Identifies a few but other are mixed up with use of irrelevant terminologies	Very poor in identifying and even explaining of the design process.
Design and develop electrical or electronic products	Confidently and competently designs the an electrical or electronic product using the steps in the design process	Designs an electrical or electronic product using few steps in the designing process	Not confident in designing an electrical or electronic product and have mixed up the designing process procedure	Not able to design any electrical product and very poor in following through he designing process.
Evaluate electrical or electronic processes and products and communicate findings through correct terminologies	Evaluate the designed products and communicate the findings through correct electrical terminology	Evaluate the designed products but communicates the findings with general terminologies	Not confident to evaluate the designed product and cannot communicate the findings well.	Very poor evaluation and cannot employ correct terminologies and cannot communicate findings.

UNIT 2. Electrical Technology

Content Standard 3.2. Analyze and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 9.3.2.4 Define electricity and conductivity and differentiate insulators from conductors

Topic 4: Fundamentals of Electricity

Learning Objectives
By the end of this topic, the students will be able to;

1. Explain Electricity and conductivity

Essential Questions:

1. What is Electricity?
2. What is conductivity?
3. How do we differentiate conductors from insulators?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Electricity, Conductivity, conductors and Insulators	Define and differentiate	Appreciate electricity	, value and careful application

Technology and Industrial Arts Application: Construction Technology, Electrical Technology

Content Background

There are two types of Electricity; Static Electricity and Current Electricity. Static Electricity is made by rubbing together two or more objects and making friction while Current electricity is the flow of electric charge across an electrical field.

Electricity is an apparent force in nature that exists whenever there is a net electrical charge between any two objects. Electrical force is created when electrons are transferred from one material to another (e.g. rubbing a wool cloth with a plastic comb).

Electrical charge is conserved; charge is neither created nor destroyed

Properties of Electricity:

CURRENT: denoted by I and measured in amperes. Current flows from negatively charged material to positively charged material and is essentially the number of electrons per second that are carried through a conductor.

VOLTAGE: Potential difference between a negatively charged object and a positively charged one (like two terminals on a battery). Potential difference is measured in units of Volts (V) which represents the work done per unit charge to move electrons between the positive and negative terminals. If a potential difference exists, then energy can be extracted.

RESISTANCE: Property of material that helps prevents the flow of electrons in it. Metals are good conductors due to low resistance. Wood is a poor conductor due to high resistance.

particles called protons and uncharged particles called neutrons. The nucleus of an atom is surrounded by negatively charged particles called electrons. The negative charge of an electron is equal to the positive charge of a proton, and the number of electrons in an atom is usually equal to the number of protons. When the balancing force between protons and electrons is upset by an outside force, an atom may gain or lose an electron. When electrons are "lost" from an atom, the free movement of these electrons constitutes an electric current.

Electricity is a basic part of nature and it is one of our most widely used forms of energy. We get electricity, which is a secondary energy source, from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources. Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. Before electricity generation began slightly over 100 years ago, houses were lit with kerosene lamps, food was cooled in iceboxes, and rooms were warmed by wood-burning or coal-burning stoves. Beginning with Benjamin Franklin's experiment with a kite one stormy night in Philadelphia, the principles of electricity gradually became understood. In the mid-1800s, everyone's life changed with the invention of the electric light bulb. Prior to 1879, electricity had been used in arc lights for outdoor lighting. The light bulb's invention used electricity to bring indoor lighting to our homes.

Conductivity

Electrical conductivity is a property of materials that determines how well a given material will conduct electricity. Electrical conductivity is closely related to resistivity (which is more commonly used): Where is the conductivity (in m/Ohm) and is the resistivity (in Ohm/m). To determine the resistance of a wire (which could be made of almost anything: copper, aluminum; this equation even works for wood!), use: Where is the cross-sectional area of the wire (in m^2) and is its length (in m).

Electrical conductivity is closely related to electrical conductance. Electrical conductivity is a property of the material itself (like silver), while electrical conductance is a property of a particular electrical component (like a particular wire).

Electrical conductivity can be defined as how much voltage is required to get an amount of electric current to flow. This is largely determined by the number of electrons in the outermost shell; these electrons determine the ease with which mobile electrons are generated. Another factor--but a less important one--is the number of atoms per unit volume, which determines the number of electrons that will readily move in response to an electric field. Materials with high conductivity, like copper and aluminum, are called conductors. Materials with low conductivity, like rubber and glass, are called electrical insulators (or just insulators when there's no possibility of confusion with thermal insulation). Another special class of materials like silicon and germanium are in between and are called semiconductors.

Generally, most metals have high conductivity (which is another way of saying metals tend to be conductors), because the electrons in their outermost shell can move easily. Non-metals tend to have low conductivity.

Conductors and Insulators

Comparison Chart

Basis For Comparison	**Conductor**	**Insulator**
Definition	Material which permits the electric current or heat to pass through it.	Restrict the electric current or heat to pass through it.
Electric Field	Exist on the surface but remain zero inside the conductor.	Do not exist on insulator.
Magnetic Field	Store energy	Do not store energy
Potential	Remain same at all the point	Remain zero.

	on conductor.	
Thermal Conductivity	High	Low
Covalent bond	Weak	Strong
Conductivity	Very high	Low
Resistance	Low	High
Electrons	Freely move	Do not move freely
Resistivity	Vary from high to low	High
Temperature coefficient	Positive temperature coefficient of resistance	Negative temperature coefficient of resistance
Conduction band	Full of electrons	Remain empty
Valence Band	Remains Empty	Full of electrons
Forbidden gap	No forbidden gap	Large forbidden gap
Examples	Irons, aluminum, silver, copper, etc.	Rubber, wood, Paper, etc.
Application	For making electrical wires and conductor	As a insulation in electrical cables or conductor, for supporting electrical equipment etc.

Examples of conductors and insulator

Conductors

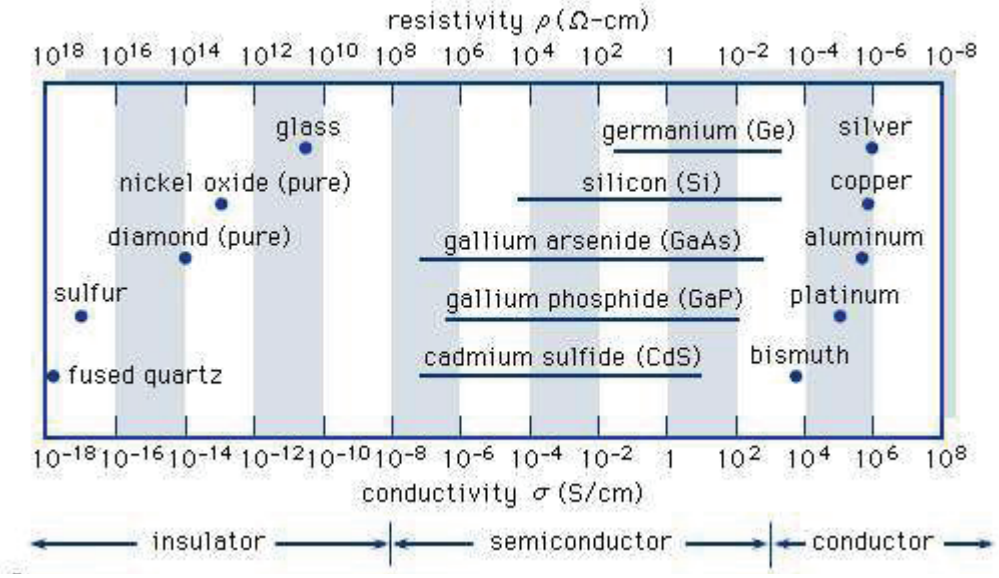
- Silver.
- Gold.
- Copper.
- Aluminum.
- Mercury.
- Steel.
- Iron.
- Sea water

Insulators:

- Glass.
- Rubber.
- Oil.
- Asphalt.
- Fiberglass.
- Porcelain.
- Ceramic.
- Quartz

Semiconductors

Semiconductors are substances such as germanium or silicon whose electrical conductivity is intermediate between that of a metal (conducting substance) and an insulator. Semiconductor, any of a class of crystalline solids intermediate in electrical conductivity between a conductor and an insulator. Semiconductors are employed in the manufacture of various kinds of electronic devices, including diodes, transistors, and integrated circuits. Such devices have found wide application because of their compactness, reliability, power efficiency, and low cost. As discrete components, they have found use in power devices, optical sensors, and light emitters, including solid-state lasers. They have a wide range of current- and voltage-handling capabilities and, more important, lend themselves to integration into complex but readily manufacturable microelectronic circuits. They are, and will be in the foreseeable future, the key elements for the majority of electronic systems, serving communications, signal processing, computing, and control applications in both the consumer and industrial markets



Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand concepts of electricity, conductivity and conductors and insulators. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Electricity

Teaching Strategies

Teachers lead students through with guided brainstorm and discovery of the topic. Teachers facilitate group discussions and present finding in class presentations. Present a video on Electricity.

Learning Strategies

Students get together in groups to brainstorm and discuss findings and present as a class discussions.

Activity 1: Brainstorm ideas on Electricity and discuss to define it.

Activity 2: Students do presentation on the definition and state how electricity works

Resources

Notes on Electricity and how it works

Lesson 2: Conductivity

Teaching Strategies

Teachers are encouraged to lead students though research to identify the three levels of conductivity. Conduct experiment to validate findings of materials to used and engage students in preparing reports and communicate findings.

Learning Strategies

Students work together in groups to analyse the level of conductivity and do experiments to proof the theory discovered. They then compile and present reports and evaluations of experiment findings

Activity 1: Students work in groups to describe and define conductivity and its levels of conductivity in terms of materials.

Activity 2: Compile report for the experiment conducted

Activity 3: Present report findings and conclusions for the conducted experiment.

Resources

Notes on conductivity

Lesson 3: Conductors, Insulators and Semiconductors

Teaching Strategies

Students are requested to bring along a list of materials to classify them according to the level of conductivity. Teacher then reaffirm the materials classified.

Learning Strategies

Students use the materials on hand to classify them according to Insulators or conductors and eventually identify if a material had fallen into a category of semiconductors.

Activity 1: Each students bring in a list of material and they work in a groups to classify them into conductors and insulators and also identify if a material has both characteristics.

Activity 2: Students to class discussion and presentation of the categorised list done on the materials used for each group.

Resources

List of insulator and conductor materials

STEAM Activity Students work in groups to build a small circuit for a conductivity tester. This tester should help students to test and verify if a material is a conductor or an insulator.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to describe how electricity works and what materials are suitable to use as conductors or insulators. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Explain Electricity and conductivity
2. Distinguish between conductors and Insulators

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Explain Electricity and conductivity	Explain thoroughly what electricity and electrical conductivity are and how they function.	Briefly states the explanation of electricity and electrical conductivity	Not confident in explaining what electricity and electrical conductivity is	Very poor explanation of electricity and electrical conductivity
2. Distinguish between conductors and Insulators	Correctly and confidently distinguishes between conductors and insulators	Distinguishes between conductors and insulators	Lacks confidence and take time in distinguishing conductors and insulators	Very poor in distinguishing conductors from insulators
3. Describe with Examples what semiconductors are.	Confidently describes semiconductors with examples	Describes what semiconductors are	Not confident in describing semiconductors	Is not able to describe or state examples of semiconductors

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 9.3.2.5 Identify symbols used and explain the functions of components and devices in electrical circuit diagrams

Topic 5: Components and symbols used on Circuit diagrams

Learning Objectives

By the end of this topic, the students will be able to;

1. Identify and discuss function of devices, components and their symbols associated with Electrical circuit

Essential Questions:

1. What are the electrical components and devices used on electrical circuit diagrams?
2. What the electrical symbols used on electrical circuit diagrams?
3. Why do we have to know the components, devices and symbols used on the circuit diagrams?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Symbols, components, devices and circuit diagrams	Identify and Explain	appreciate and value	Care, responsible,

Technology and Industrial Arts Application: Construction Technology, Electrical Technology

Content Background

Electrical Components and devices
When building electronic circuits, you will work with a number of basic electronic components, including resistors, capacitors, diodes, transistors, inductors and integrated circuits. Below is a brief overview of the components and their functions.

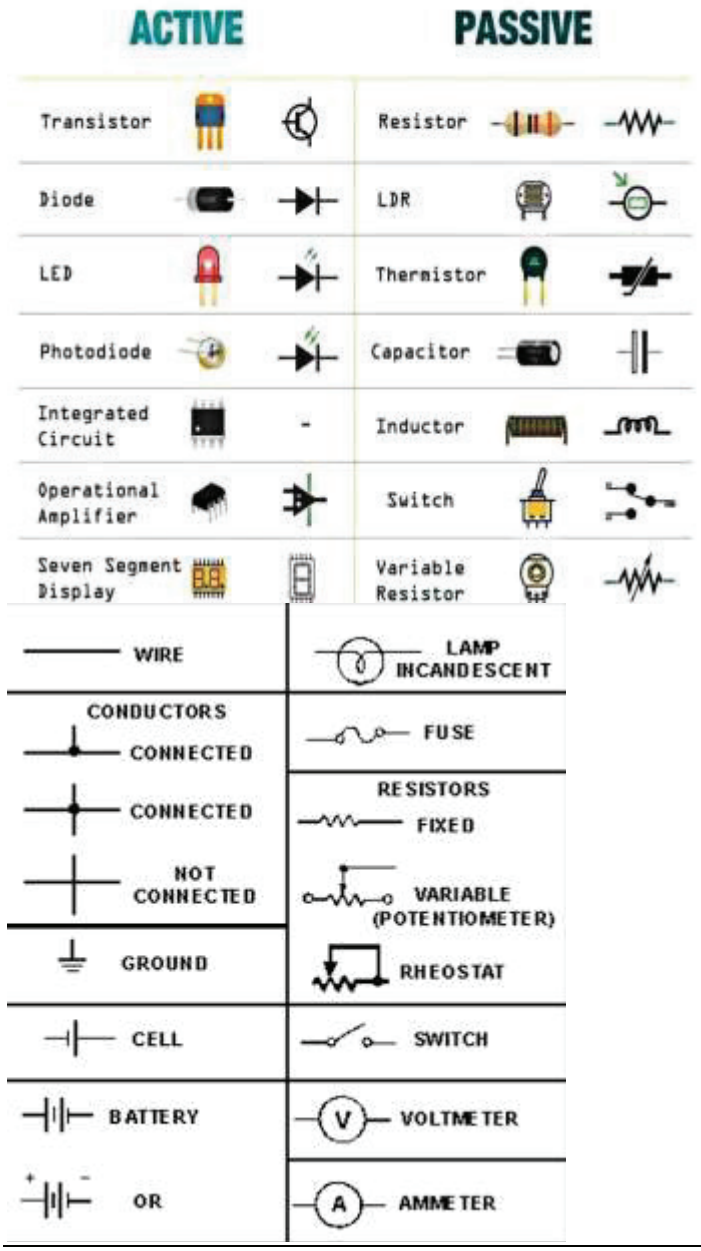
- Resistors: A resistor is one of the components you will come across in an integrated circuit. Like the name suggests, the device resists the flow of current. Resistors are graded based on their power ratings (amount of power they can handle without

exploding) and resistance values (capacity to resist current). The measurement is done in units know as ohms. The electronic symbol of the unit is O.

- Capacitors: These components can store electric charge temporarily. The components come in different varieties, with the most common ones being electrolytic and ceramic disk. The capacity of a component is usually measured in microfarads (Âμ F).
- Diodes: Diodes allow electric current to flow in a single direction only. Each diode has two terminals known as the anode and cathode. When the anode is charged with positive voltage and the cathode with a negative one, electric current can flow. Reversing these voltages will prevent the current from flowing.
- Transistors: These components are easy to identify through their three terminals. For the components to work, voltage has to be applied to one of them; the base terminal. The base can then control current flow in the two other terminals (the emitter and collector).
- Inductors: These are passive components that store energy in form of a magnetic field. An inductor simply consists of a coil of wire wound around some kind of core. The core could be a magnet or air. When current passes through the inductor, a magnetic field is created around it. The magnetic field is stronger if a magnet is used as the core.
- Integrated Circuits: An integrated circuit refers to a special device that has all the components required in an electronic circuit. The component has diodes, transistors, and other devices, all of which are etched on a tiny piece of silicon. The components are used in many electronic devices, including watches and computers.
- Microcontrollers: Microcontrollers are small computers used to control a multitude of devices, such as power tools, remote controls, medical equipment and office machines.
- Transformers: Built with two coils of wire, transformers are commonly used to step up or step down power.
- Batteries: Batteries convert chemical energy to electrical energy. The two different cells of a battery are anode (+) and cathode (-).
- Fuses: Fuses help preserve components from overloading with excessive current. A fuse consists of connection body, support, contacts, and metal-fuse material such as zinc or copper.
- Relays: These electromechanical switches shut power on or off. A relay includes an electromagnet, an armature, a series of electrical contacts and a spring.
- Switches: Switches interrupt current. The four types of switches are: single pole single throw (SPST), single pole double throw (SPDT), double pole single throw (DPST), and double pole double throw (DPDT).
- Motors: Motors convert electrical energy into mechanical energy. Key components include a rotor, stator, bearings, conduit box, enclosure, and eye bolt.
- Circuit Breakers: As a protective device, a circuit breaker can be controlled with a remote switch. It is designed to protect the circuit from overloading or a short circuit.

Electrical symbols used in circuit diagrams

An electronic symbol is a pictogram used to represent various electrical and electronic devices or functions, such as wires, batteries, resistors, and transistors, in a schematic diagram of an electrical or electronic circuit. The electrical symbols are very important especially when fixing electrical appliances because it tells you where the wire of neutral and live go.



Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to identify devices, components and their symbol so as the function of each used in the electrical circuit diagrams. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Electrical Components and devices

Teaching Strategies

Teachers are encouraged to lead students through a guided discovery where students identify devices and components used in electrical technology. Teachers could put on the board, worksheet or PowerPoint slides, certain names of devices or components for students to identify symbols and state functions of each. Teachers guide students through a lesson on electrical component and devices.

Learning Strategies

Students brainstorm and match names from circuit charts. They also do research and analyse a circuit diagrams content or use teachers circuit diagram to extract device, components used in that particular circuit. They then list all common electrical or electronic components with function and symbols.

Activity 1: Students work on a brainstorm activity on component and devices used in electrical industry.

Activity 2: Make a list of common Electrical or Electronic components and devices with functions of each

Resources

Lesson 2: Electrical symbols used on circuit diagrams

Teaching Strategies

Teacher conducts a brainstorm discussion on circuit symbols. Students are then provided with circuit diagram to analyse. Teacher facilitates the analysis activity for students.

Learning Strategies

Research and discover electrical circuit diagram and identify symbols used on it. Name the components or devices that are represented with the symbols. Students then present them to class.

Activity 1: Students work a circuit diagram analysis to identify symbols used.

Activity 2: Students work in pairs to draw an electrical circuit diagram involving circuit symbols.

Activity 3: They then present and explain the type of electrical circuit and how they have designed it and how it will function.

Resources

Electrical symbols and circuit diagram notes, pencils, drawing plates

STEAM Activity Students work in groups to create a simple voltage-current tester. They should draw the schematic diagram and a pictorial diagram that gather a transparent pen cover, wires and a diode and an LED.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to identify and explain functions of devices, component and symbols used in electrical Technology. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Identify devices, components and their symbols used on Electrical circuit diagrams
2. Explain the functions of the devices and components used on electrical circuit diagrams

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify devices, components and their symbols used on Electrical circuit diagrams	Confidently Identifies devices, components with their symbols and used them accordingly on circuit diagrams	Identifies devices, components and symbols	Not confident in identifying devices, components and symbols used in electrical circuit diagrams	Very poor in identifying devices, components
2. Explain the functions of the devices and components used on electrical circuit diagrams	Confidently explains the functions of the devices and components used on electrical circuits with appropriate electrical terminologies	Explains functions of the devices and components used in Electrical circuits with general English terminologies	Not confident in explaining the functions of devices and components used in electrical circuit diagrams	Very poor explanations of the functions of the devices and components used on electrical circuit diagrams or cannot explain at all

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 9.3.2.6 Identify the different types of circuits and explain the parts and operation of a simple practical circuit.

Topic 6: Circuits

Learning Objectives

By the end of this topic, the students will be able to;

1. Examine and discuss the types, parts and operation of circuits.

Essential Questions:
1. What are the different types of circuits in Electrical Technology?
2. What are the common parts of an electrical circuit?
3. How does a simple practical circuit operate?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Types of circuits, parts and operation of circuits.	Inquiry	Appreciate	value with care

Technology and Industrial Arts Application: Construction technology, Electrical Technology

Content Background

An electrical circuit is a path or line through which an electrical current flows. The path may be closed (joined at both ends), making it a loop. A closed circuit makes electrical current flow possible. It may also be an open circuit where the electron flow is cut short because the path is broken. An open circuit does not allow electrical current to flow.

Types of circuits

There are two basic types of electric circuits, called series and parallel circuits. They differ in the number of loops through which current can flow.

A series circuit has only one loop through which current can flow. If the circuit is interrupted at any point in the loop, no current can flow through the circuit and no devices in the circuit will

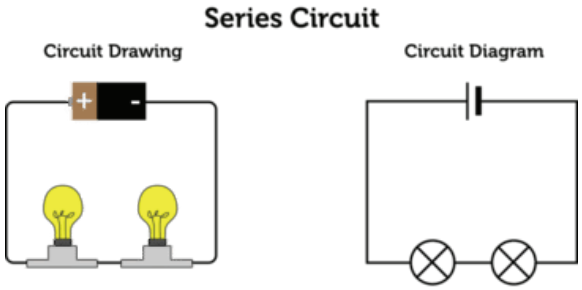
work. In the series circuit, if one light bulb burns out the other light bulb will not work because it won't receive any current. Series circuits are commonly used in flashlights.

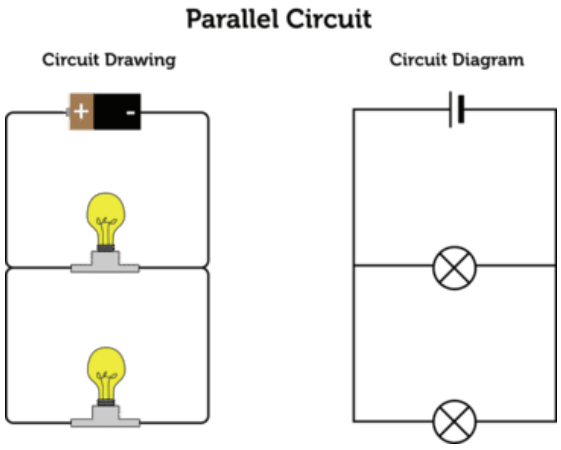
A parallel circuit has two (or more) loops through which current can flow. If the circuit is interrupted in one of the loops, current can still flow through the other loop(s). For example, if one light bulb burns out in the parallel circuit, the other light bulb will still work because current can by-pass the burned-out bulb. The wiring in a house consists of parallel circuits.

Other types of circuits

A closed circuit has a complete path for current to flow. An open circuit doesn't, which means that it's not functional. If this is your first exposure to circuits, you might think that when a circuit is open, it's like an open door or gate that current can flow through. And when it's closed, it's like a shut door that current can't flow through. Actually, it's just the opposite, so it might take a while to get used to this concept.

A short circuit is a low-resistance path, usually made unintentionally, that bypasses part of a circuit. This can happen when two bare wires in a circuit touch each other. The part of the circuit bypassed by the short circuit ceases to function, and a large amount of current could start to flow. This can generate a lot of heat in the wires and cause a fire. As a safety measure, fuses and circuit breakers automatically open the circuit when there is an excessive current.





Parts of a circuit

It is very important to know the basic parts of a simple circuit and the symbols that relate to them. A simple circuit has conductors, a switch, a load and a power source. Here are the functions of each part:

Conductors: These are usually copper wires with no insulation. They make the path through which the electricity flows. One piece of the wire connects the current from the power source (cell) to the load. The other piece connects the load back to the power source.

Switch: The switch is simply a small gap in the conductor where you can close or open the circuit. When the switch is closed, the circuit is closed and electricity flows.

The Load: The load is a small light bulb or buzzer that lights when the circuit is turned on. The load is also known as a resistor.

Cell: The power source is a cell. (Note that more than one cell put together is known as a battery)

Operation of a practical circuit

Have you ever wondered what happens when you flip a switch to turn on a light, TV, vacuum cleaner or computer? What does flipping that switch accomplish? In all of these cases, you are completing an electric circuit, allowing a current, or flow of electrons, through the wires.
An electric circuit is in many ways similar to your circulatory system. The wires in a circuit carry the electric current to various parts of an electrical or electronic system.

A battery or generator produces voltage -- the force that drives current through the circuit.
Take the simple case of an electric light. Two wires connect to the light. For electrons to do their job in producing light there must be a complete circuit so they can flow through the light bulb and then back out.

The diagram above shows a simple circuit of a flashlight with a battery at one end and a flashlight bulb at the other end. When the switch is off, a complete circuit will not exist, and there will be no current. When the switch is on, there will be a complete circuit and a flow of current resulting in the flashbulb emitting light.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to identify concepts, principles and operation of circuits. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of Circuits

Teaching Strategies

Teacher facilitates students' research on the types and functions of circuits. They then have small group activity to discuss findings and prepare a chat, PowerPoint or video to present in class as a finding of a types of circuit.

Learning Strategies

Students conduct research on the types of circuits, prepare a chart, PowerPoint or a video to present in class.

Activity 1: Design research questions and carry out research

Activity 2: Sharing ideas and preparation of a chat, power point or video.

Activity 3: Presentation of the group activity.

Resources

Lesson notes on circuits

Lesson 2: Parts of a circuit

Teaching Strategies

Teachers instruct students to explain the circuit that they have research and work out the parts of it and explain each part of the circuit that enables the circuit to function.

Learning Strategies

Students selects a circuit from their research work and start identifying the different parts that make up a circuit. Explain the importance of each part in circuit operation.

Activity 1: Work out a circuit in groups and identify and outline the importance of each part.

Activity 2: Present it as a class discussion.

Resources

Circuit diagram model and notes

Lesson 3: Operation of a practical circuit

Teaching Strategies

Teachers encourage students to build a circuit. They then are asked to observe and see how the circuit functions.

Learning Strategies

Students work in small groups to build a simple practical circuit. They turn it on to see how it operate and evaluate the circuit.

Activity 1: Brainstorm on the idea of a simple practical circuit.

Activity 2: Build the circuit and test it

Activity 3: Evaluate the circuit built and state how the circuit has operated.

Resources

Pieces of boards, battery, switch,

STEAM Activity Students work in groups to build and evaluate different types of circuits. (A series and a parallel circuit)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to explain functions of the different types of circuits. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Identify and explain the different types of circuits.
2. Identify and explain the different parts of a circuit
3. Explain the operation of a simple practical circuit.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Identify and explain the different types of circuits.	Lists and explain the different types of circuits accurately	Lists types of circuits but explains just a type of circuits	Lists the types of circuits but could not explain any of their functions	Cannot list or explain any functions.
Identify and explain the different parts of a circuit	Lists and explain the different parts of circuit accurately	Lists parts of circuits but explains just one part of circuit	Lists the parts of circuits but could not explain any of their functions	Cannot list or explain any part and its function
Explain the operation of a simple practical circuit.	Accurately explains how a circuit operates referencing each part of the circuit and how they contribute to the operation of the whole circuit	Explains how a circuit operates plainly	Not confident in explain how a circuit operates	Cannot explain how a simple circuit operates

UNIT 2. Electrical Technology

Content Standard 3.2. Analyze and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 9.3.2.7 Investigate the concepts, principles and practices related to electrical

Topic 7: Electrical Fundamentals

Learning Objectives
By the end of this topic, the students will be able to;

1. State ohms law in words and formula
2. State Kirchhoff's law in words and formula
3. Apply ohm's and Kirchhoff's Law in circuit calculations

Essential Questions:

1. What is ohms law? How is it applicable in real life?
2. What is Kirchhoff's law and how do we apply it in real circuit calculations?
3. How do we obtain values for the quantities such as voltage, current, resistance and power?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skill:	Value	Attitudes
Electrical concepts, principles and practices	inquiry, investigate and explore	appreciate	develop positive attitude

Technology and Industrial Arts Application: Constructions Technology, Electrical Technology

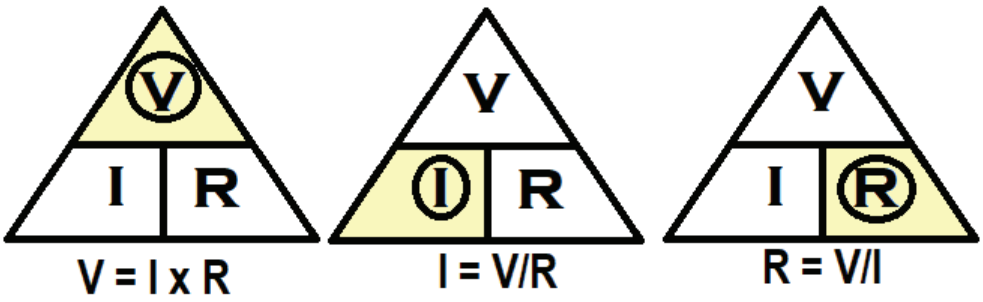
Content Background

Ohm's Law
Ohm's law states that the voltage or potential difference between two points is directly proportional to the current or electricity passing through the resistance, and inversely proportional to the resistance of the circuit.

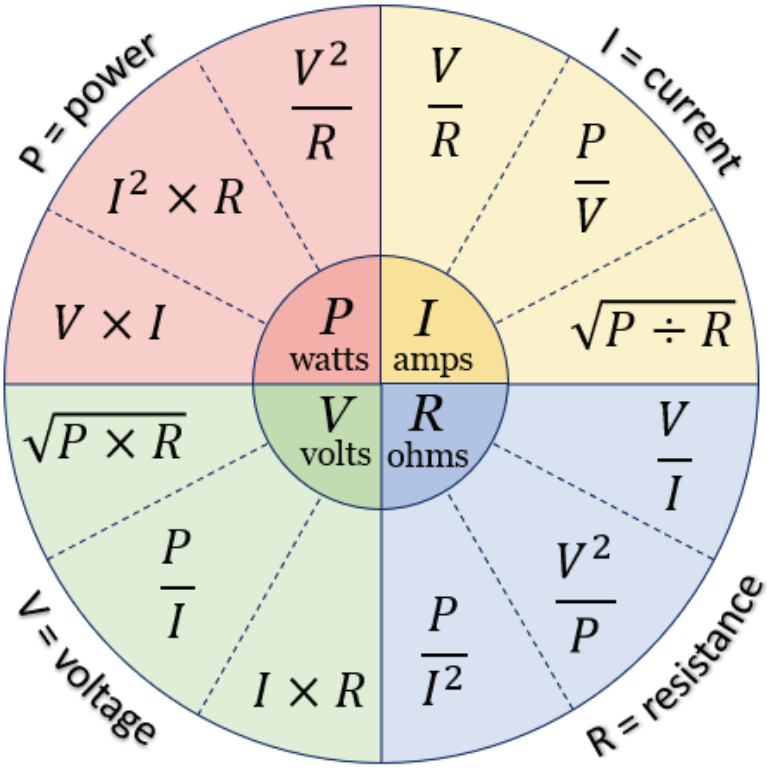
The formula for Ohm's law is V=I/R.

Ohm's law gives the relationship of current, voltage, and resistance. Ohm's law applies to all series, parallel, and series- parallel circuits
http://machineryequipmentonline.com/electric-equipment/summary-of-ohms-law/

Ohm's Law Triangle



Ohm's Law – Power Wheel
This wheel consists of formulas for Power, Current, Voltage and Resistance for circuit calculations.



Kirchhoff's Law

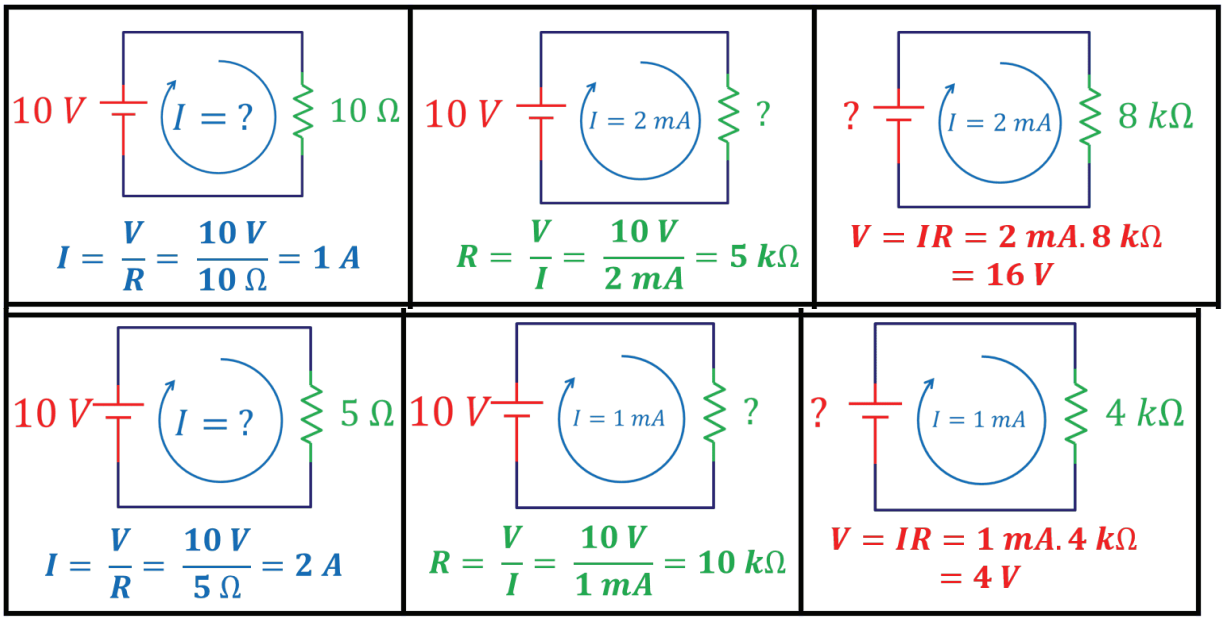
Kirchhoff's laws are fundamental to circuit theory. They quantify how current flows through a circuit and how voltage varies around a loop in a circuit.

Kirchhoff's current law (1st Law) states that current flowing into a node (or a junction) must be equal to current flowing out of it. This is a consequence of charge conservation.

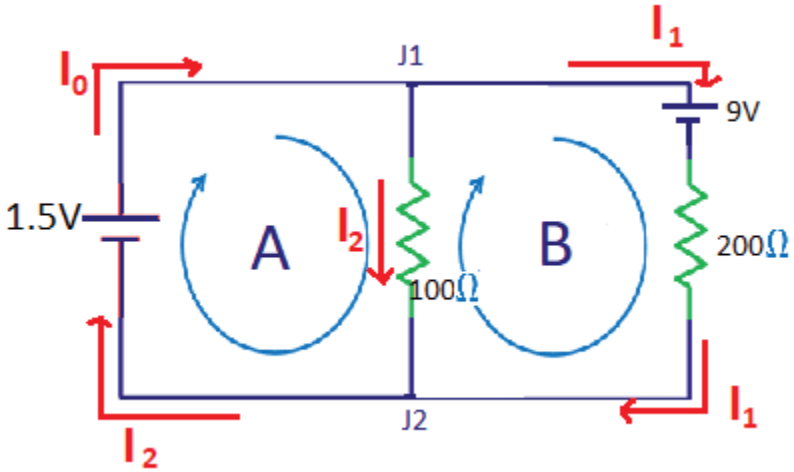
Kirchhoff's voltage law (2nd Law) states that the sum of all voltages around any closed loop in a circuit must equal zero. This is a consequence of charge conservation and also conservation of energy.

Circuit Calculations

Applications of ohms' law in circuit calculations.



Applications of Kirchhoff's Law in Circuit Calculations



Junction Rule (JR): $I_0 = I_1 + I_2$

Loop Rule (LR): $-I_2\,(100\Omega) + 1.5V = 0$

$-9V - I_1\,(200\Omega) + I_2\,(100\Omega) = 0$

$-100I_2 + 1.5 = 0$ ($I_2 = 0.015A$)

$-9 – 200I_1 + 100I_2 = 0$

$-9 – 200I_1 + 100(0.015A) = 0$

($I_1 = 0.0375$) (it will turn out to be negative because the current direction (in red on the

circuit) is wrong. It should have been in the opposite direction.)

$I_0 = I_1 + I_2$ ($I_0 = 0.015A + 0.0375$) = 0.0525A

V100Ω (voltage across 100ohm resistor)

$= I_1$ + resistor value

= 0.015A x 100

= 1.5V

V200Ω (voltage across 200ohm resistor)

$= I_2$ + resistor value

= 0.0375 X 200

= 7.5V

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to use concepts, principles and practices such as Ohm's Law and Kirchhoff's Law in solving circuit problems. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Ohm's Law

Teaching Strategies

Teachers lead a guided discussion on the Law presented and get students to work out the formula of ohm's law and further derive other formulas. Produce circuit word problems then facilitate students to solve the circuit issue using the Ohm's Law.

Learning Strategies

Students work together in groups to come up with ohms law formula and other derived formulas from ohms law and solve circuit word problems.

Activity 1: Group discussion to obtain the ohms law formula

Activity 2: Derive other formulas from ohms law using transposing and changing of subjects.

Activity 3. Work in pairs to solve word problems of circuit quantities.

Resources

Ohm's Triangle, Ohms law notes, power wheel

Lesson 2: Kirchhoff's Law

Teaching Strategies
Teachers lead a guided discussion on the law presented and get students to work out the how Kirchhoff's law is applicable in circuit calculation. Produce circuit worksheets and then facilitate students to solve the circuits using the Kirchhoff's Law.

Learning Strategies
Students work together in groups to identify application of Kirchhoff's law in circuit calculations. Then they solve circuits.

Activity 1: Brainstorm activity on the application of Kirchhoff's Law in solving circuit problems.

Activity 2. Work in pairs to solve circuits using Kirchhoff's law.

Resources

Kirchhoff's law notes and examples

Lesson 3: Circuit Calculations

Teaching Strategies

Teachers prepare worksheet on circuits for students to solve using Ohms' law and Kirchhoff's law. Get students to use the circuits built to measure qualities using a multimeter and manual calculate and compare solutions.

Learning Strategies

Students work in pairs or small groups to solve circuits on the worksheets. They then use real circuits built or build circuits then use multimeter to measure voltage, current, and resistance in the different parts of the circuits then manually calculate to compare the multimeter readings using Ohm's law, Kirchhoff's law and power wheel.

Activity 1: Solve circuits on worksheets in pairs or small groups.

Activity 2: Build a series or parallel circuit or use the built circuits to manually calculate voltage, current, resistance, power and use multimeter to confirm.

Resources

Circuit kits, worksheets on circuit problems

STEAM Activity Students work in groups to build a series and a parallel circuit using circuit kits and take use the rating of the components used to calculate current, voltage, resistance and power. Use a multimeter to confirm the solutions and draw conclusions.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to use concepts, principles and practices of Ohm's Law, Kirchhoff's to solve circuits issues. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. State ohms law in words and formula
2. State Kirchhoff's law in words and formula
3. Apply ohm's and Kirchhoff's Law in circuit calculations

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. State ohms law in words and formula	Confidently and clearly explains ohms law and state the formula	Explains ohms law briefly and states the formula	Not confident in explaining the ohm's law but can state the formula	Very Poor explanation of Ohm's law and could not state the formula at all
2. Explain Kirchhoff's law in	Confidently and clearly explains Kirchhoff's law and its application	Explains Kirchhoff's law briefly	Not confident in explaining the Kirchhoff's law	Very Poor explanation
3. Apply ohm's and Kirchhoff's Law in circuit calculations	Confidently and independently solve for circuit quantities using principles and concepts of Ohm's and Kirchhoff's Law	Solves circuits quantities using principles and concepts of Ohm's Law and Kirchhoff's Law but abit dependent on others or teacher	Not confident in solving circuit quantities using principles and concepts of Ohm's Law and Kirchhoff's Law	Cannot Solve circuits quantities using principles and concepts of Ohm's Law and Kirchhoff's Law and always seeks teacher supervision often.

Unit 3: Plumbing Technology

Units	Benchmarks	Topics	Lesson Titles
Plumbing Technology	**9.3.3.1** Describe and explain fundamental concept and its relevance in plumbing Trade	Topic 1: Fundamentals of plumbing	1. Introduction to plumbing 2. Plumbing Fundamentals 3. Career pathways in Plumbing Technology
	9.3.3.2 Analyse and describe Occupational Health and Safety regulation and standards in plumbing trade	Topic 2: Occupational Health Safety regulations and standards.	1. Occupational Health Safety Regulations and standards. 2. Application of OHS and Standards and Regulations in Plumbing 3. OHS and Standards and Regulations in Plumbing
	9.3.3.3 Demonstrate and apply basic tools and equipment and their specifications	Topic 3: Plumbing tools and equipment	1. Plumbing tools and equipment 2. Manual tools 3. Power tools and uses 4. Types of plumbing materials and Specifications
	9.3.3.4 Explore and apply Basic concept of trade drawing in plumbing	Topic 4: Trade Drawing In Plumbing	1. Trade drawing in plumbing 2. Method of isometric drawing 3. Method of pictorial drawing

UNIT 3. Plumbing Technology

Content Standard 3.3. Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.

Benchmark 9.3.3.1 Describe and explain the fundamentals, concepts, and their relevance in the plumbing trade

Topic 1: Fundamental of plumbing

Learning Objectives

By the end of this topic, the students will be able to;
1. Analyse and discuss the fundamental principles of Plumbing.
2. Explore the career pathways in plumbing trade.

Essential Questions:
1. What are the fundamental concepts of plumbing?
2. What is the importance of OHS at the workplace?
3. How does plumbing affect health and hygiene?
4. What are the career pathways in plumbing trade?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Fundamental concepts of plumbing systems and DWV distribution system	Discuss and explain	Appreciate the importance of plumbing	Respect and responsibility to the plumbing trade

Technology and Industrial Arts Application: Construction Technology: Plumbing Technology

Content Background

Introduction to Plumbing

Skilled trade workers are in high demand around the world today. A skilled worker is any person with special skills, training, knowledge or ability in their work. A skilled worker may have attended college, university or technical school. Skilled workers may have learned their skills on the job. Examples of skilled labour include engineers, software developers, crane operators, truck drivers, machinist, drafters, plumbers, craftsmen, and cooks. These workers are blue-collar workers, with varied levels of training or education, and plumbing is one of these trades.

The work required of a plumber is essentially important in our everyday lives. Because of plumbing, we can access fresh water to our homes, safely dispose waste, enjoy drinking cold water and enjoy the benefits of an air conditioning system. The proper disposal of sewage waste means healthy living for people. People with a plumbing trade certificate can find employment as pipefitters, gasfitters, sprinkler fitters and steamfitters.

Fundamental Concepts and Relevance of Plumbing Trade

What is Plumbing?

Plumbing is any system that carries fluids from a wide range of applications. Pipes, valves, plumbing fixtures, tanks, and other apparatuses carry fluids. Heating and cooling (HVAC), waste removal, and portable water delivery are the most common uses of plumbing. The word plumbing is derived from the Latin word *plumbum* for lead. Romans were the first to use lead pipes to carry water to the residence.

Plumbing at its core is a system of fixtures, pipes, valves, drains, and devices that are responsible for two important tasks within a building. The first is to distribute water and the second is to remove waste (sewage). The work performed by plumbers is very important. Here is a list of examples of functionality we enjoy because of plumbing:

- Access to fresh water from taps
- Disposal of waste and sewage
- Delivery of gas that powers appliances (including ovens) as well as heating and air conditioning systems.

Plumbing infrastructure is important for public health and sanitation today. Boiler makers and pipe makers are not plumbers although they work with piping as part of their trade and their work can include some plumbing.

Fundamentals of Plumbing

Here is an overview of how the plumbing system works. The plumbing system is made of the supply system, the drain system and the vent system.

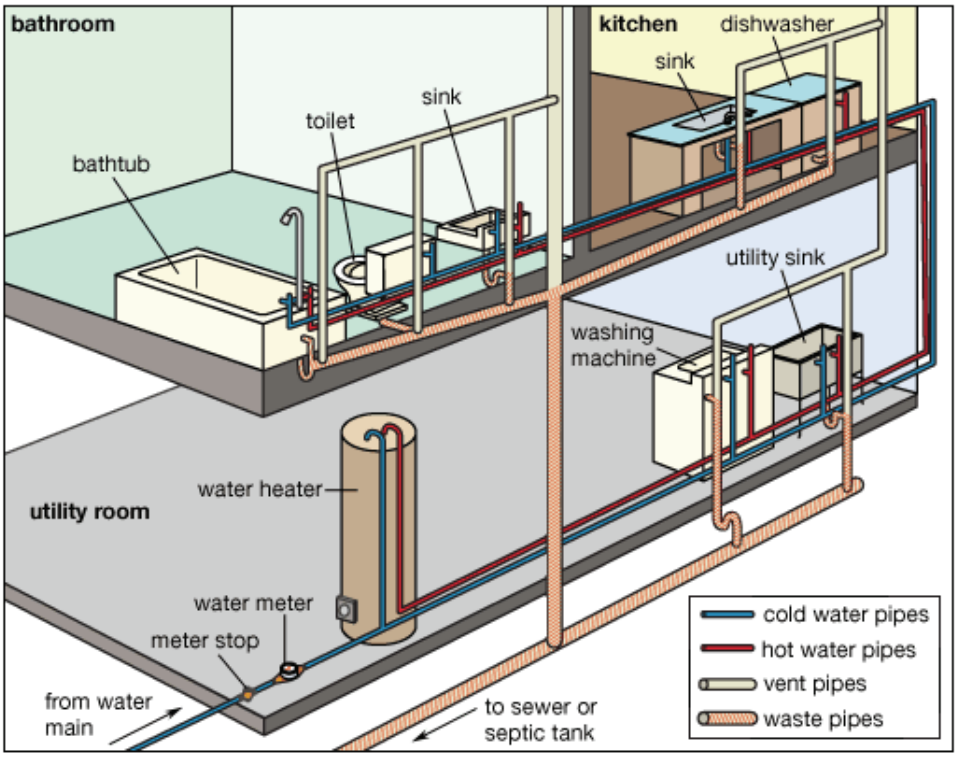
(i) The supply system brings fresh water into homes. It enters our homes under enough pressure to allow it to travel upstairs, around corners, or wherever else it's needed. In most cases a single supply pipe is used, usually in an inch (25mm) or larger in diameter that runs through a main shutoff valve or two and a water meter to the water heater, where it branches into cold and hot water pipes.

(ii) The drain system takes waste or sewage away. The DWV system also allows air to enter a plumbing system to maintain proper air pressure to enable the removal of sewage or greywater from a dwelling. Waste is produced at fixtures such as toilets, sinks, and showers. As the water runs down, proper venting is required to avoid a vacuum from being created. As the water runs

down air must be allowed into the waste pipe either through a roof vent, or the drain waste vent (DWV).

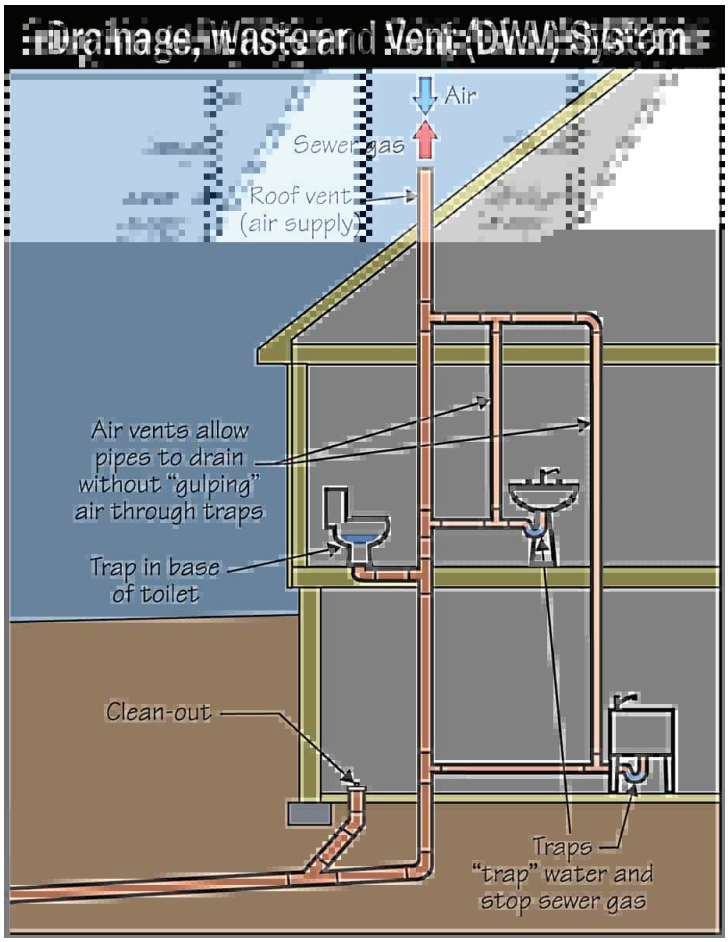
(iii) The vent system supplies air to the drainpipes so waste flows out freely. Because drains and vents use the same types of pipes and are tied together, they are referred to as the drain-waste-vent system (DWV). The air supplied by a vent system prevents siphoning action, which might otherwise pull water out of traps and toilets and allow sewage gases to enter the house. The vents carry the gases through the roof. Sewage gases, composed mainly of methane, is not only smelly, it is also harmful and dangerous.

A typical house plumbing system



© 2007 Encyclopædia Britannica, Inc.

Source:
https://www.google.com/search?q=plumbing+system+drawing&tbm=isch&rlz=1C1GCEU_enPG1032PG1032&hl=en&sa=X&ved=2ahUKEwi61OaO6Y__AhWr1HMBHY9zCB8QrNwCKAB6BQgBELYB&biw=983&bih=896#imgrc=1QVHRcEQtUTnFM&imgdii=FWlgoH0OsNS5EM



Source: **https://nextdayinspect.com/plumbing-vent-what-plumbing-vent/**

The plumbing drainage system in a home is called a drainage, waste, and vent (DWV) system. When water flows down the piping, an air supply (vent) is needed to allow the water to flow. Think of the vertical pipe as a drinking straw. If you plug the top end of a straw, the liquid won't drain from it.

The DWV system in a home consists of a series of pipes connected to each fixture; they extend above each fixture, and the system terminates at an open pipe that extends through the roof. This piping allows air into the system and prevents unbalanced pressures in the piping.

The vent also prevents the system from drawing water out of a trap at the fixture with the characteristic "glug-glug-glug" as the drain gasps for air. Plumbing traps should drain smoothly and never "glug" or gasp for air.

Types of Jobs in the Plumbing Trade

A plumber is a person who works in the skilled trades industry and specialises in the installation, repair, maintenance, and replacement of plumbing systems used for the distribution and removal of waste (sewage). Ultimately, a plumber makes it possible to transport water, air,

steam, gases, wastes, and different kinds of liquids throughout all types of buildings, from homes and offices to factories and hospitals.

Within the plumbing trade, there are six different specialties, including pipe layers, plumbers, pipefitters, steamfitters, sprinkler fitters and gasfitters. Each of these specialties focuses on one specific area and requires specialised skills and tools.

The common specialised jobs of plumbing trade are;

- **Pipefitters** concentrate on installing and maintaining pipes within industrial and commercial settings. Pipefitters generally work in power and industrial plants, where they install and maintain the pipe systems used for industrial purposes, such as manufacturing, power generation or large-scale heating and cooling systems. They work with both high-pressure and low-pressure systems. Pipefitters also install the automated controls that are used to regulate industrial systems, and they generally specialise in one specific type of system.

- **Pipe layers** provide the major framework for outside plumbing systems. They install the actual pipe to build these systems. Pipe layers begin by digging trenches and preparing the grade where the pipes will lay. They may dig manually or use machines. Once the trenches are dug, pipe layers line the trenches with clay, concrete or plastic. Piping is laid in these trenches for sewers, drains or water mains. These workers also construct oil and gas lines, and they typically solder, weld or cement pipes together in place.

- **Gasfitters** handle the installation of pipes used specifically to carry clean oxygen to hospital patients.

- **Sprinkler fitters** are a highly specialised group of plumbers. They perform the installation, repair, and maintenance of fire sprinkler systems within residential, commercial, and industrial buildings.

- **Steamfitters** work with pipe systems used to move steam under extreme pressurization within power plants and factories**.** Like pipefitters, steamfitters also generally work in power or industrial plants. Steamfitters specialise in pipe systems that move high-pressure liquids or gases.

- **Plumbers** work within residential, commercial or industrial properties to install and maintain water systems, including disposal, drainage and gas systems. In new construction, they work with blueprints to configure and install the plumbing systems. For maintenance and repair jobs, plumbers sometimes need to perform minor carpentry, such as cutting holes in walls to access pipes or hanging supports to hold pipes in place. They also install fixtures, such as showerheads, sinks and bathtubs, and appliances that use water, such as dishwashers and water heaters.

It is important to remember that plumbing is a complicated trade that requires a great amount of knowledge, skill, and experience in order to perform at an advanced level. It takes time and hard

work to become a master plumber (considered the highest level of the plumbing profession). Therefore, you can't expect to start out tackling the most advanced tasks.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the fundamental concepts and the relevance of plumbing trade. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Introduction to Plumbing

Teaching Strategies

Students are guided to investigate the plumbing trade and the skill of plumbing.

Learning Strategies

Activity 1

1. Through a series of guided activities, students define the term plumbing and try to identify what a plumber does.

Activity 2

1. Go out and interview the school plumber.
2. Research and identify the plumbing activities in the local vicinity/ area. Find out who has done it and why it was done.
3. Identify any problems with it or needs any improvement to be done.

Resources

Pictorial diagrams of the plumbing systems; supply, drain and vent systems.

Notes on- What is plumbing, what does a plumber do, and the Fundamentals of Plumbing.

Lesson 2: Fundamentals of Plumbing

Teaching Strategies

Students are guided into distinguishing the importance of plumbing in relation to the flow of water and other fluids,

Students are guided to do a research in their local vicinity to identify the application of DWV.

Learning Strategies

Activity 1

1. Research and describe the importance of plumbing in everyday living. This research activity must cover health and hygiene, socio-economic and environmental factors.

2. Establish a relationship between plumbing with water and other fluids.

Activity 2

1. Investigate the concept of DWV. Students work in groups to research and describe the plumbing systems with clear pictorial diagrams and explanation.

2. Display the pictorial diagrams of the supply, drain and vent systems with clear explanation.

3. From the pictorial diagrams, investigate any DWV system in the local vicinity. Eg. a staff house.

Resources

Notes on plumbing and its importance in health, water and sanitation

---

Lesson 3: Career pathways in Plumbing Technology

Teaching Strategies

Teachers introduce to students the purpose of offering plumbing as a subject of learning.

Students are introduced with the career pathways in plumbing to motivate them to take up plumbing as an option to pursue a career pathway.

Learning Strategies

Conduct a research with guiding questions that will lead students to discovering the terms trade and skilled workers and identify all the specialist fields of work in plumbing.

Activity 1 Investigate and describe what trade and skilled workers are with examples.

Activity 2 Explore and describe all the six specialist field of plumbing are.

Activity 3 Choose one of the specialist plumbing jobs you would like to study and give an explanation about the particular specialist field of plumbing and give reasons why you have chosen the specialist field in plumbing.

Resources

Flow charts on residential and commercial Plumbing

STEAM Activity Students work in groups to design/create a simple plumbing system in a residence or locality. Students can choose to design their project according to supply system, drain system or vent system (DWV). Depends on where they are. (locality)

Resource for steam activity

Consult the school plumber, handyman or any person familiar with the plumbing of the school or area. A family member in the plumbing trade will do.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to research and describe the fundamentals of plumbing and how it affects our everyday lives. They also analyse the job opportunities available in the plumbing trade. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Describe and define plumbing trade.
2. Identify the importance of plumbing trade.
3. Identify career pathways of plumbing trade?

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Describe and define plumbing trade.	Define and describe plumbing using trade terms clearly with examples.	Define and describe plumbing using trade terms	Define and describe plumbing using incorrect language with no examples.	Very poorly defines and describes plumbing.
2. Identify the importance of plumbing trade.	Identifies and analyses the importance of plumbing and the DWV systems with pictorial diagrams.	Identifies and describes plumbing using satisfactory language with minimal pictorial examples.	Identifies and describes plumbing using incorrect language with no pictorial examples.	Very poorly identifies and describes plumbing with no pictorial examples.
3. Identify career pathways In plumbing	Identify all six (6) career pathways of plumbing with clear descriptions.	Identifies only four (4) career pathways of plumbing with explanation.	Identifies only two (2) career pathway of plumbing with incorrect explanation.	Does not identify any career pathways.

UNIT 3. Plumbing Technology

Content Standard 3.3. Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.

Benchmark 9.3.3.2 Analyse and describe OHS Regulations and standards in the plumbing trade and work places.

Topic 2: OHS regulations and standard

Learning Objectives By the end of this topic, the students will be able to;

1.Discuss OHS regulations and standards used in plumbing technology.

Essential Questions:

1. What is Occupational Health and Safety?
2. What are the reasons to practice Occupational Health and Safety Standards at workplace?
3. What types of OHS Codes and Standards are required of those who have the responsibilities and obligations?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
(i) Occupational Health and safety standards (ii) Health and hygiene	Analysing and describing OHS and Codes & Standards of compliance	Being rational in the prevention of work related injuries.	Be responsible and alert to possible safety hazards

Technology and Industrial Arts Application: Construction Technology: Plumbing Technology

Content Background

What is Occupational Health and Safety?

The term occupational health and safety (OHS) is used to cover a broad range of workplace practices together with local and national laws. The World Health Organisation's (WHO) definition on OHS is to deal with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards. All organisations that employ or hire people to work for them must have a workplace OHS and they must comply with the national laws.

Health is a state of complete physical, mental and social well-being and not just the absence of disease. Healthcare is concern with enabling an individual to undertake their occupation with care and responsibility so that it causes least harm to their health.

The aim of OHS is to reduce work related injuries, making a healthier and safe working environment for all concerned. OHS may also protect co-workers, family members, employers, customers, and many others who might be affected by the workplace environment.

The goal of occupational health and safety programs is to foster a safe and healthy work environment.

Types of Regulations.

Occupational Health and Safety (OHS) policies are an important part of any OHS management system. An OHS Policy is simply a method of stating how employers, employees, contractors and visitors are expected to behave when they are on company property or performing company related activities. The Occupational Health and Safety (OHS) Regulations are part of the Workers Compensation laws in PNG which contain legal requirements for workplace health and safety meet minimum standards by all workplaces under the law.

These regulations cover a wide range of areas examples including the rights and responsibilities of employers and their employees.

Types of Standards or Codes

Compliance codes and codes of practice provide practical guidance to those who have duties or obligations under occupational health and safety, dangerous goods and workers compensation legislation. The following are examples of codes of compliance;

- Communicating occupational health and safety across languages
- Confined spaces
- Demolition
- Excavation
- Facilities in construction
- First aid in the workplace
- Hazardous manual handling
- Hazardous substances
- Managing asbestos in workplaces
- Noise

- Prevention of falls in general construction
- Prevention of falls in housing

It is required by law that those who have the duties and obligations under OHS to practice them and not to put themselves, those around them and equipment in danger.

What are safety precautions in plumbing?

It's crucial for plumbers to always wear protective gear for the eyes, skin, and lungs: goggles, gloves, and a face mask. Plumbers will need gloves to protect their hands from germs and infection, goggles to keep their eyes free from wastewater, flying objects, and chemicals, and a mask to filter contaminants in the air.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to define and analyse Occupational Health and Safety (OHS). The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: OHS regulation and standards.

Teaching Strategies
What is occupational Health and safety?
Discussions in groups on the research findings.

Learning Strategies
Activity 1. Define the meaning of Occupational Health and safety.
Activity 2. Which group of people does OHS protect? Explore and describe.
Activity 3. Explore and analyse the main purpose of OHS and its policies at the workplace.

Resources:
Safety manual or first aid manual of the working shop.

Lesson 2: Application of OHS and Standards and Regulations in Plumbing
Teaching Strategies
What types of OHS Codes and Standards are required of those who have the responsibilities and obligations?
Through a series of guided activities, students explore and describe standards or codes in Plumbing
Learning Strategies
Activity 1 Explore and analyse why Occupational Health and Safety policies are important in Plumbing

UNIT 3. Plumbing Technology

Content Standard 3.3. Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.

Benchmark 9.3.3.3 Demonstrate and apply basic plumbing tools and equipment and their specifications and practice in trade math.

Topic 3: Plumbing Tools and Equipment

Learning Objectives
By the end of this topic, the students will be able to;
1. Discover and discuss tools and equipment used in plumbing.

Essential Questions:
1. What tool and equipment are appropriate for specific plumbing application.

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
basic plumbing tools and equipment and specifications.	Demonstrate and application	Being innovative in the use of plumbing tools and applications.	Confidence and differentiate

Technology and Industrial Arts Application: Plumbing Technology

Content Background

What are plumbing tools and equipment?

Plumbing is one of the most enjoyable and exciting careers. It involves various activities such as installation, repair, maintenance of pipes and other equipment used in the distribution of water and disposal of waste in both residential and commercial buildings.

As a beginner, it is essential for you to make a list of plumbing tools that will help you carry out your day to day activities and improve your performance. Basic plumbing tools come under manual or power tools. Some power tools are light and portable whilst other are heavy duty, therefore they are static.

Types of manual plumbing tools.

Manual tools are hand tools which do not require electricity to operate them.

The table below contains some basic examples of manual plumbing tools.

Name of	Use	Tool
Tape measure	Tape measure is a simple but essential tool that every plumber must have. It's used in measuring various dimensions of the plumbing system.	
Adjustable wrenches	Wrenches vary with the size of the jaw head, shape, purpose as well as their handle size (see our post on the best adjustable wrench for more info). They play a critical role in holding, turning, removing or even fitting plumbing pipes and fixtures, which is why they should be included in your plumbing tools list.	
Screwdrivers	Should also be included in your plumbing tools list. They come in different sizes and shapes. They help in either screwing or unscrewing a wide variety of connections with the aid of nuts and nails.	
Pipe and tube cutters	These plumbing tools have adjustable heads to fit the size of the tube or pipe. They are used to cut both metallic and plastic equipment and should be part of your plumbing tools list.	
Gloves, goggles, and ear plugs	As a plumber, you'll be expected to work in different settings. As a result, you'll always be at risk of injury. Ear plugs, goggles, and gloves should be in your plumbing tools list to minimize the severity of injuries and enhance your safety.	

Teflon tape	Teflon tape is used on faucets, pipes as well as other components of the plumbing system to ensure that the connections are tight and leak-proof.	
Hack Saw	For cutting metals and plastic pipes	

Types of power tools and their uses.

Power tools used in plumbing require electricity to operate them. The power tools use by plumber include;

The table below shows some of the power tools used by plumber.

Name	Use	Power tool
Power Drill Corded and cordless	Power drills are handy tools for numerous jobs around the home, from installing large picture hangers to making furniture.	
Pipe threading machines	For cutting external and internal threads of pipes.	
Drain Cleaning Machine	Help clear drains quickly and efficiently with a drain cleaning machine from Grainger. Find a variety of medium- and heavy-duty drain cleaning machines that can blast through even the toughest clogs. Whether you require portability, high power or both — Grainger has a drain cleaning machine to help keep your facility running.	

Other power machines are:

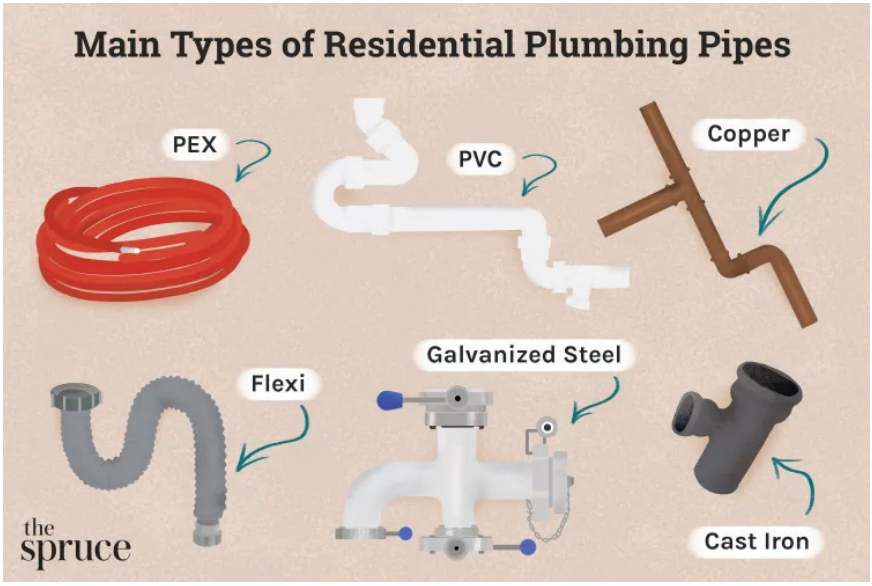
- Plumbing snakes
- Drill driver
- Pipe cutting machine

Types of plumbing materials and specifications

A home **plumbing** system will have different types of **piping materials** for different uses, including fresh water supply, waste drainage, irrigation, gas **pipes** for appliances, and so on. The type which is used in each application will largely depend on the age of the home **plumbing** system.

Here are types of plumbing materials used in piping for waste lines, water supply pipes, and natural gas supply:

- Cast iron for plumbing waste lines
- PVC (PolyVinyl Chloride) for plumbing waste lines
- Chromed brass for plumbing waste lines
- Chromed copper for water supply lines
- Galvanized iron for water supply lines



Source: https://www.thespruce.com/basic-types-of-plumbing-pipes-1822487

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic through guided discovery and research will enable students to identify and use plumbing tools and equipment correctly. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Plumbing Tools and Equipment

Teaching Strategies

What tool and equipment are appropriate for specific plumbing application?

Guide the students to identify and describe plumbing tools and equipment correctly.

Learning Strategies

Activity 1: Identify and describe the basic plumbing tools and equipment.

Activity 2: Identify and describe different types of pipes used in plumbing.

Activity 3: Identify and describe different types of plumbing fixtures.

Resources

Notes on plumbing tools

Examples of plumbing tools and equipment.

Lesson 2: Manual Tools

Teaching Strategies

Guide the students to explore and identify manual plumbing tools, their uses and applications.

Learning Strategies

Activity 1: Brainstorm on describing manual tools used by plumbers.

Activity 2: Investigate and describe different types of manual plumbing tools.

Activity 3: Produce pictorial diagrams of manual plumbing tools.

Resources

Notes on manual plumbing tools.

Examples of manual plumbing tools.

Lesson 3: Power tools

Teaching Strategies

Brainstorm to identify the power tools used by plumbers.

Learning Strategies

Activity 1: Brainstorm on describing power tools used by plumbers.

Activity 2: Investigate and describe different types of power plumbing tools.

Activity 3: Produce pictorial diagrams of manual plumbing tools.

Resources

Notes on power plumbing tools

Examples of power plumbing tools

Lesson 4: Types of Plumbing Materials and Specifications

Teaching Strategies

Guide students to explore types of plumbing materials.

Learning Strategies

Conduct a research with guiding questions that will lead to discovering what the terms are.

Activity 1: Research and identify types of plumbing materials.

Activity 2: Research and identify types of Plastic pipes used in plumbing.

Activity 3: Research and identify types of fixtures used in plumbing.

Resources

Notes on plumbing materials

Examples of plumbing materials.

STEAM Activity Students work in groups to create an activity incorporating plumbing tools and equipment.

Assessment

The main purpose of assessment is to find out if students can use the skills of synthesis to identifying and describe the tools and materials used in plumbing correctly. Students will also be assessed on their competency in the use and application of plumbing tools and materials correctly. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Identify basic tools and equipment and specifications.

2. Describe types of manual and power tools.

3. Describe types of plumbing materials and specifications.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify basic tools and equipment and Specifications.	Identifies and correctly describes plumbing tools and equipment and their specifications using correct technical terms with examples.	Identifies and describes plumbing tools and equipment and their specifications using correct technical terms without examples.	Identifies and describes plumbing tools and equipment and their specifications using incorrect technical terms.	Very poorly identifies and describes plumbing tools and their specifications.
2. Describe types of manual and power tools.	Correctly describes and uses manual and power plumbing tools to specific applications in plumbing.	Describes and uses manual and power tools to all applications in plumbing	Describes and uses manual and power tools in some applications in plumbing	Very poorly describes uses manual and power tools used in plumbing.
3. Describe types of plumbing materials and specifications.	Correctly describes and uses plumbing materials to specific applications in	Describes plumbing materials and their specifications but does not use	Describes plumbing materials and their specifications using incorrect	Very poorly describes and applies plumbing materials and their

UNIT 3. Plumbing Technology

Content Standard 3.3. Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.

Benchmark 9.3.3.4 Explore and apply basic concepts of trade drawings in plumbing.

Topic 4: Trade Drawing in Plumbing

Learning Objectives
By the end of this topic, the students will be able to;
1. Discuss fundamental principles and types of drawing in trade drawing in plumbing.

Essential Questions:
Why is technical drawing important in construction?
Who uses technical drawings?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Technical drawing for construction.	Explore the technical purpose of trade drawings and correct apply them.	Guide students to become creative.	Creative and innovative

Technology and Industrial Arts Application: Construction Technology; Plumbing Technology

Content Background

1. Types of lines used in trade drawing.

Line types used in technical drawing are used for different purposes to provide specific information to the people looking at the drawing. Drafting students or those reading the drawings have to learn what they mean, just as one learns a new language. It is a basic requirement and learned early in drafting instruction.

There are different types of lines used in technical drawing. The table below contains the types of lines used in technical drawing with their explanation.

Which type pencil use to draw which type of line?

For sketching you can use **H or HB pencil** and for shading you can use 4B and 6B . Harder leads are used for roughing out your drawings. Harder leads are very light and so good for sketching outline of drawing.

Illustration	Application
Thick	Outlines, visible edges, surface boundaries of objects, margin lines
Continuous thin	Dimension lines, extension lines, section lines leader or pointer lines, construction lines, boarder lines
Continuous thin wavy	Short break lines or irregular boundary lines – drawn freehand
Continuous thin with zig-zag	Long break lines
Short dashes, gap 1, length 3 mm	Invisible or interior surfaces
Short dashes	Center lines, locus lines Alternate long and short dashes in a proportion of 6:1,
Long chain thick at end and thin elsewhere	Cutting plane lines

2. What is trade drawing?

Technical drawing or drafting is a process of composing drawings that visually communicate how something functions or is constructed. Technical drawing is essential for communicating ideas in industry and engineering. Technical drawings communicate to building contractors and manufacturers how to construct buildings, consumer products, highways and automobiles.

Technical drawing professionals work under the supervisors of engineers, architects and designers to transform their ideas and designs into action plans. To make drawings easier to understand, people use familiar symbols, perspectives, units of measurement, notation systems, visual styles, and page layout. Together, such conventions make up a visual language and help to ensure that the drawing is clear and relatively easy to understand. Many of the symbols and principles of technical drawing are globally accepted and understood.

The need for precise communication in the preparation of a functional document distinguishes technical drawing from the expressive drawing of the visual arts. Artistic drawings are subjectively interpreted; their meanings are multiply determined. Technical drawings are understood to have one intended meaning.

Each trade has its own types and styles of drawing, however they must conform to the universally agreed practices.

3. Methods of Isometric Drawing.

An isometric drawing is a sketch that shows a three-dimensional object on a single plane. The plane is typically a sheet of paper. The purpose of an isometric drawing is to give the draftsperson a way to show how an object looks in the real world. Isometric drawings use both vertical and horizontal lines to represent an object.

How are objects drawn in isometric perspective?

Three-dimensional objects are often drawn in isometric perspective because the drawing is in three dimensions, gives a correct visual impression (top, front and side views) and the distances and lengths are to scale.

What is the advantage of isometric drawings?

One advantage is that in isometric pictorial sketching, you are able to see more of the object. Since it is at angle, the object can be exposed on its side, back, and front all at once. This can be done using an oblique sketch, but each side is not shown as much as the other.

How many axis has an isometric drawing?

The Isometric Cube is the building block of isometric drawing. Its three dimensions are represented by three equal planes that sit on three axis. The vertical axis sits at 90° to the horizontal while the two horizontal axes sit at 30°.

What is the opposite of an isometric?

The Opposite of Isometric Exercises. Related Articles. When you do an isometric exercise, you tighten a specific muscle without moving at the joint or visibly changing the length of the muscle. Isotonic exercises are the opposite, requiring you to bend and straighten at the joint, moving it through its full range of motion.

4. Methods of Pictorial Drawing.

An isometric drawing is a pictorial representation of an object in which all three dimensions are drawn at full scale. The term isometric means equal measurement. Isometric drawing is the most commonly used method of pictorial drawing. Isometric drawings are built on three lines called isometric axes. One is drawn vertically and the other two with 30 set square either side of it.

Isometric drawing differs from a perspective view in that all lengths are shown true length. In a perspective drawing the objects that are depicted to be more distant are shortened to make the view more realistic looking. The illustration below shows isometric drawings.

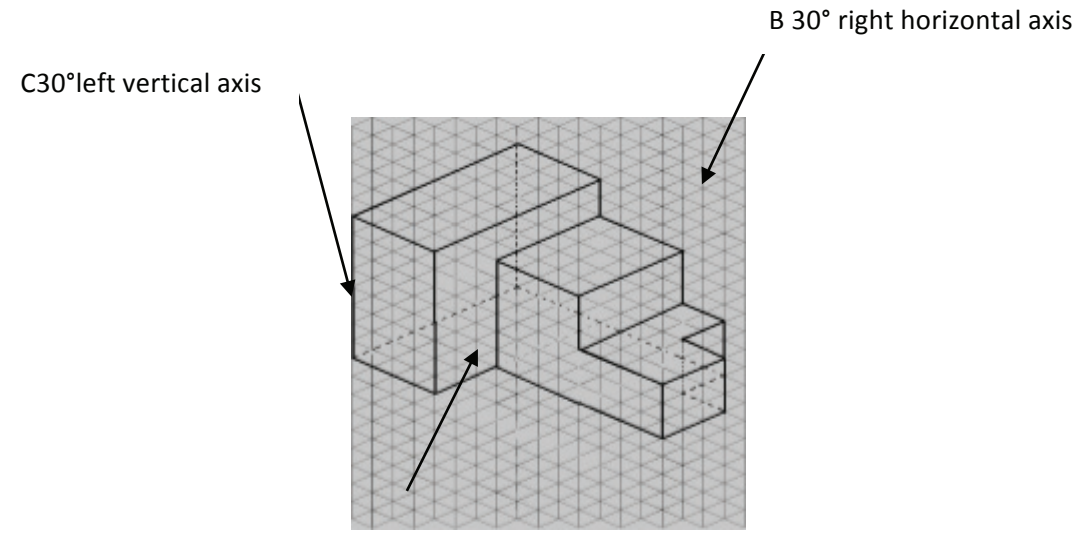


Fig.1 Isometric drawing

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to explore and describe the technical reasons for trade drawing in the construction industry. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Trade drawing

Teaching Strategies

Guide the students to explore technical and creative arts drawings and differentiate technical drawing from creative arts drawing.

Learning Strategies

Activity 1: Through a series of guided discovery activities students explore and define technical drawings.
Activity 2: Technical drawing is a “universal language”. Investigate how it is a universal language.
Activity 3: Explore and analyse the need for good communication in technical drawing.

Resources
Notes on technical drawing
Diagrams illustrating isometric drawings
Technical drawing equipment

Lesson 2: Method of Isometric Drawing

Teaching Strategies
Illustrate to students how isometric drawings are constructed using the correct projection and drawing equipment.
Learning Strategies
Activity 1: Guide the students to define clearly Isometric Drawing using pictorial diagrams.
Activity 2: Construct two isometric drawings using correct drawing equipment and dimension lines to scale.
Activity 3: Investigate and construct an orthographic drawing to contrast isometric drawing.

Resources
Notes on isometric drawing
Pictorial diagrams of isometric drawing
Technical drawing equipment

Lesson 3: Method of pictorial drawing

Teaching Strategies
Display examples of pictorial drawings of a plumbing system. Guide students to analyse the different symbols representing pipes and fixtures on the diagram.

Learning Strategies
Activity 1: Explore and describe pictorial diagrams with examples.
Activity 2: Construct a pictorial diagram of the water supply system of a house in isometric projection. (Plumbing*)*
Activity 3: Do a presentation of the pictorial diagram constructed. Explain in detail all the pipes and fixtures shown on the diagram.

Resources
Notes on pictorial diagram
A4 paper
Technical drawing equipment

STEAM Activity: Students work in groups to create an activity incorporating trade drawings in plumbing.

Assessment

The main purpose of assessment is to find out if students can use the skills of synthesis to define, explore and describe clearly with examples technical drawing, so that they can apply them to real life situation. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define trade drawing.
2. Describe methods of Isometric drawing.
3. Describe method of Pictorial drawing.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define trade drawing.	Define trade drawing clearly using correct technical terms with examples.	Define trade drawing using correct technical terms.	Define trade drawing using incorrect technical terms with no examples	Very poorly defines trade drawing.
2. Describe methods of Isometric drawing.	Describes and constructs Isometric Drawing using the isometric projection correctly and using the correct drawing equipment.	Describes and constructs Isometric Drawing using the isometric projection but using incorrect drawing equipment.	Describes and constructs isometric Drawing but not using the correct projection and using incorrect drawing equipment.	Very poorly describes and construct Isometric Drawing.
3. Describe method of Pictorial drawing.	Describes and constructs Pictorial Drawing using the isometric projection correctly and using the correct drawing equipment.	Describes and constructs Pictorial Drawing using the isometric projection but using incorrect drawing equipment.	Describes and constructs Pictorial Drawing but not using the isometric projection and using incorrect drawing equipment.	Very poorly describes and constructs Pictorial Drawing.
4. Identify the types of lines used in trade drawing.	Correctly using the types of lines used in technical drawing and also using appropriate drawing equipment correctly.	Using the types of lines used in technical drawing and drawing equipment.	Using the types lines correctly but does not use drawing equipment correctly.	Does not use lines correctly in technical drawing.

Unit 4: Welding Technology

Units	Benchmarks	Topics	Lesson Titles
4. Welding Technology	**9.3.4.1.** Investigate safe workshop set-up and safety procedures in welding.	Topic 1: Workshop organisation	1: Workshop Set-up 2: Workshop safety procedures
	9.3.4.2. Explore and interpret welding principles, codes and standards	Topic 2: Welding principles, codes and standards.	1: Welding Principles 2: Welding Codes 3: Welding Standards
	9.3.4.3. Demonstrate knowledge in fundamental print reading, measurement and layout or fit-up techniques.	Topic 3: Measurement techniques	1: Measurement 2: Print reading 3.Measurement units and drawing instruments 4: Dimensioning, Layout/ fit-up Techniques
	9.3.4.4. Investigate and analyse the properties of metals	Topic 4: Properties of Metals	1: Types of metals 2: Metal Properties
	9.3.4.5. Investigate the various welding techniques and cutting processes	Topic 5: Cutting & Welding	1: Types of Welding 2: Thermal cutting, heating and gouging 3: Brazing 4: Careers in welding

UNIT 4: Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 9.3.4.1 Investigate safe workshop set-up and safety procedures in welding.

Topic 1: Workshop organisation

Learning Objectives
By the end of this topic, the students will be able to;
1. Investigate safety procedures in a welding workshop.

Essential Questions:
1. What is a workshop set up?
2. What do we consider when setting up a welding workshop?
3. What are the workshop safety procedures in welding?

Essential Knowledge, Skills, values and attitudes:

Knowledge	Skills	Values	Attitudes
safe workshop set-up, safety procedures	Investigate	Safe appreciate	Respect the evolution of the concept

Technology and Industrial Arts Application: Construction Technology, Welding Technology

Content Background

Workshop set-up

In creating a smooth-running, functional and efficient welding lab, time spent beforehand is well worth the investment; so is choosing the right welding equipment, which can decrease energy costs, increase space and provide arc quality that promotes learning.

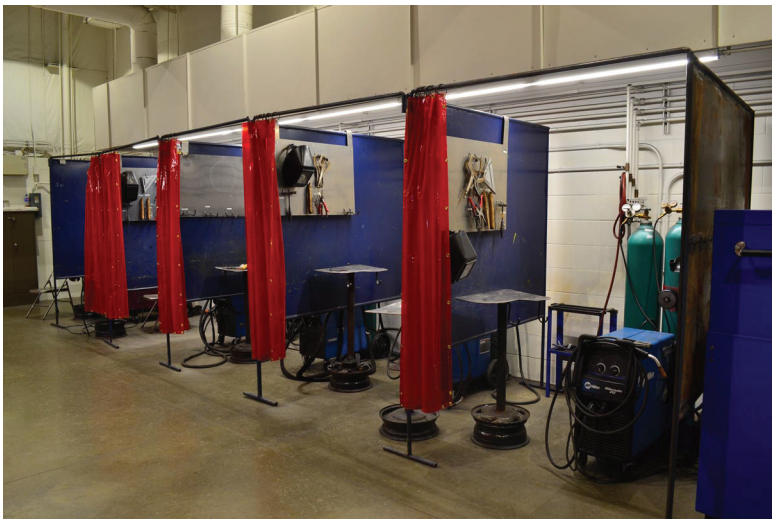
The smoothly functioning multi-process welding shop strikes a balance between spaciousness and space-efficiency. Shops with large overall footprints can decrease productivity by increasing walking time between various stations, such as work tables, welding booths, cutters, grinders, hydraulic presses and cooling tanks. Conversely, laying out a shop to economise on space – shoe-horning equipment, stations and welding operators in small areas and booths – creates problems too, as welders struggle to work in cramped quarters and avoid collisions with each other and their equipment.

2 X 3 meters [approx. 7 X 10 ft.] is a perfect booth size to accommodate the student, the equipment and an instructor to assist with hands-on skill training. Clearly, there is need for a smaller power source. An inverter would take up approximately 20-percent less space than a

rectifier type unit. Selecting the equipment ahead of time plays a big role in the shop's final layout.

Some tool organisers that help keep the welding lab organised.

- Put it on paper
- Assembling the welding shop
- Electricity connections
- Gases
- Fume extraction
- Common Areas
- Grinders



Workshop safety procedures

Welding Safety Hazards

Welding operations present several hazards to both those undertaking the activity and others in the vicinity. Therefore, it's important that one is aware of the risks and hazards welding poses, and understand what precautions one can take to protect yourself.

Electric Shock

During the arc welding process, live electrical circuits are used to create a pool of molten metal. Therefore, when welding, one is at risk of experiencing an electric shock. Electric shock is the most serious hazard posed by welding and can result in serious injuries and fatalities, either through a direct shock or from a fall from height after a shock. One is also at risk of experiencing a **secondary electric shock** should he touch part of the welding or electrode circuit at the same time as touching the metal he is welding.

One is particularly at risk if he works in electrically hazardous conditions. These include welding:

- In damp conditions.
- While wearing wet clothing.
- On metal flooring or structures.
- In cramped conditions where you are required to lie, kneel or crouch.

Noise Hazards

When carrying out welding activities, you are likely to be exposed to loud, prolonged noises. A loud noise is considered to be above 85 dB(A), and welding activities such as flame cutting and air arc gouging can produce noise levels of over 100 dB(A). This can be very damaging to the ears and can result in hearing impairment.

Regular or immediate exposure to loud noises can cause permanent noise-induced hearing loss.

Noise-induced hearing loss can have the following side effects:

- Ringing in the ears, known as tinnitus.
- Occasional dizziness, known as vertigo.
- Increased heart rate.
- Increased blood pressure.

Exposure to UV and IR Radiation

Looking at the intense bloom of UV light produced when welding, without appropriate PPE or welding curtains, can result in a painful and sometimes long-lasting condition called **arc-eye**. Many factors can affect the severity of a flash burn injury, such as distance, duration and the angle of penetration. Long-term exposure to arc flashes could also potentially result in cataracts and lead to a loss of vision.

Other forms of eye damage include:

- **Foreign bodies** entering the eye, including grit, sparks and dust.

- **Particulate fumes and gases,** which could lead to conjunctivitis.

Exposure to Fumes and Gases

Undertaking welding activities will expose one to invisible gaseous fumes, including ozone, nitrogen oxides, chromium and nickel oxides, and carbon monoxide which can easily penetrate into the lungs. Depending on the gas or fume, the concentration and duration of the exposure, the resultant damage can be severe.

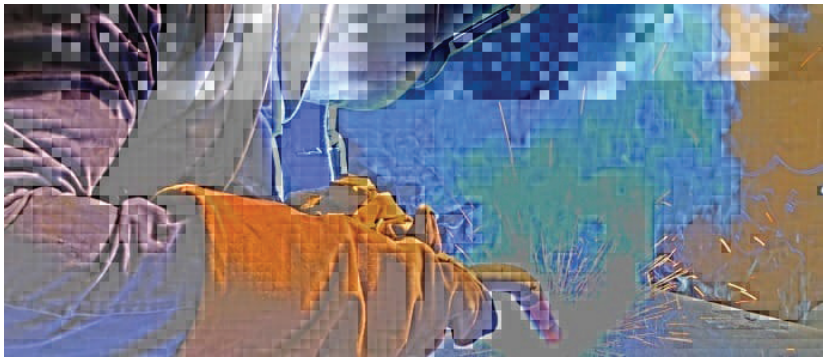
Illnesses caused by welding fumes and gases include:

- **Pneumonia.** Regular exposure to welding fumes and gases can result in a lung infection which could then develop into pneumonia. While antibiotics can usually stop the infection, severe pneumonia can result in hospitalisation, serious illness and fatalities.
- **Occupational asthma.** Chromium oxides and nickel oxides produced by stainless steel and high nickel alloy welding can both cause asthma.
- **Cancer.** All welding fumes are internationally considered 'carcinogenic'.
- **Metal fume fever.** Welding or hot work on galvanised metal and high steel weld fume exposure can often result in 'flu-like' symptoms, which are usually worse at the start of the working week. One might have heard that drinking milk before welding will help to avoid developing metal fume fever, but this is a **myth.**
- **Throat and lung irritation,** including throat dryness, tickling of the throat, coughing and tight chests.

Burns

The combination of high-temperature welding arcs, UV rays and molten metal means one is susceptible to severe burns when welding. These burns can affect the skin or eyes and can be very serious. They can also happen **very** quickly.

Burns usually occur when welders think they can skip taking precautions for a few quick welds. This is bad practice. If the outlined precautions are followed, burns can be prevented.



Welding Safety Precautions

Ensuring high levels of safety is vital when undertaking any welding activity. Ignoring PPE and safe working practices can have serious repercussions and might even lead to fatalities. Therefore, following the safety precautions below can protect one at work.

Always Wear Appropriate PPE

Employers and Managers have a duty to provide workers with the appropriate **Personal Protective Equipment (PPE)**. The PPE each one will receive will include:

- **Welding helmets with side-shields.** Welding helmets provides protection from UV radiation, particles, debris, hot slag and chemical burns. It's important that one wears the right lens shade for the work he is carrying out. Following the manufacturer's guidelines, gradually adjust the lens filter until one has good visibility that does not irritate your eyes. Also one should use a fire-resistant hood under the helmet to protect the back of the head.
- **Respirators.** Respirators protect from fumes and oxides that the welding process creates. The respirator must be suitable for the work being carrying out.
- **Fire resistant clothing.** Fire resistant clothing protects from heat, fire and radiation created in the welding process and shields from burns. It should have no cuffs, and pockets must be covered by flaps or taped closed. One should not use synthetic clothing. Instead, opt for leather and flame-resistant treated cotton.
- **Ear protection.** Ear protection protects from noise hazards. Its important one wears ear protection that is appropriate for the noise created in the workplace, and use fire resistant ear muffs if there is a risk of sparks or splatter entering the ear.
- **Boots and gloves.** Insulated, flame resistant gloves and rubber-soled, steel toe-capped safety shoes shields from electric shocks, heat, fire, burns and falling objects.

To receive full protection from your PPE, one must not:

- **Roll up sleeves or trousers.** Rolling up clothes will leave one susceptible to molten metal or sparks getting caught in the folds, which could potentially lead to severe burns. One should also never tuck his trousers into his work boots.
- **Remove helmet while welding.** One must always wear a helmet when welding and when in the vicinity of another welder. While the intensity of the radiation produced decreases the further one from a welding arc, those less than 10 metres away are still susceptible to arc-eye. Therefore, it's important that one remains behind welding curtains or wear the correct PPE, even if one isn't the worker carrying out the welding operation.

Receive Appropriate Training

Prior to starting any welding work, it's important that adequate training is received in the use and safety of welding work. Opportunities are available that are flexible and cost effective

Ensure the Workspace is Well Ventilated.

Good ventilation is important when welding as it removes airborne gases and particles from the work area. A combination of ventilation strategies to combat all the pollutants created in the welding process and there is a need to use respirators if the ventilation strategies don't reduce the exposure enough.

Ensure the Workspace is Free of Flammable Material.

One should avoid keeping flammable materials in the vicinity of welding processes as sparks, heat and molten metal splatters produced in the welding process could potentially set flammable material on fire.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of Safe workshop set-up and safety welding procedures. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning.

Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Safe workshop set-up

Teaching Strategies:

Students are engaged in brainstorming exercise to discover the *safe workshop set-up* in an allocated research or discussion group.

They then are allowed to design guiding questions that will enable them to conduct research on discussions in groups on their research.

Learning Strategies:

Be involved in brainstorming exercise to discover the concept of the *safe workshop set-up*.

Teacher	Students
Introduction	
1. What is 'safe workshop set-up'? 2. How is '*safe workshop set-up*' carried out?	1. Discuss in groups what is '*safe workshop set-up*'? 2. Also have discussions on how is '*safe workshop set-up*' carried out?
Body	
Activity 1 Brainstorm on what is '*Safe workshop set-up'*? **Activity 2** Research on what is '*Safe workshop set-up'* using the library or Google. Assist students with the sources below. **Activity 3** Groups Present their findings on the '*Safe workshop set-up'*	Do brainstorming activity Conduct research Group presentation of the findings
Conclusion	
Conclude lesson with main concepts being explained on the board	Take lesson notes
Assessment	
Assess the research and the presentation activities	Complete assessment task.

Resources:

MFW Industry standards

Lesson 2: Safety welding procedures

Teaching Strategies

Engage students in the discussion on *Safety welding procedures*.

Engage them to design guiding questions that will enable them to conduct research on *Safety welding procedures* from their group discussions.

Learning Strategies

Discover *Safety welding procedures* in their research activity using guide questions that they've derived from their discussions.

Teacher	Students
Introduction	
1. What are Safety welding procedures? 2. Instruct students to develop guide questions to assist them in their research activity). 3. What are the applications on *Safety welding procedures*?	1. Form groups and brainstorm on the *Safety welding procedure* 2. Think and develop guide questions to lead into their research work for presentation.
Body	
Activity 1 Brainstorm what is *Safety welding procedures.* **Activity 2** Research on the applications of *Safety welding procedures*? **Activity 3** Group Presentation on their research findings.	Do brainstorming activity Conduct research Group presentation
Conclusion	
Conclude lesson with main concepts being explained	Take lesson notes
Assessment	
Assess the research and presentation activities.	Complete assessment task.

Resources: MFW Industry standards

STEAM Activity: Students work in groups to create a STEAM activity that incorporates the Safety welding procedures.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to critically analyse what *Workshop organisation* is all about in the welding field based on these two learning objectives;

1. Discovering *Safe workshop set-up* and
2. Investigating *Safety welding procedures*.

Performance Assessment

1. Safe workshop set-up
2. Safety welding procedures

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Discover and express correctly what *Safe workshop set-up* is in welding and list 4 examples of the set-up procedures.	Correct explanation of the topic and 4 correct examples.	Correct explanation of the topic and 3 correct examples.	Correct explanation of the topic and 2 correct examples.	Correct explanation of the topic and 1 correct examples.
2. Investigate and explain *safety welding procedures* with at least six (6) examples recommended by welding codes and standards.	Investigate and explain *safety welding procedures* with at least six (6) examples recommended by welding codes and standards.	Investigate and explain *safety welding procedures* with five (5) examples recommended by welding codes and standards.	Investigate and explain *safety welding procedures* with four (4) examples recommended by welding codes and standards.	Investigate and explain *safety welding procedures* with only three (3) examples recommended by welding codes and standards.

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 9.3.4.2 Explore and interpret welding principles, codes and standards

Topic 2: Welding codes and standards

Learning Objectives:

By the end of this topic, the students will be able to;
1. Discover and interpret welding principles, codes and standards

Essential Questions:
1. What are basic welding principles?
2. What are welding codes and standards?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
1.Welding principles, codes and standards	Explore, interpret	Appreciate and Value	Appreciate

Technology and Industrial Arts Application: Construction Technology, Welding Technology

Content Background:

Welding principles

A weld can be defined as a coalescence of metals produced by heating to a suitable temperature with or without the application of pressure, and with or without the use of a filler material.

In fusion welding a heat source generates sufficient heat to create and maintain a molten pool of metal of the required size. The heat may be supplied by electricity or by a gas flame. Electric resistance welding can be considered fusion welding because some molten metal is formed.

Solid-phase processes produce welds without melting the base material and without the addition of a filler metal. Pressure is always employed, and generally some heat is provided. Frictional

heat is developed in ultrasonic and friction joining, and furnace heating is usually employed in diffusion bonding.

The electric arc used in welding is a high-current, low-voltage discharge generally in the range 10–2,000 amperes at 10–50 volts. An arc column is complex but, broadly speaking, consists of a cathode that emits electrons, a gas plasma for current conduction, and an anode region that becomes comparatively hotter than the cathode due to electron bombardment. A direct current (DC) arc is usually used, but alternating current (AC) arcs can be employed.

Total energy input in all welding processes exceeds that which is required to produce a joint, because not all the heat generated can be effectively utilised. Efficiencies vary from 60 to 90 percent, depending on the process; some special processes deviate widely from this figure. Heat is lost by conduction through the base metal and by radiation to the surroundings.

Most metals, when heated, react with the atmosphere or other nearby metals. These reactions can be extremely detrimental to the properties of a welded joint. Most metals, for example, rapidly oxidize when molten. A layer of oxide can prevent proper bonding of the metal. Molten-metal droplets coated with oxide become entrapped in the weld and make the joint brittle. Some valuable materials added for specific properties react so quickly on exposure to the air that the metal deposited does not have the same composition as it had initially. These problems have led to the use of fluxes and inert atmospheres.

In fusion welding the flux has a protective role in facilitating a controlled reaction of the metal and then preventing oxidation by forming a blanket over the molten material. Fluxes can be active and help in the process or inactive and simply protect the surfaces during joining.

Inert atmospheres play a protective role similar to that of fluxes. In gas-shielded metal-arc and gas-shielded tungsten-arc welding an inert gas—usually argon—flows from an annulus surrounding the torch in a continuous stream, displacing the air from around the arc. The gas does not chemically react with the metal but simply protects it from contact with the oxygen in the air.

The metallurgy of metal joining is important to the functional capabilities of the joint. The arc weld illustrates all the basic features of a joint. Three zones result from the passage of a welding arc: (1) the weld metal, or fusion zone, (2) the heat-affected zone, and (3) the unaffected zone. The weld metal is that portion of the joint that has been melted during welding. The heat-affected zone is a region adjacent to the weld metal that has not been welded but has undergone a change in microstructure or mechanical properties due to the heat of welding. The unaffected material is that which was not heated sufficiently to alter its properties.

Welding codes and Standards

Australian / New Zealand (AS/NZS) Standards

Standards Australia is the body responsible for the development, maintenance and publication of Australian Standards. The following is a partial list specific to welding:

Standard Number	Description
AS/NZS 1554.1	Structural steel welding - Welding of steel structures
AS/NZS 1554.2	Structural steel welding - Stud welding (steel studs to steel)
AS/NZS 1554.3	Structural steel welding - Welding of reinforcing steel
AS/NZS 1554.4	Structural steel welding - Welding of high strength quenched and tempered steels
AS/NZS 1554.5	Structural steel welding - Welding of steel structures subject to high levels of fatigue loading
AS/NZS 1554.6	Structural steel welding - Welding stainless steels for structural purposes
AS/NZS 1554.7	Structural steel welding - Welding of sheet steel structures
AS/NZS 3992	Pressure equipment - Welding and brazing qualification
AS/NZS 4855	Welding consumables - Covered electrodes for manual metal arc welding
AS 4041	Pressure Piping

International Organization for Standardization (ISO) Standards

International Organization for Standardization (ISO) has developed over 18500 standards and over 1100 new standards are published every year. The following is a partial list of the standards specific to welding:

Standard Number	Description
ISO 2553	Welded, brazed and soldered joints - symbolic representation on drawings (1992)
ISO 2560	Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification
ISO 3580	Covered electrodes for manual arc welding of creep-resisting steels - Code of

Standard Number	Description
	symbols for identification
ISO 3581	Covered electrodes for manual arc welding of stainless and other similar high alloy steels - Code of symbols for identification
ISO 3834	Quality requirements for fusion welding of metallic materials, five parts.
ISO 4063	Welding and allied processes - Nomenclature of processes and reference numbers
ISO 5817	Welding. Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded). Quality levels for imperfections
ISO 6520-1	Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding
ISO 6520-2	Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 2: Welding with pressure
ISO 6947	Welds. Working positions. Definitions of angles of slope and rotation
ISO 9606	Qualification test of welders — Fusion welding, parts 1 to 5
ISO 9692-1	Welding and allied processes. Recommendations for joint preparation. Manual metal-arc welding, gas-shielded metal-arc welding, gas welding, TIG welding and beam welding of steels
ISO 9692-2	Welding and allied processes. Joint preparation. Submerged arc welding of steels
ISO 9692-3	Welding and allied processes. Joint preparation. Part 3: TIG and MIG welding of aluminium and its alloys
ISO 13847	Petroleum and natural gas industries - Pipeline transportation systems - Welding of pipelines
ISO 13916	Welding - Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature
ISO 13918	Welding - Studs and ceramic ferrules for arc stud welding

Standard Number	Description
ISO 13919-1	Welding - Electron and laser-beam welded joints - Guidance on quality level for imperfections - Part 1: Steel
ISO 13919-2	Welding - Electron and laser-beam welded joints - Guidance on quality level for imperfections - Part 2: Aluminium and its weldable alloys
ISO 13920	Welding - General tolerances for welded constructions - Dimensions for lengths and angles - Shape and position
ISO 14112	Gas welding equipment - Small kits for gas brazing and welding
ISO 14175	Welding consumables — Gases and gas mixtures for fusion welding and allied processes. Replaced EN 439:1994 in Europe.
ISO 14341	Welding consumables. Wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels. Classification
ISO 14554	Resistance welding
ISO 14744	Electron beam welding, six parts
ISO 15607	Specification and qualification of welding procedures for metallic materials - General rules
ISO/TR 15608	Welding - Guidelines for a metallic material grouping system
ISO 15609	Specification and qualification of welding procedures for metallic materials - Welding procedure specification, five parts.
ISO 15610	Specification and qualification of welding procedures for metallic materials — Qualification based on tested welding consumables
ISO 15611	Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience
ISO 15612	Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure
ISO 15613	Specification and qualification of welding procedures for metallic materials —

Standard Number	Description
	Qualification based on pre-production welding test
ISO 15614	Specification and qualification of welding procedures for metallic materials - Welding procedure test, 13 parts.
ISO 15615	Gas welding equipment. Acetylene manifold systems for welding, cutting and allied processes. Safety requirements in high-pressure devices
ISO 15618-1	Qualification testing of welders for under-water welding. Diver-welders for hyperbaric wet welding
ISO 15618-2	Qualification testing of welders for under-water welding. Diver-welders and welding operators for hyperbaric dry welding
ISO 17635	Non-destructive testing of welds. General rules for metallic materials
ISO 17660-1	Welding - Welding of reinforcing steel - Part 1: Load-bearing welded joints
ISO 17660-2	Welding - Welding of reinforcing steel - Part 1: Non-load bearing welded joints
ISO/TR 20172	Welding — Grouping systems for materials — European materials
ISO/TR 20173	Welding — Grouping systems for materials — American materials
ISO/TR 20174	Welding — Grouping systems for materials — Japanese materials
ISO 24394	Welding for aerospace applications. Qualification test for welders and welding operators. Fusion welding of metallic components

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the welding principles, codes and standards. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning.

Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Welding codes and standards

Teaching Strategies:

Students are engaged in brainstorming exercise to discover the *Welding codes and standards* in an allocated research or discussion group.

They then are allowed to design guiding questions that will enable them to conduct research on the lesson topic.

Learning Strategies:

Be involved in brainstorming exercise to discover the concept of the *Welding codes and standards.*

Activity 1: Brainstorm the strategies of welding and the safety practices.
Activity 2: Research welding safety and discover welding codes and regulations
Activity 3: Do a presentation of findings in a poster format which will be a display on health and safety in welding.

Resources:

Lesson 2: Fundamentals of welding

Teaching Strategies:

Students are taken through a demonstration lesson on the fundamentals of welding, beginning with safety equipment, the welding equipment their functions and how they work.

Learning Strategies:
Pay close attention to the lesson demonstration on the fundamentals of welding; safety in welding, welding equipment and how they work.

Activity 1: Identify safety in welding from lesson demonstration.
Activity 2: Observe and participate in the demonstration in the fundamentals of welding.
Activity 3: Short quiz on the different welding equipment and their functions from observation and participation in lesson demonstration.

Resources

Lesson 3: Arc & oxy fuel gas hazards

Teaching Strategies:

Define arc and oxy welding. Students are taken through lesson demonstration on arc and oxy welding and the fuel gas hazards. Students are made aware of safety measures for self, equipment and others to be paramount in welding.

Learning Strategies:
Define arc and oxy welding.
Analyse the fuel and gas hazards in arc and oxy welding.

Activity 1: Define arc and oxy welding.
Activity 2: Analyse the gas fuel hazards of arc and oxy welding.
Activity 3: Devise safety measures in line with OHS for welding in the workplace, considering the safety of self, equipment and others.

Resources

STEAM Activity Students work in groups to create a piece of safety equipment

---

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to critically analyse what *Welding principles codes and standards* in PNG and Australia to that of the International Standards Organisation.

Performance Assessment

1. Welding principles

2. Welding Codes and Standards

Performance Assessment Scoring

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Discover and express correctly what the *principles* are in welding and list 4 examples of the set-up procedures.	Correct explanation of the topic and 4 correct examples.	Correct explanation of the topic and 3 correct examples.	Correct explanation of the topic and 2 correct examples.	Correct explanation of the topic and 1 correct examples.
2. Investigate and explain *codes and standards* with at least six (6) examples	Investigate and explain *codes and standards* with	Investigate and explain *codes and standards* with five (5)	Investigate and explain *codes and standards* with four (4)	Investigate and explain *codes and standards*
recommended by Australia and ISO standards.	at least six (6) examples recommended by Australia and ISO standards..	examples recommended by Australia and ISO standards.	examples recommended by Australia and ISO standards..	with only three (3) examples recommended by Australia and ISO standards.

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 9.3.4.3 Demonstrate knowledge in fundamental print reading, measurement and layout or fit-up techniques**.**

Topic 3: Measurement techniques

Learning Objectives
By the end of this topic, the students will be able to;
1. Discuss and demonstrate measuring techniques in Welding Technology

Essential Questions:
1. What are measurements?
2. How do we apply measurements in welding?
3. Why are measurements important in welding?

Essential Knowledge, Skills, values and attitudes:

Knowledge	Skills	Values	Attitudes
Print reading, Measurement, layout or fit-up techniques	Investigate demonstrate	appreciate and be aware	Respect the evolution of the concept

Technology and Industrial Arts Application: Construction Technology, Welding Technology

---

Content Background

Measurement

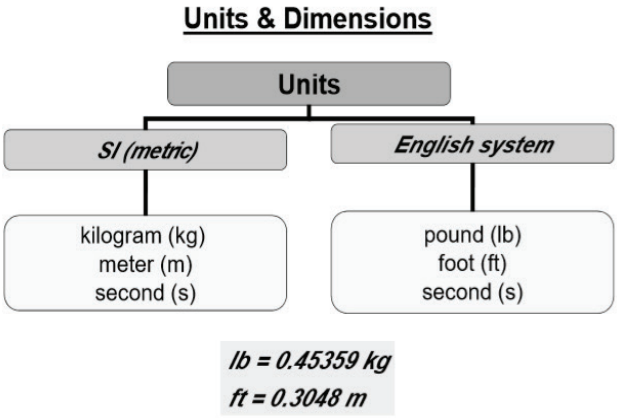
There are two main systems for measuring distances and weight, the Imperial System of Measurement and the Metric System of Measurement. Most countries use the Metric System, which uses the measuring units such as meters and grams and adds prefixes like kilo, milli and centi to count orders of magnitude. In the United States, we use the older Imperial system, where things are measured in feet, inches and pounds. It might be confusing if you are living in the U.S for the first time and are not used to this system. If you ask someone for directions, they will probably tell you something is a certain number of miles away. Or you may be told to move a few feet… But, whose feet?
The Imperial System is also called The British Imperial because it came from the British Empire that ruled many parts of the world from the 16th to the 19th century. After the U.S gained

independence from Britain, the new American government decided to keep this type of measurement, even though the metric system was gaining in popularity at the time.
We are one of the few countries in the world that still use this system, and first time visitors may find it confusing. Here are a few things to remember that will come in handy day to day:

- 1 mile equals 1.6 Kilometers.
- 1 inch is about 25 millimeters or 2.54 centimeters
- A 3-foot measurement is almost exactly 1 meter
- 1 Kilogram is just over 2 pounds
- 1 pound is about 454 grams
- For British visitors, 100 pounds = 7.14 stone

Complicated measurements, used in the sciences for example, will be in the metric system so no need to worry if you are planning to do an internship in engineering or chemistry.
By the way, the temperature scales are different too. We didn't want to make things too easy for you! Though not technically part of the metric system, Americans measure temperature in Fahrenheit, not Centigrade. You may turn on the television and listen for the weather and hear that it is 70 degrees outside. No, you won't pass out and be vaporized by the sun; 70 degrees Fahrenheit is actually very pleasant, about 21 degrees Centigrade. Centigrade has been used around the world from the mid-20th century but again, Americans held fast to the original Fahrenheit system.
Here are some more handy conversions for temperature:

- 0 degrees Celsius is equal to 32 degrees Fahrenheit. (The freezing point)
- 24 degrees Celsius is equal to 75 degrees Fahrenheit. (A very pleasant day)
- To convert Celcius (c) to Fahrenheit, use the formula (c * 1.8) + 32



Standards of Length, Mass, and Time

Length: (m)
The meter (m) was redefined as the distance traveled by light in vacuum during a time of 1/299 792 458 second.

Mass: (kg)
The kilogram (kg), is defined as the mass of a specific platinum–iridium alloy cylinder kept at the International Bureau of Weights and Measures at Sèvres, France.

Time: (s)
The second (s) is now defined as 9 192 631 770 times the period of vibration of radiation from the cesium atom.

Print reading

Introduction to Print Reading Summary

- The title block of a drawing contains: o the drawing title o the drawing number o location, site, or vendor issuing the drawing of the design, review, and approval signatures o the reference block
- The grid system of a drawing allows information to be more easily identified using the coordinates provided by the grid. The coordinate letters and/or numbers break down the drawing into smaller blocks.
- The revision block of a drawing provides the revision number, a title or summary of the revision, and the date of the revision, for each revision.
- The notes and legend section of a drawing provides explanations of special symbols or conventions used on the drawing and any additional information the designer or draftsman felt was necessary to understand the drawing.

Print reading, in the manufacturing industry, is the most efficient way to convey information about systems and equipment from the drafting table that could not be conveyed by words alone. By using symbols and notes, a large amount of information that might require many pages of written description can be presented in a condensed form on one diagram.

Since there are many different types of print, using just one diagram with all the information available for that equipment on the same page would be cluttered and ultimately useless. For this reason, the different types of prints evolved. They make the information that the specific type of print is meant to convey clear and uncluttered.

The ability to read and understand information contained on drawings is essential to perform most engineering-related jobs.
Engineering drawings are the industry's means of communicating detailed and accurate information on how to fabricate, assemble, troubleshoot, repair, and operate a piece of equipment or a system. To understand how to "read" a drawing it is necessary to be familiar with the standard conventions, rules, and basic symbols used on the various types of drawings. But before learning how to read the actual "drawing," an understanding of th e information contained in the various non-drawing areas of a print is also necessary. This chapter will address the information most commonly seen in the non-drawing areas of a nuclear grade engineering type drawing. Because of the extreme variation in format, location of information,
and types of information presented on drawings from vendor to vendor and site to site, all drawings will not necessarily contain the following information or format, but will usually be similar in nature.

Layout/ fit-up techniques

Part fit-up variations are critical to the joint quality produced by joining operations like friction stir welding (FSW). Typical fit-up issues may include: gaps, misalignment between the weld path and joint line, setup related variations, voids or holes in the weld path, mismatch between materials being joined, etc. These and other factors potentially result in variations in mechanical properties between the start and finish of the weld as well as lead to the possible formation of defects along the joint line. The purpose of this study was to determine the robustness of the FSW process to selected imperfections in joint fit-up between plates in butt-welding. Specifically, it includes a study of the effect of part fit-up variations on the transverse joint tensile strength of 0.125" thick friction stir butt-welded 7075-T73 aluminum plate. Welds were performed on an MTS® ISTIR™ PDS friction stir weld machine at the National Institute for Aviation Research in Wichita, KS. It was found that the FSW process was capable of creating a

sound defect-free joint for a range of typical fit-up discontinuities. The tolerance zone for weld path misalignment to the joint line was related to the formation of fine nugget grain structure at the bottom of the weld, with two-thirds of the tolerance zone located on the advancing side of the pin. It was also determined that a certain amount of plate gap or voids in the weld path can be tolerated without a decrease in tensile strength; beyond that point, volumetric defects form in the nugget. Otherwise, there is little variation in tensile properties along the weld joint when care is taken to ensure gap and alignment tolerances are not exceeded.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of welding technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Measurement

Teaching Strategies:
Create an understanding of the importance of measurements, the types of measurements and the main systems of measurement and measurement units and drawing instruments and their applications in the welding trade.
Research the system of measurements, measurement units and drawing instruments and their applications.

Learning Strategies:
Participate in the understanding of measurements and research the system of measurements and which are universally used and their importance to accuracy and reliability.
Activity 1: Define measurements and types of measurements.
Activity 2: Research the system of measurements, universally used and their importance to accuracy and reliability.

Resources

Lesson 2: Print Reading

Teaching Strategies:
Create an understanding of the importance of print reading that conveys information through drawings and symbols.
Study a number of universal prints used in the manufacturing industry and translate the information into simple instructions.

Learning Strategies:
Define print reading and its importance.
Research and read examples of manufacturing prints and translate into simple instructions.
Activity 1: Discussion on print reading and its importance.

Activity 2 : Discussion on print reading of symbols and drawings.
Activity 3: Research on universal prints and translation into simple instructions.

Resources

Lesson 3: Dimensioning, Layout and Fit-up Techniques

Teaching Strategies:
Be involved in brainstorming exercise to discover the concept of the *dimensioning, layout and fit-up techniques.*
Do research in groups.

Activity 1: Brainstorm the uses of measuring tools and their uses in dimensioning, layout and fit-up techniques in welding
Activity 2: Research the measuring tools and their uses in the above techniques.
Activity 3: Do demonstration or a presentation of findings in a poster format which will be a display.

Resources
Note and actual tools or readings on texts.

STEAM Activity Students work in groups to create a an activity that incorporates measurement techniques

---

Assessment
The main purpose of assessment is to find out if students can use the skill of demonstration or synthesis to critically analyse how *marking tools can* be used in

1. dimensioning
2. laying out
3. fit-up technique in the welding field;

Performance Assessment

1. Measurement
2. Dimensioning

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Discover and express correctly the *measuring tools used* in welding. List 4 examples of the tools and its uses.	Correct naming of the 4 tools and their uses.	Correct explanation of 3 and their uses.	Correct explanation of 2 and their uses.	Correct explanation of 1 and its use.

2. Investigate and explain or demonstrate *dimensioning procedures* with at least four (4) tools	. Investigate and explain or demonstrate *dimensioning procedures* with at least four (4) tools	. Investigate and explain or demonstrate *dimensioning procedures* with at least three (3) tools	. Investigate and explain or demonstrate *dimensioning procedures* with at least two (2) tools	Investigate and explain or demonstrate *dimensioning procedures* with at least one (1) tool.

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 9.3.4.4 Investigate and analyse the properties of metals

Topic 4: Properties of Metals

Learning Objectives

By the end of this topic, the students will be able to;

1. Discover the common types of metals used in welding.
2. Explore and analyse the properties of metals used in welding.

Essential Questions:
1. What are the common types of metals used in welding?
2. What are the metal properties?

Essential Knowledge, Skills, values and attitudes:

Knowledge	Skills	Values	Attitudes
Properties of metals	Investigate analyse	value and awareness	Respect and appreciate the knowledge of properties of metal

Technology and Industrial Arts Application: Construction Technology, Welding Technology

Content Background

Types of metals

The term metal production refers to all of the processes involved in the conversion of a raw material, such as a metallic ore, to a final form in which the metal can be used for some commercial or industrial purpose. Within the periodic table there are some 90 elements that can be described as metals. They all have various characteristics in common ranging from bonding

to chemical nature. Broadly speaking the metals are elements that conduct electricity, are malleable, and are ductile.

In some instances, metal production involves relatively few steps since the metal already occurs in an elemental form in nature. Such is the case with gold, silver, platinum, and other so-called noble metals. These metals normally occur in nature uncombined with other elements and can therefore be put to some commercial use with comparatively little additional treatment.

In the majority of cases, however, metals occur in nature as compounds, such as the oxide or the sulfide, and must first be converted to their elemental state. They may then be treated in a wide variety of ways in order to make them usable for specific practical applications.

Mining

The first step in metal production always involves some form of mining. Mining refers to the process of removing the metal in its free or combined state from Earth's surface. The two most common forms of mining are surface and subsurface mining. In the former case, the metal or its ore can be removed from the upper few meters of Earth's surface. Much of the world's copper, for example, is obtained from huge open-pit mines may range in depth to as much as nearly a 0.6 mi (1 km) and in width to as much as more than 2.25 mi (3.5 km). Subsurface mining is used to collect metallic ores that are at greater depths below Earth's surface.

A few metals can be obtained from seawater rather than or in addition to being taken from Earth's crust. Magnesium is one example. Every cubic mile of seawater contains about six million tons of magnesium, primarily in the form of magnesium chloride. The magnesium is first precipitated out of seawater as magnesium hydroxide using lime (calcium hydroxide). The magnesium hydroxide is then converted back to magnesium chloride, now a pure compound rather than the complex mixture that comes from the sea. Finally, magnesium metal is obtained from the magnesium chloride by passing an electric current through a water solution of the compound.

Purification

In most cases, metals and their ores occur in the ground as part of complex mixtures that also contain rocks, sand, clay, silt, and other impurities. The first step in producing the metal for commercial use, therefore, is to separate the ore from waste materials with which it occurs. The term ore is used to describe a compound of a metal that contains enough of that metal to make it economically practical to extract the metal from the compound.

One example of the way in which an ore can be purified is the froth flotation method used with ores of copper, zinc, and some other metals. In this method, impure ore taken from the ground is, first, ground into a powder and, then, mixed with water and a frothing agent such as pine oil. Next, a stream of air is blown through the mixture, causing it to bubble and froth. In the frothing process, impurities such as sand and rock are wetted by the water and sink to the bottom of the container. The metal ore does not adsorb water but does adsorb the pine oil. The oil-coated ore floats to the top of the mixture, where it can be skimmed off.

Reduction

Metals always occur in their oxidized state in ores, often as the oxide or sulfide of the metal. In order to convert an ore to its elemental state, therefore, it must be reduced. Reduction is a

chemical reaction that is the opposite of oxidation. Metals can be reduced in a variety of different ways.

With ores of iron, for example, reduction can be accomplished by reacting oxides of iron with carbon and carbon monoxide. One of the common devices used for this purpose is the blast furnace. The blast furnace is a tall cylindrical vessel into which is fed iron ore (consisting of oxides of iron), coke (nearly pure carbon) and limestone. The temperature in the blast furnace is then raised to more than 1,832°F (1,000°C). At this temperature, carbon reacts with oxygen to form carbon monoxide, which in turn, reacts with oxides of iron to form pure iron metal. The limestone in the original mixture added to the blast furnace reacts with and removes silicon dioxide (sand), an impurity commonly found with iron ore. Metal is an example. Until 1886, no economically satisfactory method for carrying out this process had been discovered. Then, as a young college chemistry student, American inventor and engineer Charles Martin Hall (1863–1914) invented a simple and inexpensive electrical method for reducing aluminum oxide. Because of Hall's invention, aluminum gained widespread use throughout the world.

In the first step in this process, aluminum oxide is separated from other oxides (such as oxides of iron) with which it also occurs by the Bayer process. In the Bayer process, the naturally occurring oxide mixture is added to sodium hydroxide, which dissolves out aluminum oxide, leaving other oxides behind. The aluminum oxide is then dissolved in a mineral known as cryolite (sodium aluminum fluoride) and placed in an electrolytic cell. When electric current passes through the cell, molten aluminum metal is formed, sinks to the bottom of the cell, and can be drawn off from the cell.

In some instances, an ore is treated to change its chemical state before being reduced. The most common ores of zinc, for example, are the sulfides. These compounds are first roasted in an excess of air, converting zinc sulfide to zinc oxide. The zinc oxide is then reduced either by reacting it with coke (as in the case of iron) or by electrolyzing it (as in the case of aluminum).

Alloys

Pure metals themselves are often not satisfactory for many practical applications. For example, pure gold is too soft for most uses and is combined with other metals to form harder, more resistant mixtures. Mixtures that contain two or more metals are known as alloys. Perhaps the best known and most widely used of all alloys is steel.

The term steel refers to a number of different substances that contain iron as their major component along with one or more other elements. Stainless steel,

Metal properties

KEY TERMS

Alloy— A mixture of two or more metals with properties distinct from the metals of which it is made.

Bayer process— A process in which sodium hydroxide is added to a mixture of naturally occurring oxides so that aluminum oxide is dissolved out of the mixture.

Hall process— A process for the production of aluminum metal by passing an electric current through a mixture of aluminum oxide dissolved in cryolite (sodium aluminum fluoride).

Noble metal— A metal that does not readily react with other elements and that, therefore, normally occurs in nature in a free, or uncombined, state.

Ore— A compound of a metal from which the metal can be extracted at an economically feasible cost.

Reduction— The process by which an atom's oxidation state is decreased, by its gaining one or more electrons.

As an example, contains about 18% chromium, 10% nickel, and small amounts of manganese, carbon, phosphorus, sulfur, and silicon, along with iron. When niobium is added to a steel alloy, the final product has unusually great strength. The addition of cobalt produces a form of steel that withstands the high temperatures of jet engines and gas turbines, and silicon steels are used in making electrical equipment.

In the final stages of metal production, the finished product is formed into some shape that can be used in other industries to make final products. Thus, steel can be purchased in the form of flat sheets, rings, wire rope and thread, slabs, cylinders, and other shapes.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of data communication and network. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of metals

Research all types of metals used in the welding industry understanding their properties and performance.

Teaching Strategies:
Discuss the different types of metals in the welding industry.
Conduct research on the different types of metals, their properties and their performances during welding.

Learning Strategies:
Discussion on different types of metals used in the welding industry.
Research on different types of metals, their properties and performances during welding.

Activity 1: Discussion on different types of metals in the welding industry.

Activity 2: Conduct research on the different types of metals used in the welding industry, their properties and their performances.

Resources

Lesson 2: Metal Properties

Teaching Strategies:
Research properties of metals using the information from the Lesson 1 and create a chart of information about metals, properties and performance when using welding techniques.

Learning Strategies:

Activity 1: Discuss the types of metals.
Activity 2: Research the properties and performance of metals when welding using different techniques.
Activity 3: Create and present a chart of metals, their properties and performance in welding.

Resources

STEAM Activity Students work in groups to create an activity that will incorporate properties of metals.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to critically investigate the common metals found on the earth's surface. Explain and describe their uses and properties.

Performance Assessment
1. Types of metals
2. Metal uses and properties

Performance Assessment Scoring

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Discover and express correctly the metals and their alloys, at least 4 metals and their alloys	Correct names of four metals and their alloys.	Correct names of three metals and their alloys.	Correct names of two metals and their alloys.	Correct names of one metal and its alloys.
2. Investigate and explain their properties and their uses of at least 4 metals.	Investigate and explain their properties and their uses of at least 4 metals.	Investigate and explain their properties and their uses of at least 3 metals.	Investigate and explain their properties and their uses of at least 2 metals.	Investigate and explain their properties and uses of at least 1 metal.

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 9.3.4.5 Investigate the various welding techniques and cutting processes

Topic 5: Welding & Cutting

Learning Objectives
By the end of this topic, the students will be able to;
1. Research and identify cutting processes in welding

Essential Questions:
1. What are the common types of welding?
2. What is thermal cutting heating and gouging?
3. What is brazing in welding?
4. What are the different welding processes?

Essential Knowledge, Skills, values and attitudes:

Knowledge	Skills	Values	Attitudes
Types of welding Cutting processes in welding	Research and identify Name and differentiate	Safety and care	Taking precautions Considerations of personal safety and the safety of others

Technology and Industrial Arts Application: Construction Technology, Welding Technology

Content Background

Types of welding processes

Gas Metal Arc Welding (GMAW/MIG)
This style of welding is also referred to as Metal Inert Gas (MIG). It uses a shielding gas along the wire electrode, which heats up the two metals to be joined. This method requires a constant voltage and direct-current power source, and is the most common industrial welding process. It has four primary methods of metal transfer: globular, short-circuiting, spray and pulsed-spray.
Gas Tungsten Arc Gas Welding (GTAW/TIG)

Welding together thick sections of stainless steel or non-ferrous metals is the most common use for this method. It is also an arc-welding process that uses a tungsten electrode to produce the weld. This process is much more time consuming than the other three and much more complex.

Shielded Metal Arc Welding (SMAW)
With this particular type of welding, the welder follows a manual process of stick welding. The stick uses an electric current to form an arc between the stick and the metals to be joined. This is often used in the construction of steel structures and in industrial fabrication to weld iron and steel.

Flux Cored Arc Welding (FCAW)
This was developed as an alternative to shield welding. The semi-automatic arc weld is often used in construction projects, thanks to its high welding speed and portability.

Thermal cutting, heating and gouging

Thermal gouging is an essential part of welding fabrication. Used for rapid removal of unwanted metal, the material is locally heated and molten metal ejected - usually by blowing it away. Normal oxy fuel gas or arc processes can be used to produce rapid melting and metal removal. However, to produce a groove of specific dimensions, particularly regarding depth and width, the welder must exercise careful control of the gouging operation. If this does not happen, an erratic and badly-serrated groove will result.

Thermal processes, operations and metals which may be gouged or otherwise shaped:

Thermal process	Process operations		Metals
	Primary	Secondary	
Oxyfuel gas flame	Gouging	Grooving Washing Chamfering	Low carbon steels, carbon manganese steels (structural), pressure vessel steels (carbon not over 0.35%), low alloy steels (less than 5%Cr) cast iron (if preheated to 400-450 deg.C)

Manual metal arc	Gouging	Grooving Chamfering	Low carbon steels carbon manganese steels (structural), pressure vessel steels, low alloy steels, stainless steels, cast iron, nickel-based alloys
Air carbon arc	Gouging	Grooving Chamfering	Low carbon steels carbon manganese steels (structural), pressure vessel steels, low and high alloy steels, cast iron, nickel-based alloys, copper and copper alloys, copper/nickel alloys, aluminium
Plasma arc	Gouging	Chamfering Grooving Washing	Aluminium, stainless steels
Note: All processes are capable of cutting/severing operations. Preheat may or may not be required on some metals prior to gouging			

Safety

It should be emphasised that because gouging relies on molten metal being forcibly ejected, often over quite large distances, the welder must take appropriate precautions to protect himself, other workers and his equipment. Sensible precautions include protective clothing for the welder, shielding inside a specially-enclosed booth or screens, adequate fume extraction, and removal of all combustible material from the immediate area.

Industrial applications

Thermal gouging was developed primarily for removal of metal from the reverse side of welded joints, removal of tack welds, temporary welds, and weld imperfections. Figure 1 illustrates the value of typical back-gouging applications carried out on arc welded joints., while Fig. 2 shows imperfection removal in preparation for weld repair.

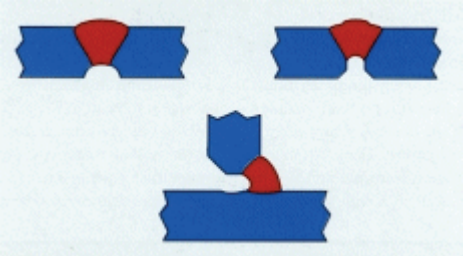


Fig.1 Typical back-gouging applications carried out on arc welded joints

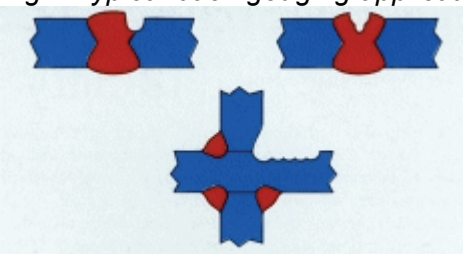


Fig. 2 Imperfection removal in preparation for weld repair

The gouging process has proved to be so successful that it is used for a wide spectrum of applications in engineering industries:

- Repair and maintenance of structures - bridges, earth-moving equipment, mining machinery, railway rolling stock, ships, offshore rigs, piping and storage tanks
- Removal of cracks and imperfections - blow holes and sand traps in both ferrous and non-ferrous forgings and castings
- Preparation of plate edges for welding
- Removal of surplus metal - riser pads and fins on castings, excess weld bead profiles, Temporary backing strips, rivet washing and shaping operations, demolition of welded and un-welded structures - site work

Thermal gouging is also suitable for efficient removal of temporary welded attachments such as brackets, strong backs, lifting lugs and redundant tack welds, during various stages of fabrication and construction work.

Gouging processes
Gouging operations can be carried out using the following thermal processes:
- Oxy fuel gas flame
- Manual metal arc
- Air carbon arc
- Plasma arc

https://www.twi-global.com/technical-knowledge/job-knowledge/thermal-gouging-008

Brazing
Brazing is a joining process traditionally applied to metals (but also to ceramics) in which molten filler metal (the braze alloy) flows into the joint.
The melting point of the filler metal is above 450°C, but always below the melting temperature of the parts to be joined, which distinguishes the process from welding where high temperatures are used to melt the base metals together.

The filler metal, while heated slightly above melting point, is protected by a suitable atmosphere which is often a flux. The molten filler metal cools to join the work pieces together providing a strong join between similar or dissimilar metals.

The atmospheres in which the brazing process can be undertaken include air, combusted fuel gas, ammonia, nitrogen, hydrogen, noble gases, inorganic vapors and vacuum, using a variety of heating sources such as torch, furnace, and induction coil.

To achieve a sound brazed joint, the filler and parent materials should be metallurgical compatible, and the joint design should incorporate a gap into which the molten braze filler can be drawn or distributed by capillary action. The required joint gap is dependent on many factors, including the brazing atmosphere and the composition of the base material and braze alloy.

Ideal for joining dissimilar metals, brazing is a commercially accepted process used in a wide range of industries due to its flexibility and the high integrity to which joints may be produced. This makes it reliable in critical and non-critical applications, and it is one of the most widely used joining methods
https://www.twi-global.com/technical-knowledge/faqs/faq-what-is-brazing

The Importance of Proper Brazing Procedures
Brazing is ideally suited for joining of dissimilar metals and is performed at relatively low temperature. We've said that a brazed joint "makes itself"—or that capillary action, more than operator skill, insures the distribution of the filler metal into the joint. But even a properly-designed joint can turn out imperfectly if the correct brazing process steps are not followed. These brazing procedures boil down the brazing process to six basic steps.

How to braze? There are six fundamentals of brazing that every brazier should follow to ensure consistent and repeatable joint quality, strength, hermeticity, and reliability. They are generally simple to perform (some may take only a few seconds), but none of them should be omitted from your brazing operation if you want to end up with sound, strong, neat-appearing joints.

For the sake of simplicity, we'll discuss these six brazing process steps mainly in terms of "manual brazing," that is, brazing with hand-held torch and hand-fed filler metal. But everything said about manual brazing applies as well to mass production brazing. The same brazing process steps must be taken, although they may be performed in a different manner.

https://www.lucasmilhaupt.com/EN/Brazing-Academy/Brazing-Fundamentals.html

Careers in Welding

People who get into welding are those who love to work with their hands and are not afraid to get dirty while doing it. Welders take pride in their job and want to **do their best at every project they take on**. When started a career in welding, are a variety of job options for those who have completed their degree and are looking for work. The following are seven welding careers you may not have thought of:

Assemblers and Fabricators:
These individuals work to put the finishing touches on a variety of consumer goods that we purchase in our daily lives. They use their welding skills to help finish making items such as toys, electronic devices, and computers. Assemblers and Fabricators also work on other vital pieces of our country's infrastructure such as modes of transportation. They help build forms of transportation such as aircraft, ships, and boats.

Boilermakers:
Boilermakers produce steel fabrications such from plates and tubes. Originally, boilermakers created boilers, although today they develop a variety of different technologies including bridges, blast makers, and other mining equipment. Many of these welders travel to the worksite to do their work. This line of work may mean some regional or national traveling to perform their welding on the structures that need to be worked on.

Jeweler, Precious Stone, and Metal Workers:
Many welders that work in the jewelry field spend their days at a small bench hunched over a specific piece of jewelry that they are working to repair. Most jewelry that they work on will be higher-cost pieces that include precious stones and metals such as gold. The goal is to get the piece close to original condition as possible to get the value of the piece as high as possible.

Machinists, Tool, and Die Makers:
These welders work on welding pieces of machines or tools that get used in a variety of different fields including transportation (i.e., automobiles, trucks, buses, aircraft, planes, or boats) or the construction industry (such as welding and finishing off construction tools). This sect of welders often has to work nights and weekends to get their jobs completed on a strict timeline for other automotive or construction projects to be able to move forward on their set schedules.

Sheet Metal Workers:
Sheet Metal Workers are welders who are responsible for welding sheets of metal together to create finished products. Most sheet metal workers work to generate heating and air conditioning systems which require these sheets of metal to be welded together to produce these units for both commercial and residential buildings. Sheet metal will often get heavy, and the structures that these welders work on become very sizable. Heavy lifting and moving large, finished pieces of work are all part of the job.

Plumbers, Pipefitters, and Steamfitters:

These welders work primarily in the construction industry to help work on building projects that are still getting completed. They often work on plumbing and pipefitting in both commercial and residential buildings. Their jobs are to ensure that the plumbing, piping, and ductwork in buildings is up to the building code and safety standards outlined in that area. These workers will have to travel to the construction site to perform their work. Deadlines are also standard in this field of welding as the plumbing and pipefitting must get finished before the next phase of construction can begin.

Metal and Plastic Machine Workers:
Metal and Plastic Machine Workers are welders who set up and operate machines that are responsible for cutting, shaping and producing both metal and plastic pieces that get used in the construction of a variety of goods that get created in our modern, consumer society. These products are often required to get built to certain safety standards set forth by the industry for which the product is getting designed.

There is a variety of options for welders when it comes to choosing a long-term career. Dream big and find a career that fits your desires and **needs as a welder**! In the end, it will make work a pleasure, and not a chore as the options in the welding field are genuinely endless.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the types of welding practices and the cutting processes. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of Welding

Teaching Strategies:
Be involved in brainstorming exercise to discover the types of welding
Do group research on the welding types and where they are applied.

Learning Strategies:
Activity 1: Brainstorm the *types of welding*
Activity 2: Research the types of welding
Activity 3: Do demonstration or a presentation of findings in a poster format which will be a display.

Resources
Text on types of welding

Lesson 2: Thermal cutting, heating and gouging

Teaching Strategies:

Be involved in brainstorming exercise to discover the concepts and skill of thermal cutting, heating, and gouging.
Do group research on one of the chosen concepts or skills above..

Learning Strategies:
Activity 1: Brainstorm the *concepts or skill of thermal cutting, heating and gouging*
Activity 2: Research one of the concepts or skill
Activity 3: Do demonstration or a presentation of findings in a poster format which will be a display.

Resources
Text on types of welding

Lesson 3: Brazing

Teaching Strategies:
Be involved in brainstorming exercise to discover the concepts and skill of brazing.
Do group research on the skill of brazing..

Learning Strategies:
Activity 1: Brainstorm the *concepts or skill of brazing.*
Activity 2: Research the concepts or skill.
Activity 3: Do demonstration or a presentation of findings in a poster format which will be a display.

Resources
Text on the brazing technique

Lesson 4: Careers in Welding

Teaching Strategies:
Be involved in brainstorming exercise to discover the different careers involved in welding.
Do group research on the careers in welding

Learning Strategies:

Activity 1: Brainstorm on the different careers in welding
Activity 2: Research the careers
Activity 3: Do demonstration or a presentation of findings in a poster format which will be a display.

Resources
A professional welder in the community or any written texts on careers in welding.

STEAM Activity: Students work in groups to create an activity that incorporates welding and cutting.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to critically investigate the various welding techniques and cutting processes.

Performance Assessment

1. Types of welding techniques
2. How to apply them.
3. Careers in welding

Performance Assessment Scoring

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Discover and express correctly the different types of welding techniques at least 4 types.	Correct names of four welding techniques and their applications.	Correct names of three welding techniques and their applications.	Correct names of two welding techniques and their applications.	Correct names of one welding technique and its applications.
2. Investigate and describe 4 career pathways in welding.	Investigate and describe 4 career pathways in welding.	Investigate and describe 3 career pathways in welding.	Investigate and describe 2 career pathways in welding.	Investigate and describe 1 career pathway in welding.

Unit 5: Engineering Technology

Units	Benchmarks	Topics	Lesson Titles
5. Engineering Technology	**9.3.5.1.** Describe how history and society has influenced the engineering field and critically analyse innovations.	Historical aspects of Engineering	1. Engineering, past, present & Future 2. Engineering Innovations 3. Influence of Engineering in the society.
	9.3.5.2. Investigate the scope of engineering, roles and responsibilities of an engineer and recognise current innovations.	Introduction to Engineering	1.Introduction to Engineering 2. Scope of Engineering 3. Roles and responsibilities of Engineers
	9.3.5.3. Explore and distinguish the different types of the Engineering fields.	Engineering Fields	1. Types of engineering fields 2. Career pathways in engineering
	9.3.5.4. Explore and discuss engineering principles and practices and the appropriate materials in engineering.	Engineering Principles and practices	1. Engineering principles 2. Engineering practices 3. Engineering materials
	9.3.5.5. Explore and analyse the general safety practices in engineering.	Occupational Health & safety	1. OHS legislations and regulations for Engineers 2. Hazards & Risk Control Measures 3. Risk Assessment & Management 4. Basic First –Aid and CPR
	9.3.5.6. Outline management and problem solving skills using the engineering design process.	Engineering Design Process	1 Steps of Engineering Design 2 Management skills 3 Problem-solving skills
	9.3.5.7. Explore and utilise communication practices appropriate to engineering.	Engineering Communication	1 Effective communication 2 Interpersonal and intrapersonal communication skills 3 Telephones, emails, directories 4 Report writing, 5 Memorandums 6 Incident reports

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 9.3.5.1. Describe how history and society has influenced the engineering field and critically analyse innovations**.**

Topic 1: Historical aspects of Engineering

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and explain the historical aspects of engineering in our society.

Essential Questions:

1. What is engineering?
2. How does engineering influence the past, present & future phenomena?
3. What does engineering innovations mean?
4. What are the main Influence of Engineering field in the society and environment?

5. What are the purposes of studying engineering fields in general perspective?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
History of engineering fields	apply	appreciate	Respect with curiosity

Technology and Industrial Arts Application: : Engineering Technology

Content Background

Historical aspects of Engineering-

The historical aspects of engineering are early theory of engineering concepts that are developed in historical era.

They are six (6) major branch of engineering; mechanical, chemical, civil, electrical, management, geotechnical and literally hundreds of different subcategories of engineering

under each branch. Generally, we will confine the discussions on basic concepts and skills of engineering in four (3) various discipline in engineering fields; Civil, Mechanical, Electrical.

Engineering is the creative application of science, mathematical methods, and empirical evidence to the innovation, design, and construction, band maintenance of structures, machines, materials, devices, systems, processes, and organisations. The discipline of engineering encompasses a broad range of more specialized fields of engineering, each with a more specific emphasis on particular areas of applied mathematics, applied science, and types of application. See glossary of engineering.

The term *engineering* is derived from the Latin *ingenium*, meaning "cleverness" and *ingeniare*, meaning "to contrive, devise".

Definition

The American Engineers' Council for Professional Development (ECPD, the predecessor of ABET) has defined "engineering" as:
The creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property.

History

History of engineering

Relief map of the Citadel of Lille, designed in 1668 by Vauban, the foremost military engineer of his age.

Engineering has existed since ancient times, when humans devised inventions such as the wedge, lever, wheel and pulley.

The term *engineering* is derived from the word *engineer*, which itself dates back to 1390 when an *engine'er* (literally, one who operates an *engine*) referred to "a constructor of military engines." In this context, now obsolete, an "engine" referred to a military machine, *i.e.*, a mechanical contraption used in war (for example, a catapult). Notable examples of the obsolete

usage which have survived to the present day are military engineering corps, *e.g.*, the U.S. Army Corps of Engineers.

The word “engine” itself is of even older origin, ultimately deriving from the Latin *ingenium* (c. 1250), meaning “innate quality, especially mental power, hence a clever invention.”

Later, as the design of civilian structures, such as bridges and buildings, matured as a technical discipline, the term civil engineering entered the lexicon as a way to distinguish between those specializing in the construction of such non-military projects and those involved in the discipline of military engineering.

Ancient era

The Ancient Romans built aqueducts to bring a steady supply of clean and fresh water to cities and towns in the empire.

The pyramids in Egypt, the Acropolis and the Parthenon in Greece, the Roman aqueducts, Via Appia and the Colosseum, Teotihuacán, the Great Wall of China, the Brihadeeswarar Temple of Thanjavur, among many others, stand as a testament to the ingenuity and skill of ancient civil and military engineers. Other monuments, no longer standing, such as the Hanging Gardens of Babylon, and the Pharos of Alexandria were important engineering achievements of their time and were considered among the Seven Wonders of the Ancient World.

The earliest civil engineer known by name is Imhotep. As one of the officials of the Pharaoh, Djosèr, he probably designed and supervised the construction of the Pyramid of Djoser (the Step Pyramid) at Saqqara in Egypt around 2630–2611 BC. Ancient Greece developed machines in both civilian and military domains. The Antikythera mechanism, the first known mechanical computer, and the mechanical inventions of Archimedes are examples of early mechanical engineering. Some of Archimedes’ inventions as well as the Antikythera mechanism required sophisticated knowledge of differential gearing or epicyclic gearing, two key principles in machine theory that helped design the gear trains of the Industrial Revolution, and are still widely used today in diverse fields such as robotics and automotive engineering.

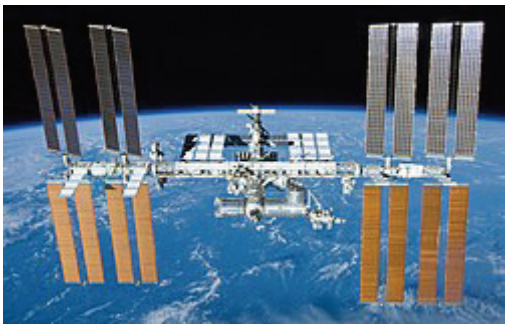
Ancient Chinese, Greek, Roman and Hungarian armies employed military machines and inventions such as artillery which was developed by the Greeks around the 4th century B.C., the trireme, the ballista and the catapult. In the Middle Ages, the trebuchet was developed.

Renaissance era

The first steam engine was built in 1698 by Thomas Savery. The development of this device gave rise to the Industrial Revolution in the coming decades, allowing for the beginnings of mass production.

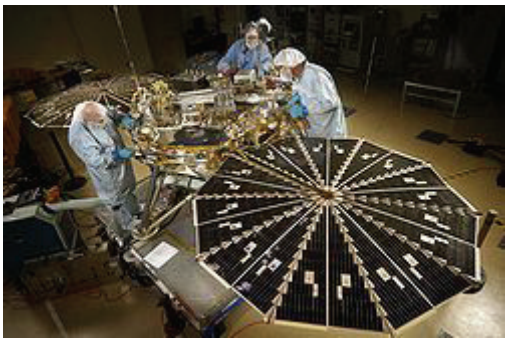
With the rise of engineering as a profession in the 18th century, the term became more narrowly applied to fields in which mathematics and science were applied to these ends. Similarly, in addition to military and civil engineering, the fields then known as the mechanic arts became incorporated into engineering.

Modern era



The International Space Station represents a modern engineering challenge for many disciplines.

The inventions of Thomas Newcomen and James Watt gave rise to modern mechanical engineering. The development of specialized machines and machine tools during the industrial revolution led to the rapid growth of mechanical engineering both in its birthplace Britain and abroad.



Structural engineers working on NASA's Mars-bound spacecraft, the Phoenix Mars Lander

John Smeaton was the first self-proclaimed civil engineer and is often regarded as the "father" of civil engineering. He was an English civil engineer responsible for the design of bridges, canals, harbours, and lighthouses. He was also a capable mechanical engineer and an eminent physicist. Smeaton designed the third Eddystone Lighthouse (1755–59) where he

pioneered the use of ‘hydraulic lime‘ (a form of mortar which will set under water) and developed a technique involving dovetailed blocks of granite in the building of the lighthouse. His lighthouse remained in use until 1877 and was dismantled and partially rebuilt at Plymouth Hoe where it is known as Smeaton’s Tower. He is important in the history, rediscovery of, and development of modern cement, because he identified the compositional requirements needed to obtain “hydraulicity” in lime; work which led ultimately to the invention of Portland cement.

The United States census of 1850 listed the occupation of “engineer” for the first time with a count of 2,000.There were fewer than 50 engineering graduates in the U.S. before 1865. In 1870 there were a dozen U.S. mechanical engineering graduates, with that number increasing to 43 per year in 1875. In 1890, there were 6,000 engineers in civil, mining, mechanical and electrical.

There was no chair of applied mechanism and applied mechanics at Cambridge until 1875, and no chair of engineering at Oxford until 1907. Germany established technical universities earlier.

The foundations of electrical engineering in the 1800s included the experiments of Alessandro Volta, Michael Faraday, Georg Ohm and others and the invention of the electric telegraph in 1816 and the electric motor in 1872. The theoretical work of James Maxwell (see: Maxwell’s equations) and Heinrich Hertz in the late 19th century gave rise to the field of electronics. The later inventions of the vacuum tube and the transistor further accelerated the development of electronics to such an extent that electrical and electronics engineers currently outnumber their colleagues of any other engineering specialty. Chemical engineering developed in the late nineteenth century. Industrial scale manufacturing demanded new materials and new processes and by 1880 the need for large scale production of chemicals was such that a new industry was created, dedicated to the development and large scale manufacturing of chemicals in new industrial plants. The role of the chemical engineer was the design of these chemical plants and processes.

The Falkirk Wheel in Scotland

Aeronautical engineering deals with aircraft design process design while aerospace engineering is a more modern term that expands the reach of the discipline by including spacecraft design. Its origins can be traced back to the aviation pioneers around the start of the 20th century although the work of Sir George Cayley has recently been dated as being from the last decade of the 18th century. Early knowledge of aeronautical engineering

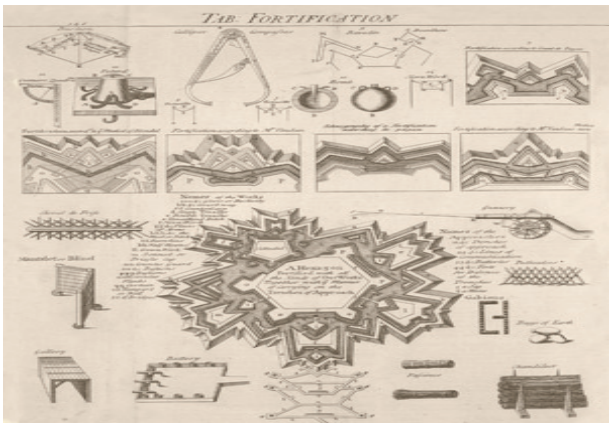
was largely empirical with some concepts and skills imported from other branches of engineering.

The first PhD in engineering (technically, *applied science and engineering*) awarded in the United States went to Josiah Willard Gibbs at Yale University in 1863; it was also the second PhD awarded in science in the U.S.

Only a decade after the successful flights by the Wright brothers, there was extensive development of aeronautical engineering through development of military aircraft that were used in World War I. Meanwhile, research to provide fundamental background science continued by combining theoretical physics with experiments.

In 1990, with the rise of computer technology, the first search engine was built by computer engineer Alan Emtage.

Engineering, a Brief History



Schematic drawing of military fortification taken from *Cyclopaedia*, published 1728

Human beings have been adapting their environment to better suit their needs and wants since before recorded history. There have always been people who designed and built tools or other devices to solve problems or improve lives.

As civilizations developed, people began *reshaping* their environment with farms, villages, ships, roads, and eventually great cities. With each advance came new challenges that required more complex and creative solutions. One early example of an activity that we now call engineering was the construction and improvement of the aqueduct system that transported water in and around Rome starting in the fourth century BC. A project of that scope today would be largely the responsibility of engineers.

The profession we know as engineering today emerged during the 1500's when specialists began using mathematics to design military fortifications. These special military architects would

generally let craftsmen do the actual construction, thus becoming the first true engineers in the modern sense of the word.

Nineteenth Century

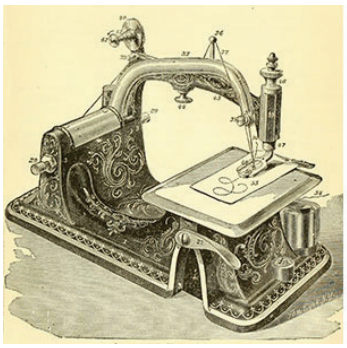
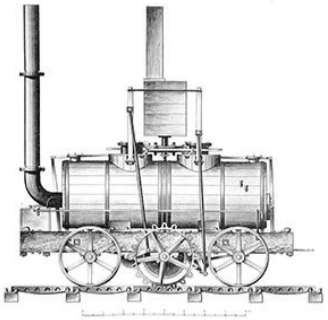
Starting in the mid-nineteenth century, new processing methods - most notably for steel and petroleum - reshaped transportation, construction, and manufacturing. Scientist, inventors and entrepreneurs flourished and “game-changing” technologies appeared in several different industries.

Advances were made in all areas, including technologies that transformed everyday activities. For example, in:

- 1851, Isaac Singer patents a continuous stitch sewing machine
- 1868, Christopher Sholes patents the first practical typewriter
- 1873, Andrew Hallidie invents cable cars for use in San Francisco
- 1874, Joseph Glidden invents barbed wire
- 1876, Alexander Graham Bell patents the telephone
- 1884, Lewis E Waterman patents a practical fountain pen

It was during the late 1800’s when inventors began identifying with the engineering process and the engineering profession began to divide into special disciplines, such as civil, mechanical, and electrical engineering.

Up until the Civil War, United States engineers were trained at military academies or through industry apprenticeship programs. Since the 1860’s more emphasis has been place on formal training that includes significant courses in mathematics and science. For example, the Massachusetts Institute of Technology opened in 1865 with 15 students.

Twentieth Century

The Greatest Engineering Achievements of the 20th Century website lists 20 ways in which engineering has transformed our world.
In the 20th century, engineering quite literally electrified the nation. It took us into the sky and out into space. It gave us cars and highways on which to drive them. It made our waters cleaner and safer and revolutionized the way we produce food.

Engineering made our homes more comfortable and efficient with appliances that saved both time and money. In connected us through telephone, radio, and television and gave us new ways to see ourselves – and the world – with a variety of imaging technologies. All of that was before the computer and the Internet.

Looking Forward

Engineers are helping feed and support an increasingly urban world population that could reach 10 billion by the year 2050. They are working to ensure that all people have access to clean, fresh water and adequate shelter.

Engineers today are developing safe, efficient, and renewable forms of energy. They are helping to improve our health with more effective drugs and medical treatments. They are working to design new and more powerful ways of creating, storing, and using information.

Engineers are now and will continue to be critical to advancing technologies that will allow individuals to work, learn, and play in new and interesting ways.

Engineering Innovation

Much of our modern society depends on engineered artifacts to function, but many members of modern society are not aware of the engineering techniques and practices that have developed the technology and infrastructure on which we rely. IPods, cell phones, airplanes, bridges, buildings, vehicles, computers, etc. are designed and created by engineers.

Impact of engineering on society

Engineering is a human endeavor. Humans have engaged in engineering to meet their needs as long as they have had needs. We invent and innovate when we are confronted with problems, needs, and desires. Inventions exist and continue to be created to meet our needs for daily life, such as access to water, energy, transportation, and entertainment. Engineering has had an impact on all aspects of society. Look around you and notice all of the things that have been made by humans. Through designing, manufacturing, testing, or selling, an engineer probably had something to do with most of these human-made items.

To understand the impact of engineering on society we can imagine how people lived 100 years ago before these technologies existed. For example, how did people communicate without telephones and the Internet? The primary method of long-distance communication was letters. While letters are a wonderful means of communication, they take time to write and even more time to be delivered. If the distance between sender and recipient was great, it may have taken months to deliver a letter.

Figure 1: Clean drinking water flowing from a faucet.

Figure 1 shows a water faucet, and represents the supply and distribution of clean water. Clean water has had a significant impact on human life. During the 1700s and 1800s, thousands of people died from diseases including cholera, typhus, and waterborne typhoid fever, and thousands upon thousands became ill. A clean water supply and good distribution not only improved health, but also contributed to the growth of new cities, the development of hydropower, the improvement of crop growth, and the availability of water recreation.

Advancements in communication have also helped change the way many companies work today. An engineer works at home managing two engineering teams from across the world. That would not have been possible with letters. Engineering solutions have continually improved the quality of life, added business value, and significantly influenced the **global economy**.

Engineering has both intended and unintended consequences. For example, air-conditioning makes comfortable life possible. However, sometimes the unintended consequences of new technologies can be negative. About a decade ago, scientists discovered that Freon and similar gasses used in air conditioners were contributing to damage to the Earth's protective ozone layer. As a result, new gasses and technology had to be developed. Consider as well the impact on culture from air conditioners. Prior to air-conditioning, many people sat on their front porch in the evenings, in part because their homes were too hot. Also, people often had very high ceilings—a design intended to help with home cooling.

Another example of unintended consequences is several years ago a company developed corn seeds that were highly resistant to weed killers and insects so that farmers would not need to spray poisons on their fields. An unintended consequence was that the new type of corn seed, after it had been growing for several years, started growing in fields where it had not been planted. Farmers tried to kill the unwanted corn plants but were unable to do it because the corn was resistant to the poisons. great engineering accomplishments of the twentieth century identified by the NAE include highways, spacecraft, the Internet, imaging, household appliances,

health technologies, petroleum and petrochemical technologies, laser and fiber optics, nuclear technologies, and high-performance materials.

Figure 2: An irrigation system waters growing cotton plants.

Figure 2 shows an irrigation system for a large farm, and represents agricultural mechanization (the development of machines that help farmers produce crops). Prior to the development of farm equipment, farmers relied on animals to help them plow their fields. The planting, watering, and harvesting of crops was all done by hand. The amount of work required to produce crops limited the crops that individual farmers could grow. This also meant that many people were employed in farming and many families grew their own produce. Machines made it possible for a single farmer to produce larger quantities of crops, as well as a more consistent quality of crops. This, in turn, provided greater supplies of food for society, and reduced its cost.

The Future of Engineering

It is very difficult to predict the future of engineering, but engineers attempt this whenever they design new products. Engineers try to determine what people will want and need—both now and in the future—and then they design things to fulfill those wants and needs. While we do not know exactly what will happen in the future, we can examine some possible scenarios. Consider natural catastrophes. There have been many significant catastrophes in the past decade including powerful hurricanes, earthquakes, and tsunamis that have killed hundreds of thousands of people and destroyed a great deal of property. If we go back further in the history of the world we also find that major volcanic eruptions and rare collisions with meteorites have impacted the entire planet. Engineers are working on ways to protect people and property from these disasters as well as ways to predict and respond rapidly to these types of disasters.

Another threat to people's wellbeing comes from disease. Between 1300 and 1500, the bubonic plague killed between one-third and one-half of Europe's population. Later, cholera killed large numbers as well. Today, these diseases have been largely eradicated in the developed world through engineering of clean water and sanitation systems. However, the world currently faces an AIDS epidemic and there are likely to be new disease threats in the future. Engineers will work with scientists, governments, and health workers to develop and implement technologies that will prevent and respond to these threats. Another certain need that will be met by engineering is energy. Because all people in the world need energy, the world production and use of energy is growing at a rapid pace. You might recall that both electrification and the

automobile were listed as great engineering achievements of the twentieth century. Fossil fuels, the source of energy used most often to produce electricity and to power automobiles, also causes pollution and contributes to global warming. Also, supplies of fossil fuels are limited and becoming more expensive.

Some wonder if the world can sustain the current energy growth and consumption patterns. With only a few countries owning the majority of energy resources, there is further concern about the supply of energy at prices that most people can afford. Engineers and scientists are working on developing new energy technologies for the future. Some emerging trends in engineering are in the areas of biotechnology and nanotechnology.
In the area of biotechnology, engineers are working on designs that impact the human body, animals, and plant life. Engineers and scientist are working on technologies to help the blind to see, the hearing impaired to hear, and the disabled to walk. Biotechnology has also opened the possibility of controversial areas such as cloning. Engineers are also working with scientist to develop crops and processes that can be used as fuels for energy.

Nanotechnology refers to the development of products and components that are very small, typically between 1 and 100 nanometers. A nanometer is 1 _ 10−9 meters. A nanometer is so small that it takes a very powerful microscope to see an object of that size. While the area of nanotechnology is very new, it shows promise to provide new technologies ranging from lighter and stronger materials to Nano robots that can repair individual cells to new treatments for cancer.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the historical aspects of engineering. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Engineering, past, present & Future

Teaching Strategies

Engage students in brainstorming exercise on the definitions of engineering fields

Engage students in the discussion of different terminologies used in engineering fields.

Learning Strategies

Discover different definitions used in engineering discipline

Activity 1: Explore and discuss what engineering is in relation to everything that is around.
Activity 2: Discuss the terminologies used in engineering.
Activity 3: Explore the six engineering fields and what they are.

Teacher	Students
Introduction	
Introduce students to structures around them and ask them to explore the creativity, innovations, inspirations	Explore structures and discover the designs, inspirations, innovations
Body	
Discover different definitions used in engineering discipline **Activity 1** Brainstorming activity on definitions of engineering fields **Activity 2** Conduct research on six major engineering fields and the definitions **Activity 3**	Do brainstorming activity Conduct research Group presentation of the findings
Conclusion	
Conclude lesson with main concepts being explained on the board	Take lesson notes
Assessment	
Assess the research and the presentation activities	Complete assessment task.

Resources

Lesson 2: Engineering Innovations

Teaching Strategies
Engage students in brainstorming exercise on History of Engineering fields Innovations past and present
Engage students in the discussion of History of Engineering fields Innovations past and present

Learning Strategies
Discover different History of Engineering fields Innovations past and present

Activity 1: Brainstorming activity on History of Engineering fields Innovations past and present
Activity 2: Conduct research on six major engineering fields and their history of Engineering fields Innovations past and present
Activity 3: Discussions and presentation of research findings on six engineering fields and their History (mechanical, chemical, civil, electrical, management, geotechnical)

Resources

_Lesson 3: Influence of engineering fields in the society and environment.

Teaching Strategies
Engage students in brainstorming exercise on the Influence of engineering fields in the society and environment
Engage students in the discussion of different Influence of engineering fields in the society and environment

Learning Strategies
Discover different Influence of engineering fields in the society and environment
Activity 1 Brainstorming activity on Influence of engineering fields in the society and environment
Activity 2 Research the Great Engineering Achievements in the twentieth century as listed the National Academy of Engineering.

Resources

STEAM Activity Students work in groups to create a model of building that is iconic in PNG that have authentic traditional designs which incorporates STEAM concepts that are evident in today's examples of buildings in PNG.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Historical aspects of Engineering. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define engineering fields
2. Analyse the historical aspects of engineering in various discipline
3. Analyse and describe the major influence in engineering fields
4. Analyse and describe the purpose of engineering fields in various discipline

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define engineering fields	Correctly defines engineering fields with examples.	Correctly defines engineering fields.	Partially defines engineering fields	Cannot define engineering fields.
2.Analyse the historical aspects of engineering in various discipline	Excellent Analysis of the historical aspects of engineering in	Analyse the historical aspects of engineering in	Partly analyses the historical aspects of engineering in	Cannot analyse the historical aspects of

	various disciplines	various discipline	various discipline	engineering in various discipline
3. Analyse and describe the major influence in engineering fields	Excellent Analysis and description of the major influence in engineering fields	Correctly Analyses and describe the major influence in engineering fields	Partly analyse and describe the major influence in engineering fields	Cannot Analyse and describe the major influence in engineering fields
4.Analyse and describe the purpose of engineering fields in various discipline	Excellently analyses and describes the purpose of engineering fields in various discipline	Very well analyse and describe the purpose of engineering fields in various discipline	Partly analyse and describe the purpose of engineering fields in various discipline	Cannot analyse and describe the purpose of engineering fields in various discipline

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 9.3.5.2. Investigate the scope of engineering, roles and responsibilities of an engineer and recognise current innovations.

Topic 2: Introduction to Engineering

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and explain the function, scope, roles and responsibilities in engineering then and now.

Essential Questions:

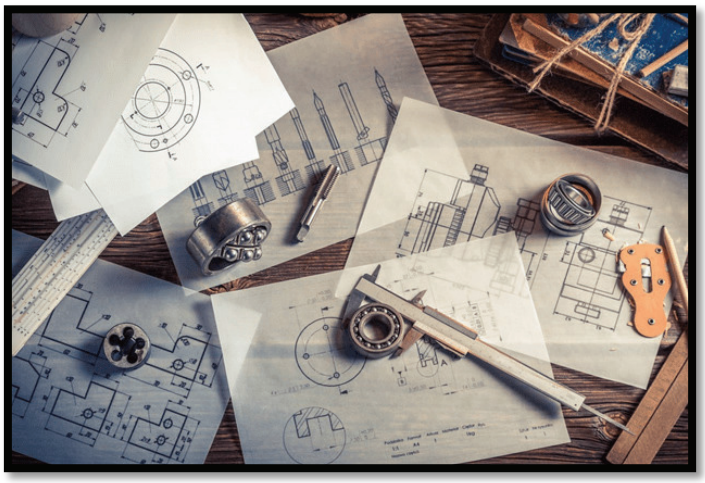
1. What are the six main types of engineering fields?
2. What are the Roles and responsibilities of Engineers?
3. What are the main Scope of Engineering Discipline?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Introduction to engineering and their roles and responsibilities	Practice	Importance	Respect

Technology and Industrial Arts Application: Engineering Technology

Content Background



Engineering is a field of study that uses knowledge from the sciences and mathematics disciplines and applies it to develop solutions to the world's problems in the form of practical applications of innovations. While scientists may discover new and unique concepts, processes, and materials, it is the role of the engineer to take these ideas and turn them into useful products or systems that can be constructed, manufactured to scale, and which will function reliably and continuously as needed to enhance the quality of life for everyone.

To achieve these objectives, the discipline of engineering requires trained engineers that possess the necessary skills and specialized knowledge that enables them to apply scientific principles to create new designs and technologies to improve the performance of existing systems or to create new and revolutionary solutions for the marketplace. Development of these skills and knowledge requires advanced education at the college level, and many specializations necessitate additional graduate study to master the subject effectively.

Engineering is a profession in which knowledge of math and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to use, economically, the materials and forces of nature for the benefit of mankind

Below a summary is presented covering the principal types of engineers, the roles they fill & the functions they perform, some alternate methods of characterizing them, and relevant statistics concerning engineers and the engineering profession.

Classifying Engineers

There are several ways by which to examine the world of engineering and to classify engineers. A few of the common approaches include:

- By education – what did they study and in what subject major did they earn their degree?
- By discipline or specialty – within the broader field of study, do they specialize in a narrower sub-sector of the overall field?
- By job function – what role do they play in the day-to-day work they do in the engineering field?
- By industry – in what vertical industry are they employed?

Education-based Characterization (i.e. Types of Engineering Degrees)

A common classification applied to engineers is to describe them by what their field of study or educational subject major was. Table 1 below summarizes the most common engineering programs of study at top U.S. colleges. There are variations in how these degree programs are structured, depending on the college. While some degree programs, such as mechanical engineering, are common across schools, others vary across institutions. For example, civil engineering may be combined at some schools with environmental engineering, as there is an overlap of a common knowledge base that engineers in these disciplines need to master. The strong integration of computer hardware in products and devices across the broad market has also led some schools to pair computer engineering with electrical engineering as a combined discipline to better address this trend.

Table 1 – Common Engineering Degree Programs	
Programs Area of Study	**What Engineers with this Degree Do**
Aeronautical & Aerospace Engineering	Design aircraft, spacecraft, missiles, satellites, and other defense systems.
Biological & Biomechanical Engineering	Develop equipment and devices used in biological research, health care, hospitals, and research facilities.
Chemical Engineering	Work in the field of production of food, pharmaceuticals, chemicals, paints, coatings, and other products that depend on the development of specialized chemicals.
Civil Engineering	Plan, design, and supervise the construction of roads, bridges, buildings, airports, dams, and other large-scale projects.
Computer Engineering	Typically focused on the hardware design aspects of computer and computer-based systems, including processors, memory, networks, I/O, and communications elements.
Electrical Engineering	Design, develop, manufacture, test, and maintain systems, components, and devices across a broad spectrum of technologies relating to the use and transformation of electrical and electronic signals, including digital, analog, and radio frequency (RF).
Environmental Engineering	Work to understand and develop solutions to environmental problems of industry and society, such as air and water pollution, sewage and waste management, recycling of materials, and the effective preservation and use of natural resources.
Industrial Engineering & Operations Research	Develop effective and efficient production systems and processes that provide for the optimum use of workers, machines, energy, and information to allow for cost efficiency. Design the layouts of factories, plants, warehouses, and other facilities using these process optimization skills.
Materials Science Engineering	Perform research, testing, and evaluation on new or improved materials whose characteristics will enhance the development of products with superior performance, durability, and cost.
Mechanical Engineering	Design mechanical devices and systems, such as tools and machinery, thermal products including sensors and detectors, and fluid flow and fluid dynamics products and systems such as pumps, valves, and hydraulic systems.

Nuclear Engineering	Focused on designing and creating the equipment and systems to take advantage of nuclear fission for the creation of electrical energy as well as the use of radioactive materials for other applications in fields such as nuclear medicine for health care and disease treatment.
Software Engineering	While computer engineers are more focused on the hardware design aspects of computer systems, software engineers focus on the science of computing, code/programming development, and the creation of specialized applications such as artificial intelligence and robotics programming.

Specialty or Discipline-based Characterization

While the degree programs mentioned above in Table 1 provide a broad means of classifying engineers, other disciplines or specialties exist within these programs which further define and classify the engineering professional. For instance, electrical engineers may pursue a concentration in digital systems design, where they might work to develop computer and digital processing equipment. Other electrical engineers might choose to specialize instead in RF design, where they may be involved in the development of new products in wireless communications, navigation, and radar systems, or radio-frequency identification (RFID) technology. Alternatively, they may choose to develop specialization around optics, lasers, optoelectronic devices, and optical signal processing design.

Table 2 – Examples of Engineering Specializations

Job Title	Job Function
RF Design	Design systems and components that involve the use of radio frequency (RF) energy and signals, such as radar systems, navigation systems, satellites, RFID technology, and wireless communications products.
Thermal Design	Focus on the modeling, analysis, and development of cooling processes and technologies to assure that thermal conditions in equipment and products are properly managed to preclude operations that might degrade performance or reduce service life and reliability.
Digital Design	Develop designs for systems and products based on microprocessor systems, memory, I/O devices, A-D and D-A converters, and other components used in computational-driven machines such as computers and signal processors.

Job Function-based Characterization (i.e. Types of Engineering Jobs)

Another means of classifying engineers is to consider them from a job function perspective. While engineers employed at startups and smaller businesses may find themselves wearing many hats, larger organizations tend to be more structurally organized with well-defined hierarchies and responsibilities. In those cases, it would not be uncommon for engineers to find themselves with specific job roles and job titles that reflect those roles. Systems engineer, design engineer, test engineer, quality control engineer, packaging engineer, health & safety

engineer, and field engineer are all examples where the specific job function and title define how the engineer is classified, adding a dimension beyond that of their educational background and specialty discipline. Table 3 below provides some examples of this method of characterization.

Table 3 – Typical Engineering Job Titles and Functions

Job Title	Job Function
Design Engineer	Designs specific parts of a system or components.
Field Engineer	Installs and operates equipment in its end-use environment, monitors for operational problems, and installs needed system upgrades.
Logistics Engineer	These engineers manage aspects of the life cycle support of systems, including spares allocation, repair strategies, and costs of preventive and corrective maintenance.
Manufacturing Engineer	Uses knowledge of production and fabrication processes to determine how best to take a given product or system design from prints and drawings into production in a factory, including selecting from competing processes that could be used as well as determining what production elements should be outsourced to other suppliers with specialized capabilities.
Packaging Engineer	Studies and develops optimal ways of creating packaging that can protect equipment and components during shipping, handling, and storage.
Quality Control Engineer	Monitors and assures the overall quality of the components and materials used in the manufacturing of the product or system, including components purchased from the supply chain.
Reliability Engineer	Analyzes and tests components and systems to assure they will continue to operate within expected performance levels over the life of the product.
Safety Engineer	Monitors and manages the manufacturing facilities and the product to prevent hazards from inadvertently being designed into the process or system that could cause injury to personnel, end users, or that may cause unintended impact to the system or components.
Systems Engineer	Determines the top-level system layout and allocates requirements downward to sub-system components.
Test Engineer	Develops test processes and procedures to assure that the product or system developed meets its overall performance requirements.

Industry-based Characterization

One other classification approach that may be applied to engineers relates to the industry focus or to the vertical market in which they operate. Some of these classifications already appeared in Table 1 shown earlier, as colleges may develop degree programs such as Nuclear Engineering or Aeronautical and Aerospace Engineering that provide a focus around a specific industry. Other examples are shown in Table 4, which include agricultural engineers and marine engineers, to name a few. In some cases, there are specific degree programs available to offer specialization, but in other cases, the label is more reflective of having experience in the industry rather than a specialization from the perspective of a unique educational program.

Table 4 – Examples of Industry-Focused Engineering Titles and Functions

Specialized Engineering Disciplines by Industry	Job Function
Agricultural Engineer	Seeks to improve the efficiency and yields of farms and crops by developing better fertilizers, machinery, storage and transportation systems, and processes.
Automotive Engineer	Works to create safe and reliable vehicles by focusing on specialty knowledge surrounding chassis and vehicle dynamics, powertrain design, and noise and vibration reduction.
Biomedical Engineer	Seeks to apply the principles of engineering to enhance the health and welfare of the population by designing products and technologies such as cardiac pacemakers, artificial organs, and replacement joints. Might also work on improving machinery such as imaging technologies and developing new materials for use inpatient care.
HVAC Engineer	Designs, develops, and supervises the installation of Heating, Ventilating, and Air Conditioning Systems (HVAC) in buildings, office complexes, residential apartments, hospitals, and other structures.
Marine & Naval Engineer	Naval engineers focus on the design of large vessels, offshore facilities, and ships considering the challenges associated with the marine environment such as the corrosive nature of salt spray and the unpredictability of weather and sea state.
Mining & Geological Engineer	Concerned with the overall safety and effective methods for the extraction of minerals and other raw materials from mines and areas of mineral deposits.
Petroleum Engineer	Works to address the challenges of locating, extracting, and transporting oil and natural gas from the deposits underground whether on land or at sea.

Introduction to engineering is the foundations of the engineering discipline; of the six (6) major branch of engineering; mechanical, chemical, civil, electrical, management, geotechnical and literally hundreds of different subcategories of engineering under each branch. This is basically to understand the fundamentals knowledge and skills in these engineering discipline. Based on the teacher's specialization to take practical lesson in which discipline is suitable to his/her trade specialisation. Therefore most of the contents are general knowledge to equip students to prepare for further education training.

The Scope of Engineering discipline – The scope of engineering discipline varies according to the job specifications;

1.The scope of structural engineering is a branch of civil engineering which is one of oldest engineering discipline, Structural engineering is the science and the art of designing civil engineering facilities so they can safely resist the forces to which they may be subjected.

2. Mechanical engineering – can be classified into R&D, analysis, Production, testing, designing, installation, and maintenance.

The Roles and responsibilities of Engineers

Engineers design, build, and maintain various complex systems and structures, from buildings to software. While there are many engineering professions, there is one consistent engineering mindset: to innovate. To do so, they must think in increasingly cross-disciplinary ways, finding combinations, patterns, and intersections between previously disparate conceptual realms. Engineers are the architects of the world. While stereotypes paint a picture of engineering as an anti-social hard science that's primarily conducted behind a computer, engineers are in fact the scientists and artists who created the Palm Islands in Dubai and the Millau Viaduct in France. An engineer's creativity does not always need to be so grandiose—nano-engineers work down to a billionth of a meter in scale.

Engineers combine rigorous scientific knowledge with elegant creativity to change society and address global problems, often in previously unthought-of ways.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of what is engineering and what is entails. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Introduction to Engineering

Teaching Strategies

Engage students in brainstorming exercise on the introduction to engineering fields in various disciplines

Engage students in the discussion introduction of engineering fields in various disciplines

Learning Strategies

Discover different purpose of engineering fields in various disciplines

Activity 1: Brainstorming activity on introduction to engineering fields in various discipline
Activity 2: Conduct research on six major engineering fields and purpose of engineering fields in various discipline
Activity 3: Discussions and presentation of research findings on six engineering fields and purpose of engineering fields in various discipline (mechanical, chemical, civil, electrical, management, geotechnical)

Resources

Lesson 2: Scope of Engineering

Teaching Strategies
Engage students in brainstorming exercise on the scope engineering fields in various disciplines
Engage students in the discussion scope of engineering fields in various disciplines

Learning Strategies
Discover different scope of engineering fields in various disciplines

Activity 1: Brainstorming activity on scope of engineering fields in various discipline
Activity 2: Conduct research on six major engineering fields and scope of engineering fields in various discipline
Activity 3: Discussions and presentation of research findings on six engineering fields and purpose of engineering fields in various discipline (mechanical, chemical, civil, electrical, management, geotechnical)

Resources

_

Lesson 3: Roles and responsibilities of Engineers

Teaching Strategies
Engage students in brainstorming exercise on Roles and responsibilities Engineers in engineering fields in various disciplines.
Engage students in the discussion on the Roles and responsibilities of Engineers engineering fields in various disciplines.

Learning Strategies
Discover different roles and responsibilities of Engineers of engineering fields in various discipline

Activity 1: Brainstorming activity on Roles and responsibilities of Engineers of engineering fields in various discipline

Activity 2: Conduct research on six major engineering fields and Roles and responsibilities of Engineers of engineering fields in various discipline

Activity 3: Discussions and presentation of research findings on six engineering fields and Roles and responsibilities of Engineers engineering fields in various discipline (mechanical, chemical, civil, electrical, management, geotechnical)

Resources

STEAM Activity Students work in groups to create an activity that incorporates the engineering scope and aims with STEAM concepts.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to Introduction to Engineering. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Analyse and describe the Introduction to Engineering
2. Analyse and describe the Scope of Engineering discipline
3. Analyse and describe the Roles and responsibilities of Engineers

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Analyse and describe Engineering	Excellently analyse and describe Engineering	Analyse and describe Engineering	Partly **a**nalyse and describe Engineering	Cannot analyse and describe Engineering
2. Analyse and describe the Scope of Engineering discipline	Excellently analyse and describe Engineering	Analyse and describe the Scope of Engineering discipline	Partly **a**nalyse and describe the Scope of Engineering discipline	Cannot analyse and describe the Scope of Engineering discipline
3. Analyse and describe the Roles and responsibilities of Engineers	Excellently analyse and describe Engineering	Analyse and describe the Roles and responsibilities of Engineers	Partly **a**nalyse and describe the Roles and responsibilities of Engineers	Cannot analyse and describe the Roles and responsibilities of Engineers

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 9.3.5.3. Explore and distinguish the different types of the Engineering fields.

Topic 3: Engineering Fields

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss and enumerate the different types of engineering field and their functions.

Essential Questions:

1. What are the types of engineering fields?
2. What are the purpose of the engineering discipline?
3. What are the terminologies used for the different types of engineering?
4. What are the processes of manufacturing bricks, (structural engineering)?
5. What are the Common terminologies in respective engineering discipline?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
The Engineering Fields and Description	Research	Familiarize the Engineering discipline	Respect and curiosity

Technology and Industrial Arts Application: Construction Technology: Engineering Technology

Content Background

Engineering Fields/Discipline-

They are six (6) major branch of engineering; mechanical, chemical, civil, electrical, management, geotechnical and literally hundreds of different subcategories of engineering under each branch. They have certain functions, processes of manufacturing things, equipment, materials, etc. Mechanical, chemical, civil, electrical, geotechnical,

Mechanical engineering- Is an engineering discipline that combines engineering physics, and mathematics, principles with material science to design, analyse, manufacture, and maintain mechanical systems.

Chemical engineering- is a branch of engineering that uses principle of chemistry, physics, mathematics, biology, economics to efficient use, produce, design, transport and transform energy materials**.**

Civil engineering- is a professional engineering discipline that deals with design, construction, and maintenance of the physical and naturally built environment, including public works, such as roads, bridges, canals, dams, airports, sewage system, pipelines, structural components, of building, and railways**.**

Electrical engineering- is one of the newer branches of engineering and dates back to late 19 century. It is the branch of engineering that deals with the technology of electricity. Electrical engineers work on range of components devices, and system, from tiny microchips to huge power station generators**.**

Geotechnical engineering- Is the branch of engineering concern with the analysis, design, and construction foundation, slopes, retaining structures, embankments, tunnels, levees, wharves, landfills, and other systems that are made of or are supported by soil or rock.

Career Pathways in Engineering

It is believed that majoring in Mechanical or Civil Engineering is the only way to guarantee a high-paying job. Even if this fact is true, to clear up any misunderstanding, one must first comprehend how to select the appropriate Engineering degree from a variety of options.

Determine areas of interest, preferred domains, and the types of work profiles or responsibilities that is appealing. When picking one of the Engineering branches, factors such as the number of hours spent by a professional in this career and the potential for advancement in that profile must be taken into account.

Instead of following the crowd, evaluate ones strengths and weaknesses and chart their path.

Here are different branches that one can get an Engineering degree.

1. Mechatronics engineering

Other fields of engineering are inextricably tied to this one. Electronics, telecommunications, control systems, and mechanical engineering are all part of Mechatronics Engineering. Real-time computer interfacing, controllers and actuators, sensors, and modeling are among the topics covered in this course. A Mechatronics engineer can work in any field that suits him or her, including Artificial Intelligence.

2. Computer Science Engineering

This branch is responsible for the design and prototype of a variety of computing devices and systems. It primarily focuses on various approaches for embedding computing logic into physical systems after it has been correctly translated. Candidates pursuing this engineering

degree, on the other hand, have the option of specializing in areas such as telecommunications, web design, computer hardware, software implementation and maintenance, and so on.

Computer Science Engineering is concerned with the systematic study of algorithmic methods for mapping information. Design, theory, application, execution, and efficiency are all included in the mapped data. It also deals with the study of building and implementing distributed platforms for converting multimedia into a stream of data.

Examples of professions:

- Data scientists
- computer programmers
- systems analysts
- hardware engineers
- software developers
- system engineers
- IT consultants
- system designers
- networking engineers
- web developers
- database administrators
- mobility testers
- e-commerce specialists
- software testers

3. Civil Engineering

Civil engineering is one of the historic and important engineering disciplines. This engineering degree encompasses the planning, construction, maintenance, and supervision of infrastructures. They also look at sewage systems and water treatment facilities. As a result, the course also includes public and environmental health protection, as well as enhancing existing infrastructure.

4. Mechanical engineering

This discipline of engineering analyses the design, manufacture, operation, and maintenance processes of all equipment and systems. Manufacturing, machine design, aerospace systems, energy conservation, and fluid mechanics are all areas where Mechanical Engineering is changing as a result of technological advancements.

It encompasses industries such as AC, power plants, huge industrial machines, vehicles, & even the most basic household appliances. You are not limited to pursuing an engineering degree at the bachelor's level. You can pursue a variety of courses after completing an engineering degree in mechanical engineering to develop a successful career!

5. ECE (Electronics and Communications Engineering)

It is the study, design, development, and testing of electronic equipment utilized in diverse systems. Engineers in the field of electronics & communications also design and supervise the production of communications & broadcasting systems. Topics covered in this branch in this engineering stream are:

- Analog transmission,
- basic electronics,
- microprocessors,
- solid-state devices,
- digital and analog communication,
- satellite communication,
- antennae, and
- wave progression.

Electronic devices, circuits, and communications equipment are also manufactured in this department.

6. Electrical engineering

This engineering degree is distinct from Electronics Engineering, which deals with principles relating to electrical devices and systems. This Engineering curriculum covers topics like -

- electromagnetism for energy transmission,
- generation,
- storage,
- processing,
- control,
- conversion, etc.

7. Aerospace engineering

Aerospace Engineering is one of the most sought-after engineering fields because it deals with the design and building of spacecraft and aircraft. Astronautical Engineering and Aeronautical Engineering are the two engineering degree branches that it is divided into. Aeronautical engineering is concerned with crafts that operate within the earth's atmosphere.

Astronautical engineering is concerned with crafts that operate outside of the earth's atmosphere. Aerospace engineering is primarily concerned with the design, maintenance, construction, testing, and development of rockets, planes, helicopters, and satellites. Aerospace Engineering is regarded as one of the most difficult engineering degree branches that have established a niche for itself among students. However, once completed, this course provides your profession a boost allowing it to soar to new heights.

8. Chemical engineering

It is the application of a set of methods and concepts to convert raw materials/chemicals into useful goods such as clothing, beverages, paint, fuel, and so on. Chemical engineering makes

efficient use of chemistry, biology, and economics to design, manufacture, transport, and transform products, energy, and materials. Chemical engineering has a bright future ahead of it.

9. Marine engineering

This engineering degree is concerned with the design and operation of mechanical equipment for seagoing vessels, ports, and harbor installations. A marine engineer takes care of the design, construction, maintaining vehicles and structures that are utilized on or near water.

Deal with the ship's internal system, which includes the propulsion, electrical, refrigeration, and steering systems, is the responsibility of marine engineers.

10. Automobile engineering

Automobile Engineering is one of the most important engineering areas, and it deals with the design and production of vehicles for transportation. It is a sub-discipline of Mechanical Engineering. Automobile Engineering is concerned with the creation, manufacture, repair, testing, and control of automobiles & their engines, as well as fuel management. A car engineer supervises the entire process, from the conceptual stage till the manufacturing stage.

11. Software engineer

Software engineering entails a thorough examination of the design, development, maintenance, and basic engineering of various software systems. It teaches you how to handle problems such as low-quality software projects. You'll also be expected to create products that end consumers can utilize, and features that attract new people. The demand for software engineers is expanding to meet the quickly changing needs of various consumers as well as the changing working environment.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the fields of engineering. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of engineering fields

Teaching Strategies

Engage students in brainstorming exercise on Types of engineering fields

Engage students in the discussion the types of engineering fields

Learning Strategies
Discover different Types of engineering fields of engineering fields in various discipline

Activity 1: Brainstorming activity on types of engineering fields of Engineers of engineering fields in various discipline
Activity 2: Conduct research on six major engineering fields and types of engineering fields
Activity 3: Discussions and presentation of research findings on six engineering fields and Roles and responsibilities of Engineers engineering fields in various discipline (mechanical, chemical, civil, electrical, management, geotechnical)

Resources

Lesson 2: Career Pathways in Engineering

Teaching Strategies

Engage students in brainstorming exercise on Types of engineering fields
Engage students in the discussion the types of engineering fields and the different careers in engineering.

Learning Strategies
Discover different Types of engineering fields in various discipline and the careers in engineering.

Activity 1: Brainstorming activity on types of engineering fields of Engineers of engineering fields in various disciplines
Activity 2: Conduct research on six major engineering fields and types of engineering fields and the career pathway in engineering.
Activity 3: Discussions and presentation of research findings on six engineering fields and the careers in engineering.

Resources

STEAM Activity Students work in groups to create an activity that incorporates the concepts in the different types of engineering.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Engineering Fields/Discipline. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. List and describe the Types of engineering fields
2. Analyse and describe the Specific terminologies for the different types of engineering

3. Analyse the processes involved in manufacturing blocks, stone wall, bicycle, etc..

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. List and describe the Types of engineering fields	Correct description of more than 5 types of engineering fields.	Correct description of more than 3-4 types of engineering fields	Correct description of more than 2-3 types of engineering fields	Description of 1 type of engineering field.
2. Analyse and describe the Specific terminologies for the different types of engineering discipline.	Analyse and describe correctly	Describe correctly	Few attempt	Not attempted
3. Analyse the processes involved in manufacturing blocks, stone wall, bicycle, etc..	Analyse and describe correctly	Describe correctly	Few attempt	Not attempted

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 9.3.5.4. Explore and discuss engineering principles and practices and the appropriate materials in engineering.

Topic 4: Engineering Principles and practices

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and explain engineering principle, practices and types of engineering equipment.

Essential Questions:

.1. What is engineering principles?
2. What is engineering practices?
3. What are the types of engineering materials?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Engineering Principles and practices	inquiry	Appreciate engineering and innovations	determination

Technology and Industrial Arts Application: Construction Technology: Engineering Technology

Content Background

Engineering Principles and Practices

Engineering principles and practices are the ideas, rules, or concepts that need to be kept in mind when solving an engineering problem. Engineering principles and practices varies according to the engineering discipline.

Mechanical, chemical, civil, electrical, geotechnical.

Mechanical engineering Principles- is an engineering discipline that combines engineering physics, and mathematics, principles with material science to design, analyse, manufacture, and maintain mechanical systems**.**

Chemical engineering principles- is a branch of engineering that uses principle of chemistry, physics, mathematics, biology, economics to efficient use, produce, design, transport and transform energy materials**.**

Civil engineering Principles - is a professional engineering discipline that deals with design, construction, and maintenance of the physical and naturally built environment, including public works, such as roads ,bridges, canals, dams, airports, sewage system, pipelines, structural components, of building, and railways**.**

Electrical engineering Principles - is one of the newer branches of engineering and dates back to late 19 century. It is the branch of engineering that deals with the technology of electricity. Electrical engineers work on range of components devices, and system, from tiny microchips to huge power station generators**.**

geotechnical engineering Principles - Is the branch of engineering concern with the analysis, design, and construction foundation, slopes, retaining structures, embankments, tunnels, levees, wharves, landfills, and other systems that are made of or are supported by soil or rock.

What are the four basic engineering design principles?
Engineers **designing** a visual product will use **principles** of line, color, shape and form to make their **design** more visually pleasing, Others may not care what their product looks like, and will concentrate on **principles** like ease-of-use, or economy

1. Engineering principles-

The following engineering principles apply to both Bridge Building and Software Development and the following Professional Principles are the key difference between a Software Engineer and a Software Programmer.

- Testability
- Maintainablity
- Integrity
- External integration is well defined
- Ethics
- Management

Testability - It is designed to have a repeatable test that can be performed to ensure that it is as expected. With bridge building, you could test the concrete, the steel, expansion and contraction in hot weather, etc.
Maintainability - It is designed to last. A bridge should last twenty years with a designed way to maintain the bridge or safely widen the bridge if so desired.
Integrity - It is designed to have structural integrity. A bridge will not just break in half. In memory state must not just become corrupt.
External integration - It is designed to have a particular well defined way to integrate with its environment without any confusion. A bridge takes cars. There is a sign that says the maximum tonnage and height of the bridge - no confusion.
Ethics - Act primarily in the best interests of (a) the above principles, (b) the users, and (c) the client. If the bridge is going to break and kill people, you cannot sign off on the construction.

Management - An engineer is proactively involved in the management of various responsibilities because the ultimate responsibility rests on the engineer. An engineer does not sit on the side listening to builders about bridge building. An engineer is actively involved in listening to builders and will let them do their speciality but is proactive in coordinating the various specialists towards the ultimate goal. Bridge building is typically managed by civil engineers - there are concrete and steel specialists but they are typically coordinated at a design level by the engineer, *not* by business.

Do not confuse engineering with architecture. An architect may design something without regard to engineering. It becomes the engineer's job to build it according to engineering principles. In the context of software development, you could argue that the SoftwareDevelopmentLifeCycle is part of the responsibility of the management princple of a software engineer but it is certainly not the entire role of the engineer's management responsibility

Simple principles govern why and how things happen. If we learn these principles we can understand how different phenomena affect our daily lives, why certain things happen as they do, and how we can use them to our benefit.

2. Engineering practices:

"Engineering is the profession in which a knowledge of mathematics and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind."

Taking above definition as the starting point, we can arrive at the following basic requisite principles for engineering applications:

1- It is necessary to have work performed by employing theoretical and applied methods so as to assimilate information on mathematical and natural sciences.

2- It is necessary to employ rationally the information gathered.

3- The objective is to develop methods by using such information for the utilization of materials and forces in ways other than found in their original state in nature.

4- It is essential that findings attained by the use of such methods convey benefit to mankind.

5- It is required to have the developed methods economically viable.

Having ascribed the requisite attributes for implementation, loyalty to the application process and identification of moral values, we may commence on the ultimate definition of "good engineering" practices.

Ethical rules to be observed in the execution of their profession.

Those rules are:

1. to accept responsibility in making engineering decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment

2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

3. to be honest and realistic in stating claims or estimates based on available data;

4. to reject bribery in all its forms;

5. to improve the understanding of technology, its appropriate application, and potential consequences;

6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;

9. to avoid injuring others, their property, reputation, or employment by false or malicious action;

10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

The idea that constitutes the foundation of good engineering is good science. In fact, there is no conflict of concepts between good science and good engineering. What is scientifically good is also good for engineering. No example can be cited in the history of science where a scientifically sound idea has failed in engineering practice.

Good science reveals itself in the disclosure of the secrets of nature, and in turn, those revelations are used in resolving engineering problems. Science and engineering may be developed through empiricism. New discoveries generally originate from empiricism and experimentation.

Standards that are nothing more than good engineering practices put in writing regulate the concept of “good engineering”. Certain standards may not always represent the good engineering practice in its entirety. It should also be kept in mind that what is mandatory at all times is not the standards, but good engineering rules. 3 Good engineering practices, just like the doctrinal precedents in law, are capable of setting the foundations of an unshakable case through the good offices of arbitration boards or expertise teams, and may be also cited by commercial organizations, chambers of engineers and quoted in technical agreements. Now that we have touched upon theory and basics of the subject, let’s turn to its implementation in everyday life.

Good engineering is initiated by a good description of anticipated problems/requirements. This is half of the entire work. Identification, analysis and solution of the problems and have those expressed in the best possible manner in writing are elements that help the realization of good engineering practices.

As the subject here is engineering practice, it would be negligent to pass without a word of analysis on the human factor executing that practice, namely the engineer.

Engineers and engineering profession have always been controversial subjects, and will continue to be so. Therefore, both positive and negative sides of the person and the profession have to be discussed. This subject has always been vehemently debated in the lift industry. There will always be engineers in the lift industry who perform engineering profession well or poorly, even if under the responsibility of others, but also who show an allergic reaction to the word “engineer”, and actually identify themselves as craftsmen.

When you ask such a person what an engineer is, his response would be, “a person we have to keep on the payroll so as to build lifts, but other than that, has no contribution to the firm”. In view of the realities we have to acknowledge in life, this definition may well be correct.

There are, in literature, other definitions of engineering put forth by thinkers, academicians and other professionals. Some such definitions regard engineering as an craft, and others as a profession.

In the western world that regards engineering as a profession, there is an acceptance of two types of engineers. One type are those who have received a “diploma” at the end of formal engineering training, and the latter are self-taught, “risen from the ranks” engineers, who, after demonstrating certain abilities and skills, have had themselves registered as members in the chambers of engineers.

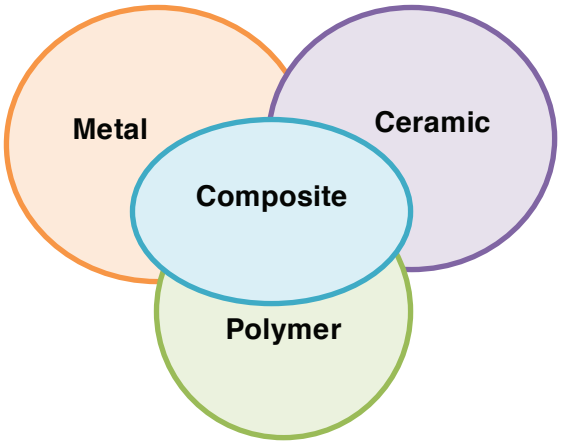
There is a valid approach in the West that strives to gather the ‘de facto” engineers under a certain roof discipline, and have their shortcomings eliminated so as to prevent their indulging in dangerous ventures.

Good engineering practice may be defined in following terms: “Good engineering practices are engineering works performed in conformance with rules based on demonstrated basic scientific facts or experiences that, as a result, create products that would not be detrimental to mankind.” When conformity with the definition of engineering quoted in the beginning of this article and basic principles and ethical rules origination from that definition are attained, engineering practices will be “good” whether we like it or not.

3. Types of engineering materials

Engineering materials refers to the group of materials that are used in the construction of manmade structures and components. The primary function of an engineering material is to withstand applied loading without breaking and without exhibiting excessive deflection. The major classifications of engineering materials include metals, polymers, ceramics, and

composites. Generally, engineering materials are classified into four types viz. Metals and alloys, ceramics and glasses, polymers, and composites.



Classification of Engineering Materials

Metals and Alloys	Ceramics and Glasses	Polymers	Composites
• Ferrous Alloys § Carbon Steel § Low-Alloy Steel § Tool Steel § Stainless Steel § Cast Iron • Aluminum Alloys • Nickel Alloys • Copper Alloys • Titanium Alloys	• Glass • Cements • Clay Products • Refractories • Abrasives	• Thermoplastic Polymers • Thermosetting Polymers • Elastomers	○ Particulate Composites ○ Fibrous Composites ○ Laminated Composites

Properties of Engineering Materials

Mechanical properties of the materials are strength (compressive or tensile), toughness, stiffness, elasticity, plasticity, ductility, brittleness and hardness. Physical properties of materials are density, conductivity (thermal or electrical), acoustical (sound transmission or absorption), optical, combustibility. Chemical properties of materials are composition (oxide or compound), acidity or alkalinity, weathering corrosion.

Metals and Alloys

Inorganic materials are composed of one or more metallic elements.

- They usually have crystalline structures and are good thermal and electrical conductors.
- They maintain their good strength at high and low temperatures.
- Many metals have high elastic strength and high elastic modulus.

- They are the least resistant to corrosion.
- They have sufficient ductility.
- One more important characteristic, they can be strengthened by alloying and heat treatment.

Ceramics and Glasses

Inorganic materials consisting of both metallic and non-metallic materials bonded together chemically.

- They can be crystalline (ceramics), non-crystalline (glasses), or a mixture of both (glasses and ceramics).
- They have high hardness, high moduli, and high-temperature strength.
- Since they are brittle, they cannot be used as good as metals.
- Generally, they have a high melting point and high chemical stability.
- Ceramics are generally poor conductors of electricity.
- Ceramics have high strength on compression.

Polymers

Organic materials consist of long molecular chains or networks containing carbon.

- They generally have low densities and low rigidity.
- Their mechanical properties may vary considerably.
- Most polymers are non-crystalline but some consist of a mixture of both crystalline and non-crystalline regions.
- Most of them are corrosion resistant, but they cannot be used at high temperatures.
- Most of them are poor conductors of electricity due to the nature of atomic bonding.
- They generally have good strength to weight ratio.

Composites

Materials where two or more of the above materials are brought together on a macroscopic level.

- They are designed to combine the best properties of each of its components.
- Usually, they consist of a matrix and reinforcement.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of engineering principles and practices. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for

students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Engineering principles

Teaching Strategies
Engage students in brainstorming exercise on engineering principles
Engage students in the discussion the analyse the processes involved in engineering principles

Learning Strategies
Discover different processes involved in Engineering principles and engineering fields in various discipline
Activity 1: Brainstorming activity on engineering principles in various discipline
Activity 2: Conduct research on engineering principles
Activity 3: Discussions and presentation of research findings on principles and their significance in engineering.

Resources

Lesson 2: Engineering practices

Teaching Strategies

Engage students in brainstorming exercise on engineering practices
Engage students in the discussion the engineering practices.

Learning Strategies

Discover different processes involved in engineering practices
Activity 1: Brainstorming activity on engineering practices
Activity 2: Conduct research on the engineering practices
Activity 3: Discussions and presentation of research findings on engineering practices

Resources

Lesson 3: Engineering materials

Teaching Strategies
Engage students in brainstorming exercise on engineering materials
Engage students in the discussion the engineering materials, their classification and properties.

Learning Strategies
Discover different processes involved in engineering materials their classification and properties.
Activity 1: Brainstorming activity on engineering materials their classification and properties.
Activity 2: Conduct research on engineering materials, their classification and properties.
Activity 3: Discussions and presentation of research findings on engineering materials their classification and properties.

Resources

STEAM Activity Students work in groups to create product using engineering materials using math and science and arts concepts.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Engineering Principles and practices. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.
Performance Assessment

1. List and describe the Types of engineering fields
2. Analyse and describe the Specific terminologies for the different types of engineering discipline.
3. Analyse the processes involved in manufacturing blocks, stone wall, bicycle, etc..

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Analyse and explain engineering principles	Analyse and describe correctly	Describe correctly	Few attempt	Not attempted
2. State and describe engineering practices	Correct description of more than 5 types of engineering practices.	Correct description of more than 3-4 types of engineering practices.	Correct description of more than 2-3 types of engineering practices.	Description of 1 type of engineering practices.
3. List and describe the types of engineering materials	Correct description of more than 5 types of engineering materials.	Correct description of more than 3-4 types of engineering materials.	Correct description of more than 2-3 types of engineering materials.	Description of 1 type of engineering material.

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 9.3.5.5. Explore and analyse the general safety practices in engineering.

Topic 5: Occupational Health & Safety Practices in Engineering

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and describe OHS standards regulations for Engineers
2. Analyse and discuss safety in engineering.

Essential Questions:

1. What is OHS standards and regulations for Engineers?
2. What are the Engineering Hazards & Risk Control Measures?
3. What is the engineering Risk Assessment & Management?
4. What are the engineering Basic First –Aid and CPR?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Engineering Occupational Health & safety	Apply	Safety and precautions	Cautious, aware of dangers and well versed with safety measures

Technology and Industrial Arts Application: Engineering Technology

Content Background

Occupational Health & safety practices in Engineering- Is the OHS practices that all engineers would adhere and comply according to the engineering discipline is concern. Therefore it is paramount the all engineers or the project manager ensure that all worker/trades men/women should be safe and free from accidents/casualties.

Engineering Standards

What are Standards?

Standards are documents created by professional and/or governmental organisations that contain technical definitions, specifications, and guidelines to ensure consistency, safety, and quality of materials, products, processes, and services.

The use of standards is voluntary, but encouraged in order to facilitate interchangeability across companies and support international trade.

What are Codes and Regulations?

Codes and Regulations set mandatory legal requirements. They are implemented by different levels of government and regulatory authorities, such as federal or state agencies and municipalities, and incorporate standards that have been created by that agency or by standards developing organisations. Codes and regulations reference specific standards as the method to meet what is required. Building codes can vary by state, county, or municipality.

Effective management of Health and Safety risks in the engineering industry means being aware of the numerous potential hazards. From the risks associated with operating heavy machinery to the use of harsh chemicals, the potential injuries and illnesses that can occur in engineering environments can be life-threatening.

Managing these risks and protecting an engineering team can be a complex job with a heavy workload. The risk assessment of many different processes, the inspection and servicing cycles of different units of machinery and systems, keeping on top of training and ensuring licenses are up to date is a struggle to manage all.

Machinery Risks

In engineering, injuries and cases of ill health involving machinery measure in the thousands each year. With different pieces of machinery for different engineering processes, keeping on top of managing the health and safety measures associated with each can be time-consuming. Some elements to consider:

- Maintenance – keeping your machinery in good condition and good working order is vital. Malfunctioning or poorly maintained machinery can pose a serious health and safety risk, so ensure your machines are in good working order by conducting daily inspections, and ensuring they receive regular servicing and auditing.
- Safeguards and safety equipment – many machines will have safety mechanisms installed including emergency stops and guards. It's important to ensure these are installed correctly and are in good working order, so it's important to include these elements in one's regular inspections of machinery and servicing routines.
- Training – it's vital to ensure that anyone using the machinery in a business is fully trained and possesses any required licenses. This not only protects those using the machinery but also ensures your business's compliance, so keeping on top license and training renewals (including first aid training) will keep workers safe and the business within the law.
- PPE/clothing – Ensure the engineering team are equipped with the appropriate PPE for the job at hand, including safety goggles and head protection. It's important to ensure that machine operators are wearing suitable clothes and are not at risk of becoming

entangled in the machinery. In general, the use of gloves next to engineering machinery such as lathes, drills, and other rotating-style equipment is considered dangerous due to the increased risk of entanglement.

Vehicle Risks

Many of the vehicle related injuries in the engineering industry are caused by delivery Lorries or fork-lifts. While some incidents are unavoidable, the large majority of health and safety incidents can be prevented with some simple measures:

- Site Rules – drivers who are unfamiliar with the premises or the site one is working on will need clear signage to indicate the site's traffic rules. Often, incidents occur whilst Lorries are reversing or due to unclear traffic rules leading to a collision with other vehicles or pedestrians. Ensure the site has a safe planned route for delivery drivers and that it's clearly communicated.

- Site Planning – careful planning of your site is required to ensure that vehicles and traffic routes are separated from pedestrian routes in order to prevent injuries from a collision. Ensure pedestrian routes are clearly marked and any points where it is necessary for vehicle and pedestrian routes to intersect should be clearly signposted and situated at well-lit, clearly visible points.

- Forklifts – forklifts need to be kept in good working order and included in the health and safety audits and inspections. Only drivers who are trained and authorised to use the vehicle should be driving them, as untrained drivers are likely to cause accidents. Ensure that the forklifts used are suitable for the job at hand and that drivers are given enough time to complete the required work – pressured environments are where dangerous mistakes are more likely to be made.

Slips, Trips and Falls

Engineering workplaces can be messy with oil, dust and other waste from machines and work processes. As well as this, slips, trips and falls are made all the more dangerous with the risk of falling into machinery or sharp edges. Managing these risks effectively needs attention to detail to identify potential risks.

- Risk assessment – as with any work environment, careful, detail-driven risk assessment is required. For slips, trips and falls this requires careful surveying of the environments your team will be working in for any potentially dangerous features such as uneven flooring, uncovered blades, wobbly handrails or unfenced drops.

- Oil – machinery used in engineering can leak oil and cause slip hazards. Ensuring your machines are in good working order will limit the amount of oil that is leaked, and installing a containment system to catch the leaked oil can keep it away from walkways and work areas, protecting workers. As an added bonus, collected oil can be reused, saving your company money.

- Dust – some processes produce dust and particles that can make an otherwise well-gripped floor dangerously slippery. The amount of dust that ends up on the floor can be reduced by rethinking processes, however wherever dust is produced a small amount will inevitably make its way onto the floor. Testing your flooring for grip and the effect that dust or other substances your processes produce has on it can help you identify whether new flooring is required to protect the workers

Electricity and Switchgear

Switchgear and electrical equipment, when maintained properly and used correctly, is generally very safe. The reason it's one of the most common health and safety risks in Engineering is that when things go wrong, it can go catastrophically wrong, leading to fatalities, life-long illness or serious injury.

Some important things to consider when dealing with health and safety around electricity and switchgear are:

- The age of the Equipment – while it's not a legal requirement to replace old equipment such as oil circuit-breakers, many businesses are upgrading to more modern alternatives, such as vacuum breakers. There are many reasons for this, but one important one is that newer equipment is easier to maintain. The expertise and replacement parts required to manage older equipment aren't as easy to find, and newer equipment must fall in line with regulatory requirements.

- Training – many of the incidents that occur around electrical equipment and switchgear are due to a lack of knowledge on the part of the operators and staff. Ensure everyone working on site is aware of the potential risks around electrical equipment by scheduling training sessions, and then ensure training logs are adequately updated.

- Overstressed equipment – ensure equipment is rated to deal with present-day current loads and fault levels. Older equipment may not have been designed for the amount of power modern work practices use, so testing the voltage both upstream and downstream of the switchgear, and how the equipment is coping, can prevent serious incidents occurring.

- Maintenance – ensuring the equipment is kept in good working order is essential. This means regular inspections carried out by capable people who have the expertise and knowledge to spot faults or potential risks in your equipment.

Keeping track can be complex, and when things get busy, important tests, training or inspections can be overlooked.

https://www.notifytechnology.com/products/incident-management/

Manual Handling

In engineering, manual handling is an everyday task that workers will need to be completing safely time and time again. Certain factors can affect how safely workers can move heavy objects around site.

- Training – as with any industry where large, unwieldy or heavy objects need to be moved by workers, manual handling training needs to be in place to ensure workers are not putting themselves at risk of injury. Ensuring this is provided at regular intervals means you can be sure your business maintains compliant.
- Environment – ensure the route your staff needs to take whilst carrying large, heavy or unwieldy objects is clear of any obstacles or potential hazards. Stairs, sharp corners, nearby machinery, slippery floors or narrow walkways can all increase the risk of injury whilst moving objects, so risk assessing the routes your staff need to take while loading/unloading goods or equipment can protect your team.
- Sharp edges – unfinished and sharp edges on objects that need to be carried can cause injury both to those who are carrying the object, and anyone nearby who could come into contact with it. Ensure that edges are finished or protected to help the site remain injury-free.

Risk management can be done well with the best practices documents are shared. Making risk assessments, best practice documents and training materials shareable means that workers can access any information they may need while carrying out their work from their mobile devices. This can mean that time is saved as best practice information is readily available, and fewer risks are taken in an effort to get them done quickly, as information can be accessed quickly and easily.

https://www.notifytechnology.com/insights/health-and-safety-risks-engineering/

Engineering Basic First –Aid and CPR :First Aid and injuries on site

The site is not always the best place to be. Accidents are prone to happen and site injury is always quite common. Some of the **project injuries** can be avoided and if not first aid measures can be taken immediately so as to avoid deaths or worsening of the conditions. The scope of this description is to enlighten the project managers on some of the accidents that can occur on site and the possible ways on managing the injuries.

Procedure

Bruises and fractures can happen and will happen from time to time to the site members. These are not very dangerous accidents and can be managed with simple **first aid on site** measures. The person that has been bruised or had a fractured is to rest for some time. The place can then be iced and compressed then elevated. This will take just a few minutes and the person can get back to work in a short time.

Electrical injuries are also very common **site injuries**. These can be cause by poor installation or shocks as the installation is taking place. The first thing you need to do is to make sure that you don't move the person or touch them. You then need to call the hospital if the shock was due to a high voltage and the person does not come to.

Dislocations and repetitive stress injuries are also injuries that can need to be given some first **aid on site** treatment when they occur so that they don't become very severe. Repetitive stress injuries are mostly due to repeated actions. These can be avoided if the site workers change their motions from time to time.

Some **site injuries** are usually very simple to resolve but others require that you do some CPR to the injured person. CPR is very simple but you have to make sure that you call 911 even before you decide to do the procedure. You then need to check if the person is breathing or if they are having difficulties breathing. After you have done this you have to do some chest compressions and check on the worker who has been hurt. If this does not work you then have to do mouth to mouth resuscitation. Altitude sickness is an example of injury that may require such attention.

Cuts are scrapes are also common **project injuries** that can be happen as the workers are doing the construction. For these you need to make sure that you have a first aid kit with swabs ready for doing some first aid. The injured worker needs to first of all make sure that they stop what they are doing. They then need to look for a disinfectant and disinfect the cut or scrape. If the cut is too deep and done with a blunt and rusty thing then the person will need tetanus shot. You as the project manager need to make sure that you take the responsibility of paying the bills of the injured workers.

https://planningengineer.net/courses/data-management-and-planning-reporting-skills/

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of safety practices in engineering. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: OHS Standards and regulations for Engineers

Teaching Strategies

Engage students in brainstorming exercise on OHS standards and regulations for Engineers
Engage students in the discussion the OHS standards and regulations for Engineers

Learning Strategies
Discover different OHS legislations and regulations for Engineers

Activity 1: Brainstorming activity OHS standards and regulations for Engineers
Activity 2: Conduct research on six major engineering fields and OHS standards and regulations for Engineers
Activity 3: Discussions and presentation of research findings on OHS standards and regulations for Engineers

Resources

Lesson 2: Hazards & Risk Control Measures

Teaching Strategies

Engage students in brainstorming exercise on Engineering Hazards & Risk Control Measures
Engage students in the discussion the Engineering Hazards & Risk Control Measures

Learning Strategies.
Discover different Engineering Hazards & Risk Control Measures
Activity 1 Brainstorming activity Engineering Hazards & Risk Control Measures
Activity 2. Conduct research on six major engineering fields and Engineering Hazards & Risk Control Measures
Activity 3. Discussions and presentation of research findings on six engineering fields and Engineering Hazards & Risk Control Measures

Resources

Lesson 3: Risk Assessment & Management

Teaching Strategies
Engage students in brainstorming exercise on Risk Assessment & Management
Engage students in the discussion the Risk Assessment & Management

Learning Strategies.
Discover different Risk Assessment & Management
Activity 1 Brainstorming activity Risk Assessment & Management
Activity 2. Conduct research on six major engineering fields Risk Assessment & Management
Activity 3. Discussions and presentation of research findings on six engineering fields and Engineering Hazards & Risk Control Measures

Resources

Lesson 4: Basic First –Aid and CPR

Teaching Strategies
Engage students in brainstorming exercise on Basic First –Aid and CPR
Engage students in the discussion the Basic First –Aid and CPR

Learning Strategies.
Discover different Basic First –Aid and CPR
Activity 1 Brainstorming activity Basic First –Aid and CPR Basic First –Aid and CPR
Activity 2. Conduct research on six major engineering fields Basic First –Aid and CPR
Activity 3. Discussions and presentation of research findings on six engineering fields and Basic First –Aid and CPR

Resources

STEAM Activity Students work in groups to create an activity that incorporates safety in engineering.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Occupational Health & safety practices in Engineering. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Analyse and describe OHS legislations and regulations for Engineers
2. State and define Engineering Hazards & Risk Control Measures in engineering discipline
3. State and describe engineering Risk Assessment & Management
4. State and apply engineering Basic First –Aid and CPR

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Analyse and describe OHS legislations and regulations for Engineers	Analyse and describe correctly	Describe correctly	Few attempt	
2. State and define Engineering Hazards & Risk Control Measures in engineering	Correct definition of more than 5 types of Engineering Hazards & Risk Control Measures in engineering discipline	Correct definition of more than 3-4 types Engineering Hazards & Risk Control	Correct definition of more than 2-3 types Engineering Hazards & Risk Control	Definition of 1 type of Engineering Hazard & Risk Control Measure in engineering discipline

discipline		Measures in engineering discipline	Measures in engineering discipline	
3. State and describe engineering Risk Assessment & Management	Correct statement of engineering Risk Assessment & Management in good clear English.	Correct statement of engineering Risk Assessment & Management English.	A statement of engineering Risk Assessment & Management English.	Unclear statement
4. State and apply engineering Basic First –Aid and CPR	Correct description of CPR and clear statement of more than 5 applications engineering Basic First –Aid.	Correct description of CPR and clear statement of 3-4 applications engineering Basic First –Aid.	Description of CPR and clear statement of 2 applications engineering Basic First –Aid.	Unclear description of CPR and unclear statement of1 application engineering Basic First –Aid.

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 9.3.5.6 Outline management and problem solving skills using the engineering design process.

Topic 6: Engineering Design Process

Learning Objectives

By the end of this topic, the students will be able to;

1 Explore and analyse the management and problem solving skills in engineering in relation to the Engineering design process.

Essential Questions:

1. What are the Steps of Engineering Design?
2. What are the Engineering Management skills?
3 what are the Engineering Problem-solving skills?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Engineering design	apply	appreciate	Intuitive, curious

Technology and Industrial Arts Application: Construction Technology: Engineering Technology

Content Background

Engineering Design Process- Engineering design processes are the processes that are involved in designing certain structure or equipment from the basic techniques to the advance. The engineering design process is a common series of steps that engineers use in creating functional products and processes

The **engineering design process** is a series of steps that guides engineering teams as we solve problems. The design process is **iterative**, meaning that we repeat the steps as many times as needed, making improvements along the way as we **learn from failure** and uncover new design possibilities to arrive at great solutions.
The overarching themes of the engineering design process are **teamwork** and **design**

THE DESIGN PROCESS

The Steps of the Engineering Design

Engineering is the design, analysis, and creation of things that are practical and useful in our lives. At its core, engineering incorporates design. Design, simply put, is creating something that has not existed before. Engineers help design, create or change almost everything we encounter in our lives, including what we feel, eat, see, and hear. Look around you for a moment and notice how much of your environment has been designed by humans. Perhaps you are reading inside a building; people designed, engineered, and constructed it. This book has been designed; if you are reading it in a paper format, the paper, ink, and binding have been manufactured, while if you are reading it electronically, the computer on which you are reading has been designed and fabricated. Almost every aspect of modern life depends on and is affected by technological **artifacts** such as bridges, buildings, vehicles, cell phones, computers, and so on. These technological artifacts are designed and created by engineers; the process by which engineers create is often called the engineering design process. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often **iterative**), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.

The Design Process

The word *design* has several meanings. One meaning is a plan or drawing that shows the look and function of an object or structure before it is made. This is the meaning of design that we consider in this chapter. Examples of this meaning for design include;

- a team of architects may develop the design of a building, specifying the building's appearance and the layout of rooms, doors, and hallways;
- a team of engineers may develop the design for a new jet engine, specifying its structure and the materials from which it is built.

Figures 1 and 2 show examples of this type of design.

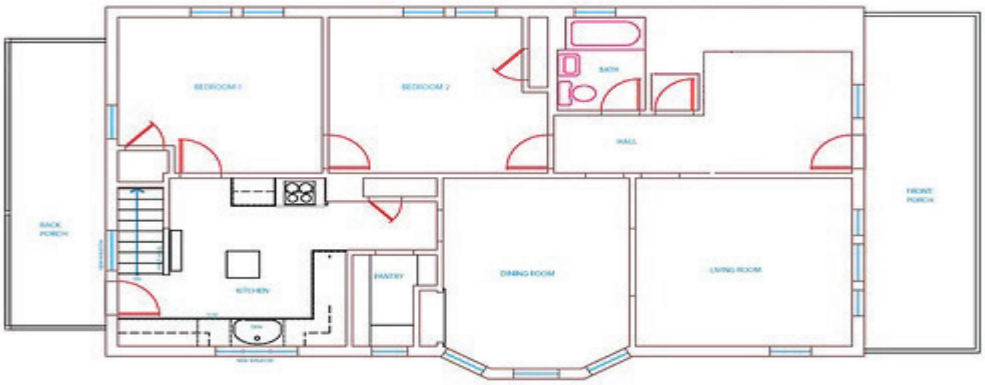


Figure 1: The floor plan of the first story of a house. Architects document their designs using such floor plans.

In general conversation, the word design is often used to mean "an arrangement of lines or shapes to form a pattern or decoration." Figure 2 shows an example of this meaning for design; this is *not* the meaning that we are considering in this chapter.

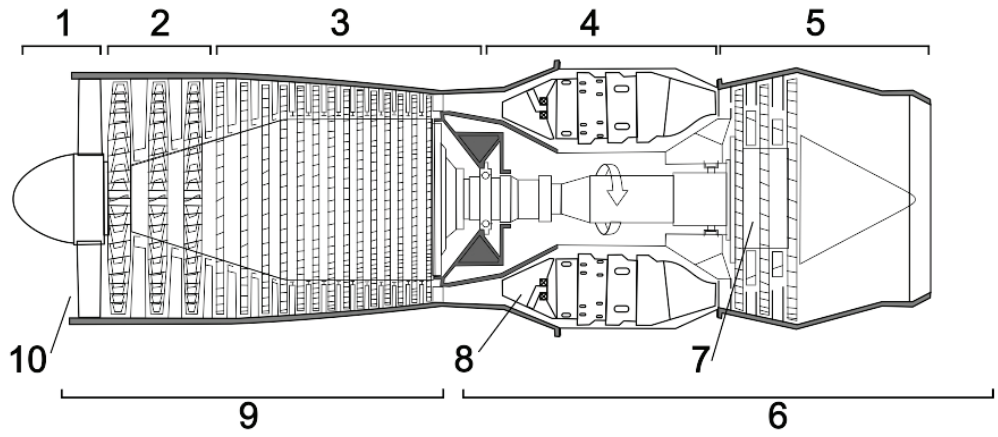


Figure 2: A design of a jet engine.

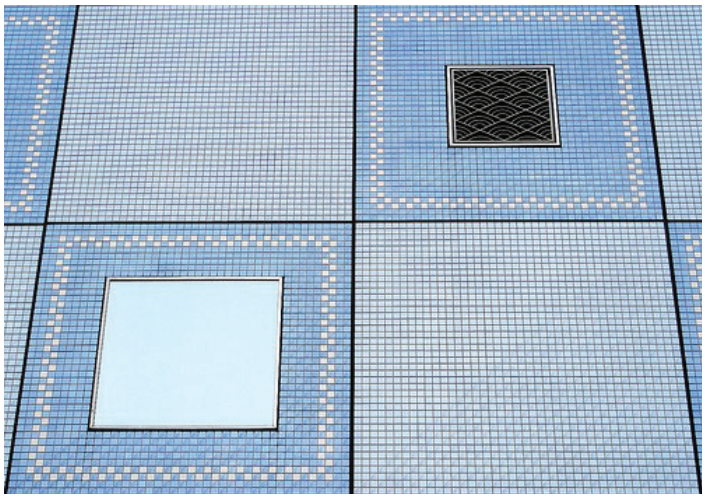


Figure 3: A design can be an arrangement of shapes and lines that forms a decorative pattern.

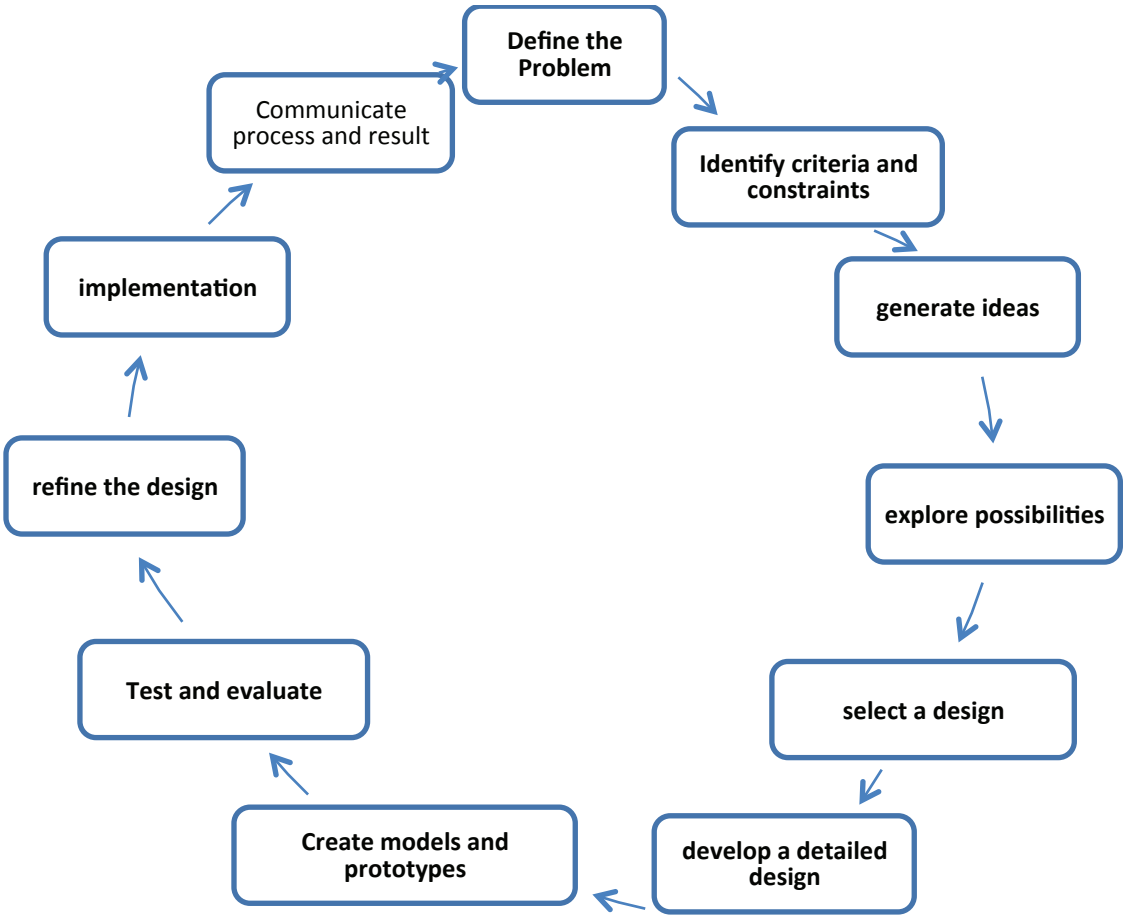
A process by which a design for an object or a structure is created is called a *design process*. All design processes have similarities. They all involve creativity. They all involve making decisions. However, engineering design tends to require a more extensive and specialized knowledge of technology, math, and science than other types of design.

Engineering Design

Teams undertake several different types of engineering design projects. Most projects involve modifying or enhancing an existing product or process; these projects are described as **incremental design**. Sometimes a new product is developed from scratch. Such a project would be a new design. Both types of projects use the design process. The purpose of most design projects is to develop an object, structure, or process that meets the needs of **customers** and **stakeholders**. A customer is someone who will use the designed object; customers usually pay for the product. A stakeholder is someone who has an interest in the product. Customers are stakeholders; other stakeholders may include government agencies, companies, and individuals.

A Design Process

A typical engineering design process involves all the steps of a design process. Other descriptions of the design process may break the process into somewhat different steps and may use somewhat different terms to describe the steps but most design processes are similar.



In many real-life situations, the design team may revisit a step several times to create the final design. We now describe the steps in more detail.

Define the problem. In the problem definition step, the needs of potential customers are investigated; potential competitors are identified and their market positions are **characterized**; **constraints** imposed by government regulations or technological limitations are, identified; and constraints on the design effort such as available personnel, time, and money are established. The problem definition process results in a clear understanding of the scope of the design project and the resources available to solve the design problem. This understanding is often expressed in a **problem statement**. This understanding is also expressed in the form of criteria and constraints.

Identify criteria and constraints. Criteria and constraints are used to evaluate the quality of a design. Constraints describe conditions that must be met by the design and

design process; a design must meet all constraints. Criteria are measurable values that can be used to compare several designs and determine which is better.

Generate ideas. Once criteria and constraints are identified, the design team generates ideas for designs. These ideas come from many different sources; these include existing products (including competitors' products), brainstorming and other creative activities, and market and technical research. Ideas are combined to generate potential designs; at this stage, designs are concepts without a significant level of detail.

Explore possibilities. After potential designs are generated, they are explored to understand their characteristics and likely advantages and disadvantages.

Select a design concept. Potential designs are evaluated relative to the constraints and criteria, and one or more is selected to be designed in detail and prototyped. This selection is made using a structured process that requires the constraints to be met and chooses the best design according to the criteria.

Develop a detailed design. The selected design is developed in more detail. The **design architecture** is established by identifying physical and functional chunks. Shapes and **dimensions** are determined, materials and fabrication processes are selected, and product components are identified. The design is developed in enough detail that prototypes and models of the design can be made.

Create models and prototypes. One or more prototypes are typically implemented to characterize various aspects of the design. Prototypes may be physical models of the design in which dimensions, materials, and fabrication processes emulate important aspects of the design. Increasingly, prototypes are implemented using computer modeling software that simulates mechanical, electrical, and other characteristics of the product.

Test and evaluate. Prototypes are tested to see whether the design meets all constraints and performs acceptably relative to the criteria.

Refine the design. Testing and evaluation may reveal weaknesses of the design or indicate ways in which the design may be improved. At this point, the design may be refined to better meet the criteria and constraints. Sometimes, testing and evaluation show that a design will not work, so that a different design concept must be selected; in this case, the process goes back to the "Select a design concept" step.

Implementation. Depending on the context, the design is produced or constructed.

Communicate process and results. The activities and results of the design process are documented. This documentation is communicated to the appropriate stakeholders in the design.

The design process is often called a sequential process because each step follows the previous one in direct sequence. This model does not account for the iterative nature of many actual design projects; as designs are developed, prototyped, and evaluated, their strengths and weaknesses are better understood and changes are made to the design on the basis of this improved understanding. After changing the design, the process of prototyping and evaluating is repeated. The design process in which the processes are iterated is often called a spiral design process. In a spiral design process changes are made in the design, and then the improved

design is evaluated. The advantage of using a spiral design process is that the end design is often much better than the initial design. The significant disadvantage of the spiral design process is that time and resources are required for each loop in the spiral; if these are not planned for, the project may easily be late and over budget.

The Engineering Management Skills

What is Engineering Management?

Managing modern teams of engineers requires technical knowledge, leadership and management skills. Learn about blending leadership skills with technical expertise in this ***field.***

Types of Engineering Management

Within the field of engineering management, roles vary by specialization. Here are some of the fields within engineering management and the specific responsibilities in each role:

- Mechanical engineering managers lead teams, projects, and innovations in the design and improvement of mechanical systems, typically in specialized areas like automotive, robotics, and electronics.

https://engineering.rice.edu/academics/graduate-programs/online-meml/blog/master-of-mechanical-engineering-and-master-of-engineering-comparision

- Bioengineering managers lead teams, projects, and innovations in the interface of medicine and engineering. They participate in the design of medical and diagnostic devices, biocompatible materials, and advance biomedical engineering, ecological engineering, and orthopedic medicine.

- Chemical and Bio molecular engineering managers lead teams, projects, and innovations in chemical plant operations, waste management, life sciences, and the production of items such as medicine and plastics on a large scale. Their work focuses on the study and manipulation of chemicals and biological molecules, which often finds applications in materials and nanotechnology, engineered biological systems, energy, sustainability and the environment. When chemical-based innovations emerge, these managers lead engineering teams to scale them up.

- Civil and Environmental engineering managers lead teams, projects, and innovations related to societal infrastructures. Projects can include bridges and roadways, and ecological improvements, like contamination remediation, green energy, and infrastructure for smart cities.

- Electrical and Computer engineering managers lead teams, projects, and innovations in the study, design, and development of electricity, electronics, electromagnetism, and computer hardware and software, ranging from electrical components and information technology hardware to supercomputers and cloud-based hardware and cyber-

infrastructure. Semiconductor manufacturing is another area that is filled with these engineering managers.

- Industrial and Systems engineering managers lead teams, projects, and innovations in the optimization and development of industrial and manufacturing systems, processes, machines, and organizations.
- Materials Science and Nanoengineering managers lead teams, projects, and innovations in the study, discovery, creation, testing, and use of materials (like advanced plastics and graphene) by understanding their behavior from the the atomic to macroscopic scale. This is done in order to create tools and materials solutions for industry or human problems.
- Software engineering managers lead teams, projects, and innovations in the development of advanced software systems and computer programs, many of which are cloud based, platform based, and increasingly incorporating AI and machine learning.

Engineering management and leadership is a “broadly integrative and synthesis-focused enterprise engineering discipline”[1], where, akin to mechanical engineering and civil engineering, design and synthesis are key elements of the engineering work. Engineering management covers the gap between engineering and business management, namely the combination of technical and economic decision-making with analytical skills, optimization capabilities, and technical product development.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the engineering design process. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Steps of Engineering Design

Teaching Strategies

Engage students in brainstorming exercise on Steps of Engineering Design
Engage students in the discussion the Steps of Engineering Design

Learning Strategies

Discover different Steps of Engineering Design

Activity 1 Brainstorming activity on Steps of Engineering Design
Activity 2. Conduct research on six major engineering Steps of Engineering Design
Activity 3. Discussions and presentation of research findings on six engineering fields Steps of Engineering Design

Resources

_____

Lesson 2: Engineering Management Skills

Teaching Strategies

Engage students in brainstorming exercise on Engineering Management skills
Engage students in the discussion the Engineering Management skills

Learning Strategies
Discover different Engineering Management skills
Activity 1 Brainstorming activity on engineering Management skills
Activity 2. Conduct research on six major Engineering Management skills
Activity 3. Discussions and presentation of research findings on six engineering Management skills

Resource

_____

_

Lesson 3: Engineering Problem-solving skills

Teaching Strategies

Engage students in brainstorming exercise on engineering Problem-solving skills
Engage students in the discussion Problem-solving skills

Learning Strategies
Discover different processes involved in Problem-solving skills in various engineering fields

Activity 1 Brainstorming activity Problem-solving skills in various engineering discipline
Activity 2. Conduct research on six major engineering Problem-solving skills
Activity 3. Discussions and presentation of research findings on six engineering fields in problem-solving skills

Resources

_____

_

STEAM Activity Students work in groups to create an activity that incorporates the engineering design process.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Engineering Design Process .Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Analyse and apply the Steps of Engineering Design in various discipline
2. Analyse and describe the Engineering Management skills various discipline
3. Analyse and apply engineering Problem-solving skills in various discipline

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced A	Meet Standard B	Progressing C	Not Yet D
Analyse and apply the Steps of Engineering Design in various discipline	Analyse and apply the Steps of Engineering Design correctly	Apply the Steps of Engineering Design correctly	Few analyse	Hard to analyse the steps correctly
2. Analyse and describe the Engineering Management skills various discipline	Analyse and describe the Engineering management skills correctly	describe the Engineering management skills correctly	Few analyse	Hard to analyse management skills
3. Analyse and apply engineering Problem-solving skills in various discipline	Analyse and apply the Engineering problem solving skills correctly	Apply the engineering problem solving skills correctly	Few analyse	Hard to analyse and apply problem solving skills

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.
Benchmark 9.3.5.7. Explore and utilise communication practices appropriate to engineering.

Topic 7: Engineering Communication

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss effective communication and professional documents used by engineers.
2. Employ proper communication skills in using technology.

Essential Questions:

1. What is engineering Effective communication?
2. What are the engineering Interpersonal and intrapersonal communication skills?
3. How do engineering communication used on Telephones, emails, directories?
4. How do engineers communicate via Report writing, memorandum, incidents report?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Engineering Communication	Apply	Importance of communication	Honesty and integrity

Technology an Industrial Arts Application:

Content Background

Engineering Communication

Engineering communication is concerned with the sending and receiving of signals especially by means of electrical or electroacoustic devices and electromagnetic waves.

Engineers communicate in order to enhance their professional performance. An engineer's ability to communicate is intimately related to his/her work performance. Engineers, like other professions, communicate because they need to. The nature of their work demands that they reach out to others.

Engineering communication skills are essential for presenting concepts and designs, and critical to the **engineering** design process. **Engineers** with the ability to clearly **communicate** can confidently present their ideas to decision-makers in presentations, meetings, and reports

As an engineer with career progression you will find yourself performing:

- Less engineering, designing, calculating, problem solving

-More communicating, emails, meetings, reports

Engineering communication.

Both written and verbal communication skills are of the utmost importance in business, especially in engineering. Communication skills boost you or your team's performance because they provide clear information and expectations to help manage and deliver excellent work.

Being able to clearly share ideas with others is an **important** quality in a leader. ... Because their **roles** require team building and leadership, **engineers** must be able to clearly **communicate** complex ideas and technical project plans. They also need to be strong persuaders to see their designs come to **life**

Effective Engineering communication-

Engineers are creative types. They are responsible for dreaming up and building systems that companies will implement or sell, with the goal of improving the bottom line. Because their roles require team building and leadership, engineers must be able to clearly communicate complex ideas and technical project plans. They also need to be strong persuaders to see their designs come to life. Building consensus is a giant step toward delivering a project on time and according to specifications.
Here are a few important communication skills that every engineer should possess, and tips on how to master them.

PUBLIC SPEAKING
Many people are intimidated by public speaking. But in the working world, it is a vital skill to be able to talk in front of groups of people, as well as to larger crowds. Being able to communicate ideas freely and confidently affects everyday interactions and can impact career paths. Incorporating relatable, self-deprecating and humorous content engages the audience. Several professional groups offer coaching to help members feel more at ease with public speaking. For example, the nationwide Toastmasters organization offers tips and mentoring to improve speakers' confidence and abilities. For engineers in particular, this talent is key to sharing ideas at staff meetings, trade shows and conferences.

DOCUMENTATION/WRITING
Engineers need to be able to report their findings in a clear, concise manner. They will be expected to explain how their ideas evolved, why they designed a project as they did, why a project meets current needs and what makes an idea worth investment. Engineers must be able to communicate the level of effort required, the materials necessary and a time estimate of how long the solution will take — from building a prototype to designing for manufacturability to mass production. Further, some engineers' jobs depend on their being published in prestigious industry journals. Community colleges typically offer business writing classes that can help hone a student's writing technique.

SPEAKING WITH AUTHORITY

The enemy of any speaker is the audience's attention span. Engaging presenters have a knack for playing to their audience by being plain-spoken and knowledgeable without being dull or preachy. Understanding the power of the pause — not rushing in to fill every quiet moment with a word — is a particularly useful tactic. In addition, telling a relevant story helps draw in the audience and is effective for explaining a particularly complex subject. Engineers who can articulate their vision for a product and get support from other engineers, as well as management, will reap career benefits. Having thorough knowledge of the subject matter is the most crucial element for being viewed as an expert whose opinion is worthy of attention.

Effective communicators are more likely to be promoted than those who struggle to get their message across. Engineers who are good communicators are recognized by their supervisors and by their clients, which often leads to loyal customers and solid performance reviews.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of communication in engineering. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Effective communication

Teaching Strategies

Engage students in brainstorming exercise on engineering effective communication
Engage students in the discussion the analyse the effective communication

Learning Strategies

Discover different processes involved in effective communication various discipline

Activity 1 Brainstorming activity on Engineering effective communication in various discipline

Activity 2. Conduct research on six major engineering effective communication

Activity 3. Discussions and presentation of research findings on six engineering field's effective communication

Resources

Engineering communication pdf-Kaunas university
Structural Engineer's
Pocket Book
Fiona Cobb

Lesson 2: Interpersonal and intrapersonal communication skills

Teaching Strategies
Engage students in brainstorming exercise on Interpersonal and intrapersonal communication skills.
Engage students in the discussion the analyse the Interpersonal and intrapersonal communication skills.

Learning Strategies
Discover different processes involved in Interpersonal and intrapersonal communication skills engineering fields in various discipline.
Activity 1 Brainstorming activity on Interpersonal and intrapersonal communication skills in various discipline.
Activity 2. Conduct research on six major Interpersonal and intrapersonal communication Skills.
Activity 3. Discussions and presentation of research findings on six engineering fields Interpersonal and intrapersonal communication skills.

Resources

_

Lesson 3: Telephones, emails, directories

Teaching Strategies
Engage students in brainstorming exercise on Telephones, emails, directories
Engage students in the discussion the analyse the processes involved in Telephones, emails, directories

Learning Strategies
Discover different processes involved Telephones, emails, directories engineering fields in various discipline
Activity 1 Brainstorming activity on Telephones, emails, directories in various discipline discipline
Activity 2. Conduct research on six major various Telephones, emails, directories
Activity 3. Discussions and presentation of research findings on six engineering fields Telephones, emails, directories

Resources

Lesson 4: Report writing

Teaching Strategies
Engage students in brainstorming exercise on engineering Report writing
Engage students in the discussion the Report writing

Learning Strategies
Discover different processes Report writing etc engineering fields in various discipline
Activity 1 Brainstorming activity on Report writing in various discipline
Activity 2. Conduct research on six major Report writing

Activity 3. Discussions and presentation of research findings on Report writing)

Resources

Lesson 5: Memorandums

Teaching Strategies

Engage students in brainstorming exercise on Memorandums
Engage students in the discussion the analyse the processes involved in developing memorandums

Learning Strategies
Discover different processes involved in memorandums engineering fields in various discipline

Activity 1 Brainstorming activity on Memorandums in various discipline
Activity 2 . Conduct research on six major engineering Memorandums
Activity 3. Discussions and presentation of research findings on six engineering fields Memorandums)

Resources

Lesson 6: Incident reports

Teaching Strategies

Engage students in brainstorming exercise on Incident reports
Engage students in the discussion the analyse the processes involved in Incident reports

Learning Strategies
Discover different processes involved in Incident reports engineering fields in various discipline

Activity 1 Brainstorming activity on Incident reports in various discipline
Activity 2. Conduct research on six major Incident reports
Activity 3. Discussions and presentation of research findings on six engineering fields Incident reports

Resources

STEAM Activity Students work in groups to create an activity that incorporates the engineering communication.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to Engineering Communication .Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define engineering Effective communication
2. State and describe the engineering Interpersonal and intrapersonal communication skills
3. List and develop engineering communication skills using Telephones, emails, directories

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	**Advanced**	**Meet Standard**	**Progressing**	**Not Yet**
1. Define engineering Effective communication	Define and describe correctly	Define correctly	Few attempt	Not attempted
2. State and describe the engineering Interpersonal and intrapersonal communication skills	State and describe correctly	Describe correctly	Few attempt	Not attempted
3. List and develop engineering communication skills using Telephones, emails, directories	List and describe correctly	Describe correctly	Few attempt	Not attempted

Planning and Programming

The 8 steps in Planning and Programming Process

1. Identify the number of Strands and Units in the subject Syllabus
2. Identify the total number of Content Standards, Benchmarks and Number of Topics (Syllabus and Teacher Guide)
3. Consider the Facts and Considerations in the Planning and Programming Process (subject related)
4. Distribute the Content evenly across the 4 school terms in a Matrix (Proposed Template)
5. Expand and plot the distributed content into the complete Yearly Content Overview for the subject for the grade (Proposed Template)
6. Develop the Termly Programs (Proposed Template)
7. Develop the Weekly Teaching Program (Proposed Template) Daily Lesson Plan (SBC Template
8. Review, Evaluate and Re-plan the yearly, termly, weekly Programs

Planning and Programming Process

The Planning and Programming Process used by the Business and Technology Subjects is an 8 step process. This process begins from Unpacking the Content Standards and Benchmarks and ends with planning a daily lesson plan.

Step 1: Identify the number of Strands and Units in the subject Syllabus
Step 2: Identify the total number of Content Standards, Benchmarks and Number of Topics (Syllabus and Teacher Guide)
Step 3: Consider the Facts and Considerations in the Planning and Programming Process (subject related)
Step 4: Distribute the Content evenly across the 4 school terms in a Matrix (Proposed Template)
Step 5: Expand and plot the distributed content into the complete Yearly Content Overview for the subject for the grade (Proposed Template)
Step 6: Develop the Termly Programs (Proposed Template – 3 part programme)
Step 7: Develop the Weekly Teaching Program (Proposed Template) Daily Lesson Plan (SBC Template)
Step 8: Review, Evaluate and Re-plan the yearly, termly, weekly Programs

TECHNOLOGY AND INDUSTRIAL ARTS PLANNING AND PROGRAMMING PROCESS

Planning and Programming Process involves 8 steps. The steps are outlined and described with samples provided to assist and guide you.

Step 1: Identify the number of Strands and Units in the subject Syllabus (Grade 9&10 TIA Syllabus Page 31)

It is important to first identify the strand and unit names for familiarisation and also the number of strands and units in the Grade 9 Technology and Industrial Arts subject.

Technology and Industrial Arts has 5 strands and 13 Units

Table of Strands and Units

The table below outlines the strands and units for grade 9 Technology and Industrial Arts subject. This helps teachers understand how to deal with units per strand when they are expanded into evidence outcomes and benchmarks at each grade.

The strands and units of content standards explain the progression from Grade 9 to Grade 10, linking to senior high school Technology and Industrial Arts content. The order and linkage of units signifies what the students will achieve from one grade to the next.

Technology and Industrial Arts is organised around five strands – Textile Technology, Food Technology, Construction Technology, Communication Technology and Computer Technology. These strands are comparable with the strands used internationally. The Content Standard of each Strand is based on units. The Strands, Units and Content Standards are outlined in the table below:

Step 1: Identify the number of Strands and Units in the subject Syllabus (Grade 9&10 TIA Syllabus Page 31)

STRANDS	UNITS
Textile Technology	Fibres and Fabrics
	Textiles and Clothing
Food Technology	Food and Nutrition
	Food Science
Construction Technology	Building Technology
	Electrical Technology
	Plumbing Technology
	Welding Technology
	Engineering Technology
Communication Technology	Data Communication and Network
	Computer Security and Safety
Computer Technology	Computer Architecture
	Computer Software

Step 2: Identify the total number of Content Standards, Benchmarks and Number of Topics (Syllabus and Teacher Guide)

- Use the Syllabus to derive the total number of Content Standards and total number of Benchmarks
- Use the unpacking tool to derive your topics and the total number of topics
- Place or slot them in a matrix as in the sample shown below so you are knowledgeable and made aware of the total number of content standards, benchmarks and topics that you will be working with in the planning and programming of teaching and learning for the subject in a school year for that grade.

Grade 9 Technology and Industrial Arts Content Matrix

Consult the Grade 9 Technology and Industrial Arts Content Matrix showing the total number of strands, units, content standards, Benchmarks and topics to be covered in Grade 9.

Total Number Of Strands	Total Number Of Units	Total Number of Content Standards	Total Number Of Benchmarks	Total Number Of Topics
1	2	2	11	11
2	2	2	13	13
3	5	5	29	29
4	2	2	12	12
5	2	2	11	11
Totals	13	13	77	77

Step 3: Consider the Facts and Considerations in the Planning and Programming Process (subject related)

It is important to consider and analyse facts that are worth considering if these facts will help or if these facts will pause a challenge to the planning and programming process.

Facts and Considerations about the Grade 9 Technology and Industrial Arts

1. As per the Matrix, there are a total of 77 Benchmarks and Topics which must be programmed and taught in a school year.

2. TIA is now a subject which requires all students to take all 5 strands in the subject unlike the OBE practice.
3. There are no specialist teachers who are trained to teach all the specialist content in the TIA subject.
4. Current practice has one teacher who can teach Food and Textile (Currently Home Economics), one teacher who can teach Construction Technology (currently Practical Skills) and one teacher who can teach Communication and computer Technology (currently Computer Studies and ICT).

5. With consideration #4, there are 3 personnel who will be required to teach TIA together to deliver the subject. ***Thus, this fact is considered to propose the Planning and Programming Process for TIA subject into a 3-part Teaching and Learning Planning and Programming Process.*** Which means TIA Subject Program is made up of 3 sub-programs.
6. Time Allocation for Grade 9 Technology and Industrial Arts is 200 minutes per week which means it has 5 periods/5 lessons a week: 1 block of 40 minutes (1period) periods and 1 x 160 minutes (4 periods block).
7. There is a total of 40 teaching weeks in a school year (4 Terms x 10 Weeks each)
8. In a term, there are about 8 weeks of actual teaching weeks which gives us 40 periods/40 lessons of actual teaching in a term (6 periods a week x 8 actual teaching weeks in a term).
9. Using these facts and considerations, we can Plan and Program TIA according to this understanding

Understanding 1:

There are 3 x Teachers who are required to teach the TIA subjects in 40 weeks. Therefore teaching and learning must be programmed using the 3 parts (40 /3 = 13.3 weeks per part).

Understanding 2:

There are 77 Benchmarks for TIA that must be planned and programed for 40 weeks but distributed equally according to the 3-parts: Textile & Food =34 BMs; Construction = 33 BMs; Communication &Computer = 33. (use the strand with the highest BMS to determine the number of BMS per week = 34 /16 = 2.1 BMS week)

Understanding 3:

The 3-factor plan and program for TIA becomes the Yearly plan and Program (meaning to say, the plan and program will be utilised by the teacher for 3 lots of students taking TIA in a rotation approach for a year. The TIA Content distribution will be determined by the 3 parts (3 available personnel) and therefore the content will be distributed.

Understanding 4:

In the instance where the school decides to deliver the Food Technology, Textile Technology, Communication Technology and Computer Technology from term 1-3, then the Construction Technology gets to be taught in Term 4. This allows for the school to acquire or make available the necessary requirements for the Construction Technology strand. Otherwise, it becomes school-based and students are awarded an attainment certificate- for the strands they have learnt and NOT TIA. TIA is externally examined and certified.

Step 4: Distribute the Content evenly across the 3-Parts (Proposed Template)

The teaching content outweighs the teaching weeks and therefore considerations must be made on teaching and learning approaches for example; integration, project-based learning, etc. we have provided some information to help you distribute the Technology and Industrial Arts subject content to be programmed fairly across the 3-parts. The tables include:

Grade 9 Technology and Industrial Arts Content distribution for the Teaching Year
The Grade 9 TIA has been distributed according to the 3-parts in a 13 week rotation program. *The content standards and Benchmarks according to the Distribution are also written and provided for you in a table (4a).*

Week	Textile Technology and Food Technology	Construction Technology	Communication and Computer Technology
1	**Textile Technology: Fibres and Fabrics:** CS: 9.11 BMs: 9.1.1.1 and 9.1.1.2	**Building Technology** CS: 9.3.1 BMS: 9.3.1.1. 9.3.1.2, 9.3.1.3,	**Communication Technology Data Communication and Network** CS: 9.4.2 BMs: 9.4.1.1, 9.4.1.2, ,
2	**Textile Technology: Fibres and Fabrics**: CS: 9.11 BMs: 9.1.1.3, .1.1.4,	**Building Technology** CS: 9.3.1 BMs: 9.3.1.4, 9.3.1.5, 9.3.1.6,	**Communication Technology Data Communication and Network** CS: 9.4.1 BMs: 9.1.4.3, 9.1.4.4, 9.1.4 .5
3	**Textile Technology: Textile and Clothing:** CS: 9.1.2 BMs:9.1.2.1, 9.1.2.2,	**Electrical Technology** CS: 9.3.1 BMs: 9.3.2.1, 9.3.2.2, 9.3.2.3,	**Communication Technology Computer Security and Safety** CS: 9.4.2 BMs: 9.4.2.1, 9.4.2.2,
	Assessment	Assessment	Assessment
4	**Textile Technology: Textile and Clothing:** CS: 9.1.2 BMs: 9.1.2.3, 9.1.2.4,	**Electrical Technology** CS: 9.3.2 BMs: 9.3.2.4, 9.3.2.5,	**Communication Technology Computer Security and Safety** CS: 9.4.2 BMs: 9.4.2.3, 9.4.2.4
5	**Textile Technology: Textile and Clothing**: CS: 9.1.2 BMs: 9.1.2.5, 9.1.2.6,	**Electrical Technology** CS: 9.3.2 BMs: 9.3.2.6, 9.3.2.7	**Communication Technology Computer Security and Safety** CS: 9.4.2 BMs: 9.4.2.5, 9.4.2.6,
6	**Food Technology:**	**Plumbing Technology**	**Computer Technology**

	Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.1. 9.2.1.2	CS: 9.3.3 BMs: 9.3.3.1, 9.3.3.2	**Computer Architecture** CS: 9.5.1 BMs: 9.5.1.1, 9.5.1.2
	Assessment	Assessment	Assessment
7	**Food Technology:** **Food and Nutrition:** CS: 9.2.1 BMs: 9.2.1.3, 9.2.1.4	**Plumbing Technology** CS: 9.3.3 BMs: 9.3.3.3, 9.3.3.4,	
8	**Food Technology:** **Food and Nutrition:** CS: 9.2.1 BMs: 9.2.1.5, 9.2.1.6,	**Welding Technology** CS: 9.3.4 BMs: 9.3.4.1, 9.3.4.2,	**Computer Technology** **Computer Architecture** CS: 9.5.1 BMs: 9.1.5.3, 9.1.5.4
9	**Food Technology:** **Food and Nutrition:** CS: 9.2.1 BMs: 9.2.1.7	**Welding Technology** CS: 9.3.4 BMs: 9.3.4.3, 9.3.4.4, 9.3.4.	**Computer Technology** **Computer Architecture** CS: 9.5.1 BMs: 9.1.5.5
	Assessment	Assessment	Assessment
10	**Food Technology:** **Food Science:** CS: 9.2.1 BMs: 9.2.2.1, 9.2.2.2	**Engineering Technology** CS: 9.3.5 BMs: 9.3.5.1, 9.3.5.2,	**Computer Technology** **Computer Software** CS: 9.5.2 BMs: 9.5.2.1, 9.5.2.2
11	**Food Technology:** **Food Science**: CS: 9.2.1 BMs: 9.2.2.3, 9.2.2.4,	**Engineering Technology** CS: 9.3.5 BMs: 9.3.5.3, 9.3.5.4,	**Computer Technology** **Computer Software** CS: 9.5.2 BMs: 9.5.2.3, 9.5.2.4
12	**Food Technology:** **Food Science:** CS: 9.2.1 BMs: 9.2.2.5	**Engineering Technology** CS: 9.3.5 BMs: 9.3.5.5, 9.3.5.6, 9.3.5.7	**Computer Technology** **Computer Software** CS: 9.5.2 BMs: 9.5.2.5,
13	Summative Assessment		

Grade 9 Technology and Industrial Arts Content Standards and Benchmarks Overview as per Strands and Units

The five strands – Textile Technology, Food Technology, Construction Technology, Communication Technology and Computer Technology are unpacked into units to Benchmarks as outlined in the table below:

STRAND 1: TEXTILE TECHNOLOGY	
UNIT 1: FIBRES AND FABRICS	
Content Standard	**Benchmarks**
CS1.1 Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs,	**9.1.1.1 – 9.1.1.6**
	9.1.1.1 Compare and contrast social, economic, cultural and technological changes to textiles, fashion and clothing
	9.1.1.2 Distinguish the properties and characteristics of fibres and fabrics

their construction, production, representation, regulation and marketing.	**9.1.1.3** Explore the elements of design and the design and construction of fashion ideas
	9.1.1.4 Describe the functions of tools and equipment and their safe usage
	9.1.1.5 Explore the range of textile construction techniques
	9.1.1.6 Apply appropriate safety practices in fashion design and construction
STRAND 1: TEXTILE TECHNOLOGY	
UNIT 2: TEXTILE AND CLOTHING	
CS1.2 Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions	**9.1.2.1 – 9.1.2.6**
	9.1.2.1 Describe historical influences, technological progression and emerging trends as inspirational sources of design
	9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions
	9.1.2.3 Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects
	9.1.2.4 Describe how the properties of textile fibres affect textile wear and care
	9.1.2.5 Apply the design process to respond to needs and opportunities in textile design projects
	9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work
STRAND 2: FOOD TECHNOLOGY	
UNIT 1: FOOD AND NUTRITION	
CS 2.1 Students will be able to examine and analyze the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.1 – 9.2.1.7**
	9.2.1.1 Compare and contrast the nature and properties of food
	9.2.1.2 Practice safety and hygiene procedures in tool and equipment, food handling, meal preparation and food development
	9.2.1.3 Examine the nutritional components of food and food development and the impact of food consumption on nutrition.
	9.2.1.4 Explore nutrition as integral to making food choices
	9.2.1.5 Discuss economic, social and technological influences of food, food product and food sciences
	9.2.1.6 Explore ways of meeting nutritional requirements to maintain optimum nutrition or manage nutritional issues
	9.2.1.7 Apply the design process to create food items using combinations of basic ingredients with variations using a selection of techniques and food preparation equipment
STRAND 2: FOOD TECHNOLOGY	
UNIT 2: FOOD SCIENCE	
CS 2.2 Students will be able to investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions, lifestyle, business)	**9.2.2.1 – 9.2.2.6**
	9.2.2.1 Identify and describe the cultural, physical, biological and nutritional characteristics of food that influence food development
	9.2.2.2 Describe the nutritional and sensory characteristics of food to meet the needs, health and occasions.
	9.2.2.3 Apply management strategies in food selection, meal preparation, product development, storage and preservation
	9.2.2.4 Explore safety and hygiene practices relating to food, and changes that occur in the functional properties of food.
	9.2.2.5 Examine the social, economic and environmental impact of food processing technology, and the role packaging plays in the distribution of food from the point of production to consumption

	9.2.2.6 Apply the design process to create food solutions.
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 1: BUILDING TECHNOLOGY	
CS 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.	**9.3.1.1 – 9.3.1.6**
	9.3.1.1 Investigate the history and theory of buildings
	9.3.1.2 Identify and describe a variety of construction materials, components, and processes
	9.3.1.3 Describe the elements of drawings, and their application in technical drawings.
	9.3.1.4 Identify and describe the elements of safety
	9.3.1.5 Describe the scope and purpose of building codes, and identify other regulations and standards that apply to construction projects
	9.3.1.6 Apply mathematical skills and scientific concepts in the planning and building of a variety of construction projects
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 2: ELECTRICAL TECHNOLOGY	
CS 3.2 Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	**9.3.2.1 – 9.3.2.7**
	9.3.2.1 Describe the historical development of electricity
	9.3.2.2 Investigate and communicate OHS legislation and regulation and assess and employ emergency procedures whilst observing safety
	9.3.2.3 Identify, design, develop and evaluate processes and products related to electrical technology and communicate the findings through the use of appropriate electrical and electronic terminology.
	9.3.2.4 Define electricity and conductivity and differentiate insulators from conductors
	9.3.2.5 Identify symbols used and explain the functions of components and devices in electrical circuit diagrams
	9.3.2.6 Identify the different types of circuits and explain the parts and operation of a simple practical circuit.
	9.3.2.7 Investigate the concepts, principles and practices related to electrical
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 3: PLUMBING TECHNOLOGY	
CS 3.3 Investigate and analyse fundamental concepts of plumbing and theories, OHS, Occupational Health and safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in (DWV) Drain, waste, vent system, and water distribution system.	**9.3.3.1 – 9.3.3.4**
	9.3.3.1 Describe and explain the fundamentals, concepts, and their relevance in the plumbing trade
	9.3.3.2 Analyse and describe OHS Regulations and standards in the plumbing trade and work places.
	9.3.3.3 Demonstrate and apply basic plumbing tools and equipment and their specifications and practice in trade math.
	9.3.3.4 Explore and apply basic concepts of trade drawings in plumbing.
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 4: WELDING TECHNOLOGY	
CS 3.4 Investigate and analyse safety procedures, print reading,	**9.3.4.1 – 9.3.4.5**
	9.3.4.1 Investigate safe workshop setup and safety procedures in welding

measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.	**9.3.4.2** Explore and interpret welding principles, codes and standards
	9.3.4.3 Demonstrate knowledge in fundamental print reading, measurement and layout or fi t-up techniques
	9.3.4.4 Investigate and analyse the properties of metals
	9.3.4.5 Investigate the various welding techniques and cutting processes
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 5: ENGINEERING TECHNOLOGY	
CS 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	**9.3.5.1 – 9.3.5.7**
	9.3.5.1 Describe how history and society has influenced the engineering field and critically analyse innovations.
	9.3.5.2 Investigate the scope of engineering, roles and responsibilities of an engineer and recognise current innovations
	9.3.5.3 Explore and distinguish the different types of the Engineering fields.
	9.3.5.4 Explore and discuss engineering principles and practices and the appropriate materials in engineering.
	9.3.5.5 Explore and analyse the general safety practices in engineering.
	9.3.5.6 Outline management and problem solving skills using the engineering design process.
	9.3.5.7. Explore and utilise communication practices appropriate to engineering.
STRAND 4: COMMUNICATION TECHNOLOGY	
UNIT 1: DATA COMMUNICATION AND NETWORK	
CS 4.1 Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.1 – 9.4.1.7**
	9.4.1.1 Define the elements of data communication system.
	9.4.1.2 Describe the functions of the different components of a computer network.
	9.4.1.3 Define the OSI (Open Systems Interconnect) model and how it functions.
	9.4.1.4 Explore the use of technical terminology, basic scientific concepts, and mathematical concepts used in communications technology and apply them to the creation of media products.
	9.4.1.5 Explore and articulate the core concepts, techniques, and skills required to produce a range of communications media products or services.
	9.4.1.6 Research and apply the design brief to design, configure and manage simple network.
	9.4.1.7 Explore the Authoring Software or Multimedia associate software
STRAND 4: COMMUNICATION TECHNOLOGY	
UNIT 2: COMPUTER SECURITY AND SAFETY	
CS 4.2 Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control	**9.4.2.1 – 9.4.2.5**
	9.4.2.1 Investigate and demonstrate appropriate posture in using computer equipment
	9.4.2.2 Identify health hazards associated with the use of ICT and propose good ergonomic practices

system for both hardware, software and information security in society.	**9.4.2.3** Identify effects of the widespread use of computers and associated technologies on society
	9.4.2.4 Evaluate the impact of past, current and emerging technologies on the Individual, society and environments.
	9.4.2.5 Demonstrate an understanding of and apply safe work practices in communications technology activities
STRAND 5: COMPUTER TECHNOLOGY	
UNIT 1: COMPUTER ARCHITECTURE	
CS 5.1 Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	**9.5.1.1 – 9.5.1.6**
	9.5.1.1 Comprehend and explain the Computer System and types of computer.
	9.5.1.2 Explore generations of computer
	9.5.1.3 Investigate and describe the design brief of solving problems.
	9.5.1.4 Identify and describe the functions of, as well as important advances related to, electronic and computer components;
	9.5.1.5 Demonstrate a basic understanding of binary numbers and digital logic
	9.5.1.6 Explore and describe hardware and software troubleshooting principles
STRAND 5: COMPUTER TECHNOLOGY	
UNIT 2: COMPUTER SOFTWARE	
CS 5.2 Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.	**9.5.2.1 – 9.5.2.5**
	9.5.2.1 Explore programming software and applications
	9.5.2.2 Demonstrate the understanding of Operating Systems/ Software and File Management
	9.5.2.3 Apply typing skills with speed (20wpm) and accuracy (80%)
	9.5.2.4 Create documents using Microsoft Office
	9.5.2.5 Explore the Authoring Software or Multimedia associate software

Grade 9 Technology and Industrial Arts Content Standards, Benchmarks and Topics Overview as per the Strands and Units

STRAND 1: FOOD TECHNOLOGY **UNIT 1: FIBRES AND FABRICS**		
Content Standard	**Benchmark**	**Topic**
CS1.1 Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.	**9.1.1.1** Compare and contrast social, economic, cultural and technological changes to textiles, fashion and clothing	Impact of changes on textiles, fashion and clothing
	9.1.1.2 Distinguish the properties and characteristics of fibres and fabrics	Introduction to fibres and fabrics
	9.1.1.3 Explore the elements of design and the design and construction of fashion ideas	Designing and Construction
	9.1.1.4 Describe the functions of tools and equipment and their safe usage	Functions and safe usage of tools and equipment
	9.1.1.5 Explore the range of textile construction techniques	Techniques in textile construction
	9.1.1.6 Apply appropriate safety practices in fashion design and construction	Safety practices in fashion designing and construction

STRAND 1: TEXTILE TECHNOLOGY **UNIT 2: TEXTILE AND CLOTHING**		
Content Standard	**Benchmark**	**Topic**
CS1.2 Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions	**9.1.2.1** Describe historical influences, technological progression and emerging trends as inspirational sources of design	Sources of Design
	9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions	Fundamentals of design process
	9.1.2.3 Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects	Tools and techniques in project designs
	9.1.2.4 Describe how the properties of textile fibres affect textile wear and care	Textiles wear and care
	9.1.2.5 Apply the design process to respond to needs and opportunities in textile design projects	Designing a textile project
	9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work	Documenting a project portfolio
STRAND 2: FOOD TECHNOLOGY **UNIT 1: FOOD AND NUTRITION**		
Content Standard	**Benchmark**	**Topic**
CS 2.1 Students will be able to examine and analyze the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.1** Compare and contrast the nature and properties of food	Nature and properties of food
	9.2.1.2 Practice safety and hygiene procedures in tool and equipment, food handling, meal preparation and food development	Safety and hygienic practices in food product development
	9.2.1.3 Examine the nutritional components of food and food development and the impact of food consumption on nutrition.	Food and nutrients
	9.2.1.4 Explore nutrition as integral to making food choices	Food metabolism
	9.2.1.5 Discuss economic, social and technological influences of food, food product and food sciences	Influences on food product development
	9.2.1.6 Explore ways of meeting nutritional requirements to maintain optimum nutrition or manage nutritional issues	Food composition and energy metabolism
	9.2.1.7 Apply the design process to create food items using combinations of basic ingredients with variations using a selection of techniques and food preparation equipment	Food product development
STRAND 2: FOOD TECHNOLOGY **UNIT 2: FOOD SCIENCE**		
Content Standard	**Benchmark**	**Topic**
CS 2.2 Students will	**9.2.2.1 – 9.2.2.6**	

be able to investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions, lifestyle, business)	**9.2.2.1** Identify and describe the cultural, physical, biological and nutritional characteristics of food that influence food development	Characteristics and properties of cereals, vegetables, fruits, legumes, fats and oils
	9.2.2.2 Describe the nutritional and sensory characteristics of food to meet the needs, health and occasions.	Sensory characteristics of food
	9.2.2.3 Apply management strategies in food selection, meal preparation, product development, storage and preservation	Food management
	9.2.2.4 Explore safety and hygiene practices relating to food, and changes that occur in the functional properties of food.	Food safety and hygienic practices
	9.2.2.5 Examine the social, economic and environmental impact of food processing technology, and the role packaging plays in the distribution of food from the point of production to consumption	Factors influencing food processing and packaging
	9.2.2.6 Apply the design process to create food solutions	The technology design
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 1: BUILDING TECHNOLOGY**		
Content Standard	**Benchmark**	**Topic**
CS 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.	**9.3.1.1** Investigate the history and theory of buildings	The history and theory of buildings
	9.3.1.2 Identify and describe a variety of construction materials, components, and processes	Building construction materials
	9.3.1.3 Describe the elements of drawings, and their application in technical drawings.	Trade drawing
	9.3.1.4 Identify and describe the elements of safety	The Elements Occupational Health and Safety
	9.3.1.5 Describe the scope and purpose of building codes, and identify other regulations and standards that apply to construction projects	Building Codes, Standards and regulations
	9.3.1.6 Apply mathematical skills and scientific concepts in the planning and building of a variety of construction projects	Trade Maths
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 2: ELECTRICAL TECHNOLOGY**		
Content Standard	**Benchmark**	**Topic**
CS 3.2 Analyse and apply the technological processes, concepts, principles and practices related to	**9.3.2.1 – 9.3.2.7**	
	9.3.2.1 Describe the historical development of electricity	History of Electricity
	9.3.2.2 Investigate and communicate OHS legislation and regulation and assess and employ emergency procedures whilst	Workplace and Electrical safety

Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	observing safety	
	9.3.2.3 Identify, design, develop and evaluate processes and products related to electrical technology and communicate the findings through the use of appropriate electrical and electronic terminology.	Electrical or Electronic processes and products
	9.3.2.4 Define electricity and conductivity and differentiate insulators from conductors	Fundamentals of electricity
	9.3.2.5 Identify symbols used and explain the functions of components and devices in electrical circuit diagrams	Components and devices used on circuit diagrams
	9.3.2.6 Identify the different types of circuits and explain the parts and operation of a simple practical circuit.	Circuits
	9.3.2.7 Investigate the concepts, principles and practices related to electrical	Electrical Fundamentals

STRAND 3: CONSTRUCTION TECHNOLOGY
UNIT 3: PLUMBING TECHNOLOGY

Content Standard	Benchmark	Topic
CS 3.3 Investigate and analyse fundamental concepts of plumbing and theories, OHS, Occupational Health and safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in (DWV) Drain, waste, vent system, and water distribution system.	**9.3.3.1 – 9.3.3.4**	
	9.3.3.1 Describe and explain the fundamentals, concepts, and their relevance in the plumbing trade	Fundamental concept and relevance of plumbing trade
	9.3.3.2 Analyse and describe OHS Regulations and standards in the plumbing trade and work places.	Topic 2: Occupational Health and Safety regulations and standard
	9.3.3.3 Demonstrate and apply basic plumbing tools and equipment and their specifications and practice in trade math.	Plumbing tool and equipment
	9.3.3.4 Explore and apply basic concepts of trade drawings in plumbing.	Trade Drawing

STRAND 3: CONSTRUCTION TECHNOLOGY
UNIT 4: WELDING TECHNOLOGY

Content Standard	Benchmark	Topic
CS 3.4 Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.	**9.3.4.1 – 9.3.4.5**	
	9.3.4.1 Investigate safe workshop setup and safety procedures in welding	Workshop Organisation
	9.3.4.2 Explore and interpret welding principles, codes and standards	Welding Standards
	9.3.4.3 Demonstrate knowledge in fundamental print reading, measurement and layout or fi t-up techniques	Measurement Techniques
	9.3.4.4 Investigate and analyse the properties of metals	Metals
	9.3.4.5 Investigate the various welding techniques and cutting processes	Cutting and Welding

STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 5: ENGINEERING TECHNOLOGY**		
Content Standard	**Benchmark**	**Topic**
CS 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	**9.3.5.1 – 9.3.5.7**	
	9.3.5.1 Describe how history and society has influenced the engineering field and critically analyse innovations.	Historical aspects of Engineering Design Process
	9.3.5.2 Investigate the scope of engineering, roles and responsibilities of an engineer and recognise current innovations	Introduction to Engineering
	9.3.5.3 Explore and distinguish the different types of the Engineering fields.	Engineering Fields
	9.3.5.4 Explore and discuss engineering principles and practices and the appropriate materials in engineering.	Engineering Principles and practices
	9.3.5.5 Explore and analyse the general safety practices in engineering.	Occupational Health & safety
	9.3.5.6 Outline management and problem solving skills using the engineering design process.	Engineering Design Process
	9.3.5.7. Explore and utilise communication practices appropriate to engineering.	Engineering Communication
STRAND 4: COMMUNICATION TECHNOLOGY **UNIT 1: DATA COMMUNICATION AND NETWORK**		
Content Standard	**Benchmark**	**Topic**
CS 4.1 Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.1** Define the elements of data communication system.	Data Communication Systems
	9.4.1.2 Describe the functions of the different components of a computer network.	Computer Networks
	9.4.1.3 Define the OSI (Open Systems Interconnect) model and how it functions.	OSI Model
	9.4.1.4 Explore the use of technical terminology, basic scientific concepts, and mathematical concepts used in communications technology and apply them to the creation of media products.	Communication Technology Terminologies Basic Scientific and Mathematical Concepts in creating media products
	9.4.1.5 Explore and articulate the core concepts, techniques, and skills required to produce a range of communications media products or services.	Media Communication
	9.4.1.6 Research and apply the design brief to design, configure and manage simple network.	Design Brief-Simple Network
	9.4.1.7 Explore the Authoring Software or Multimedia associate software	Authoring Software Multimedia
STRAND 4: COMMUNICATION TECHNOLOGY **UNIT 2: COMPUTER SECURITY AND SAFETY**		
Content Standard	**Benchmark**	**Topic**

CS 4.2 Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society.	**9.4.2.1 – 9.4.2.6**	**9.4.2.1 – 9.4.2.6**
	9.4.2.1 Investigate and demonstrate appropriate posture in using computer equipment	Postures in Computer Equipment Usage
	9.4.2.2 Identify health hazards associated with the use of ICT and propose good ergonomic practices	Health and Safety in ICT
	9.4.2.3 Identify effects of the widespread use of computers and associated technologies on society	Effects of Computer Usage
	9.4.2.4 Evaluate the impact of past, current and emerging technologies on the Individual, society and environments.	Emerging Technological Impact
	9.4.2.5 Demonstrate an understanding of and apply safe work practices in communications technology activities	Safe Working Practices/Habits

STRAND 5: COMPUTER TECHNOLOGY
UNIT 1: COMPUTER ARCHITECTURE

Content Standard	Benchmark	Topic
CS 5.1 Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	**9.5.1.1** Comprehend and explain the Computer System and types of computer.	Computer System
	9.5.1.2 Explore generations of computer	History of Computers
	9.5.1.3 Investigate and describe the design brief of solving problems.	Design Brief
	9.5.1.4 Identify and describe the functions of, as well as important advances related to, electronic and computer components;	Computer Electronics
	9.5.1.5 Demonstrate a basic understanding of binary numbers and digital logic	Binary
	9.5.1.6 Explore and describe hardware and software troubleshooting principles	Troubleshooting

STRAND 5 COMPUTER TECHNOLOGY
UNIT 2: COMPUTER SOFTWARE

Content Standard	Benchmark	Topic
CS 5.2 Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.	**9.5.2.1** Explore programming software and applications	Software Programming
	9.5.2.2 Demonstrate the understanding of Operating Systems/ Software and File Management	Operating System
	9.5.2.3 Apply typing skills with speed (20wpm) and accuracy (80%)	Keyboarding
	9.5.2.4 Create documents using Microsoft Office	Microsoft Office
	9.5.2.5 Explore the Authoring Software or Multimedia associate software	Authoring Software/ Multimedia

Grade 9 Technology and Industrial Arts Topics and Lesson Titles as per Strands and Units

The strand, Units and Benchmarks are further unpacked into Topics and Lesson Titles in the Teacher Guides. These are outlined in the table below:

STRAND 1: TEXTILE TECHNOLOGY **UNIT 1: FIBRES AND FABRICS**	
Topics	**Lesson Titles**
Benchmarks	**9.1.1.1 – 9.1.1.6**
Topic 1: Impact of changes on textiles, fashion and clothing	**Lesson 1**: Exploring Textiles? **Lesson 2:** Origins of textiles, fashion and clothing **Lesson3:** Factors affecting changes in textile, fashions and clothing
Topic2: Introduction to fibres and fabrics	**Lesson 1:** What are fibres and fabrics? **Lesson 2:** Characteristics and properties of fibres and fabrics **Lesson 3:** From fibres to fabrics.
Topic 3: Designing and Construction	**Lesson 1:** Elements of design and design types. **Lesson 2:** Sources of fashion ideas. **Lesson 3:** Basic construction processes.
Topic 4: Functions and safe usage of tools and equipment	**Lesson 1:** Textile Construction methods tools and their functions. **Lesson 2:** Safety when using textile tools and equipment. **Lesson 3:** Care and maintenance of textile products.
Topic 5: Techniques in textile construction	**Lesson 1:** Textile construction methods **Lesson 2:** Colouring and decorating methods **Lesson 3:** Fabric finishes
Topic 6: Safety practices in fashion designing and construction	**Lesson 1:** Differentiating between textile designing and construction processes **Lesson 2:** Safety practices in textile.
STRAND 1: TEXTILE TECHNOLOGY **UNIT 2: TEXTILE AND CLOTHING**	
Benchmarks	**9.1.2.1 – 9.1.2.6**
Topic 1: Sources of Design	**Lesson 1:** Sources of design **Lesson 2:** Technological progression **Lesson 3:** Emerging trends
Topic 2: Fundamentals of design process	**Lesson 1:** Importance of design process **Lesson 2:** Skills in the design process **Lesson 3:** Various artistic version
Topic 3: Tools and techniques in project designs	**Lesson 1:** Fashion and types of garments **Lesson 2:** Transferring patterns from garment to garment **Lesson 3:** Patterning techniques
Topic 4: Textiles wear and care	**Lesson** Types of tools for textile projects **Lesson** Safe uses of special tools **Lesson** Care for tools
Topic 5: Designing a textile project	**Lesson** What is design process **Lesson** Phases in Textile Project development **Lesson** Textile Projects
Topic 6 Documenting a project portfolio	**Lesson** People and textile industry **Lesson** Textile technology equipment **Lesson** Textile Project exhibit

STRAND 2: FOOD TECHNOLOGY **UNIT 1: FOOD AND NUTRITION**	
Benchmarks	**9.2.1.1 – 9.2.1.7**
Topic 1: Nature and properties of food	**Lesson 1:** Introduction to food –(Nature and sources of food) **Lesson 2:** Food groups and dietary guidelines **Lesson 3:** Properties of starch, carbohydrates, fats and oil **Lesson 4:** Introduction to food product development
Topic 2: Safety and hygienic practices in food product development	**Lesson 1:** Personal hygiene and safety practices **Lesson 2:** Kitchen hygiene **Lesson 3:** Hygiene practices and safety in food development (preparation etc.)
Topic 3: Food and nutrients	**Lesson 1:** Functions of nutrients and food sources **Lesson 2:** Eating practices **Lesson 3:** Meal planning
Topic 4: Food metabolism	**Lesson 1:** Digestion and absorption of food **Lesson 2:** Functions of food and nutrients in human body **Lesson 3:** Over nutrition and malnutrition (anorexia, bulimia, obesity, hypertension etc.)
Topic 5: Influences on food product development	**Lesson 1:** Food ingredients **Lesson 2:** Principles of cooking methods **Lesson 3:** Food management **Lesson 4:** Economic, Social and technological influences on food product development
Topic 6: Food composition and energy metabolism	**Lesson 1:** Food composition **Lesson 2:** Food labelling **Lesson 3:** Energy metabolism **Lesson 4:** Meals for special needs
Topic 7: Food product development	**Lesson 1:** Introduction to food product development **Lesson 2:** Design process **Lesson 3:** Design Brief **Lesson 4:** Sensory analysis
STRAND 2: FOOD TECHNOLOGY **UNIT 2: FOOD SCEINECE**	
Benchmarks	**9.2.2.1 – 9.2.2.6**
Topic 1: Characteristics and properties of cereals, vegetables, fruits, legumes, fats and oils	**Lesson 1** Cooking methods in food product development **Lesson 2** Physical and biological properties of cereals, vegetables and fruits **Lesson 3** Physical and biological properties of fruits, legumes, fats and oils
Topic 2: Sensory characteristics of food	**Lesson 1** Sensory analyses of food **Lesson 2** Nutritional functions of food **Lesson 3** Functional foods
Topic 3: Food management	**Lesson 1** Food management **Lesson 2** Trends, fashion and food **Lesson 3** Seasons and food
Topic 4: Food safety and hygienic practices	**Lesson 1** Food borne diseases **Lesson 2** Contamination **Lesson 3** First Aid

Topic 5: Factors influencing food processing and packaging	**Lesson 1** Factors that influence food processing **Lesson 2** The role of food packaging **Lesson 3** Developments in packaging and distribution **Lesson 4** Techniques to evaluate products and processes
Topic 6: The technology design	**Lesson 1** Design brief and the technological process **Lesson 3** Evaluate the new product **Lesson 2** Using a design product to create a new product
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 1: BUILDING TECHNOLOGY**	
Benchmarks	**9.3.1.1 – 9.3.1.6**
Topic 1: The history and theory of buildings	**Lesson 1:** Introduction to Building **Lesson 2:** Definition of Building **Lesson 3:** Different Types of Building **Lesson 4:** Types of material used **Lesson 5:** Importance of building and career paths.
Topic 2: Building construction materials	**Lesson 1:** Define Building materials **Lesson 2:** Timber Building Materials **Lesson 3:** Bricks and Concrete materials **Lesson 4:** Metal and steel materials
Topic 3: Trade drawing	**Lesson 1:** Define trade drawing **Lesson 2:** Types of trade drawing **Lesson 3:** Isometric drawing **Lesson 4:** Pictorial drawing **Lesson 5:** Orthographic drawing **Lesson 6:** Types of lines use
Topic 4: The Elements Occupational Health and Safety	**Lesson 1:** Define occupational Health and safety **Lesson 2:** The regulations of OHS **Lesson 3:** The standards of OHS
Topic 5: Building Codes, Standards and regulations	**Lesson 1:** Define Building legislations and regulations **Lesson 2:** Types of building codes **Lesson 3:** Types of building regulations
Topic 6: Trade Maths	**Lesson 1:** Define Applied maths **Lesson 2:** Formulae to calculate substructure **Lesson 3:** Define sub- structure member (footings, post, bearers) **Lesson 4:** Define super -structure members (Floor joist, studs, roofing frame) **Lesson 5:** Types of building defect
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 2: ELECTRICAL TECHNOLOGY**	
Benchmarks	**9.3.2.1 – 9.3.2.7**
Topic 1: History of Electricity	**Lesson 1:** Electrical Energy Production & Supply **Lesson 2:** Modern Power Generation methods **Lesson 3:** Renewable and sustainable energy practices.
Topic 2: Workplace and Electrical safety	**Lesson 1:** Electrical Energy Production & Supply **Lesson 2:** Renewable and sustainable energy practices. **Lesson 3:** Career Pathway in Electrical Technology
Topic 3: Electrical or Electronic processes and products	**Lesson 1:** OHS legislation & Regulation **Lesson 2:** Personal Safety **Lesson 3:** Emergency procedures.

Topic 4: Fundamentals of electricity	**Lesson 1:** Electrical or Electronic processes **Lesson 2:** Electrical or Electronic products
Topic 5: Components and devices used on circuit diagrams	**Lesson 1:** Electricity **Lesson 2:** Conductivity **Lesson 3**: Conductors and Insulators
Topic 6: Circuits	**Lesson 1**: Electrical components & devices **Lesson 2:** Electrical symbols used in circuit diagrams
Topic 7: Electrical Fundamentals	**Lesson 1:** OHMs LAW **Lesson 2**: Kirchhoff's Law **Lesson 3:** Circuit Calculations
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 3: PLUMBING TECHNOLOGY**	
Benchmarks	**9.3.3.1 – 9.3.3.4**
Topic 1: Fundamental concept and relevance of plumbing trade	**Lesson 1:** Introduction to plumbing trade. **Lesson 2:** Importance of plumbing trade. **Lesson 3:** Career pathways of plumbing trade.
Topic 2: Occupational Health and Safety regulations and standard	**Lesson 1:** Define Occupational Health Safety regulations and standards. **Lesson 2:** Types of regulations and standards.
Topic 3: Plumbing tool and equipment	**Lesson 1:** Define plumbing tools and equipment. **Lesson 2:** Types of manual tools and equipment. **Lesson 3:** Types of plumbing materials and specifications.
Topic 4: Trade Drawing	**Lesson 1:** Define trade drawing. **Lesson 2:** Methods of Isometric drawing. **Lesson 3:** Methods of Pictorial drawing. **Lesson4:** Types of lines used.
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 4: WELDING TECHNOLOGY**	
Benchmarks	**9.3.4.1 – 9.3.4.5**
Topic 1: Workshop Organisation	**Lesson 1:** Workshop Set-up **Lesson 2:** Workshop safety procedures
Topic 2: Welding Standards	**Lesson 1:** Welding Principles **Lesson 2:** Welding Codes **Lesson 3:** Welding Standards
Topic 3: Measurement Techniques	**Lesson 1:** Measurement **Lesson 2:** Print reading **Lesson 3:** Layout/ fit-up Techniques
Topic 4: Metals	**Lesson 1:** Types of metals **Lesson 2:** Metal Properties
Topic 5: Cutting and Welding	**Lesson 1:** Types of Welding **Lesson 2:** Thermal cutting, heating and gouging **Lesson 3:** Brazing **Lesson 4:** Welding processes
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 5: ENGINEERING TECHNOLOGY**	
Benchmarks	**9.3.5.1 – 9.3.5.7**
Topic 1: Historical aspects of Engineering Design Process	**Lesson 1:** Engineering, past, present & Future **Lesson 2:** Engineering Innovations **Lesson 3:** Influence of Engineering in the society.
Topic 2: Introduction to Engineering	**Lesson 1:** Introduction to Engineering **Lesson 2:** Scope of Engineering **Lesson 3:** Roles and responsibilities of Engineers
Topic 3: Engineering Fields	**Lesson 1:** Types of engineering fields **Lesson 2:** Specific terminologies for the different types of engineering.

	Lesson 3: Processes of manufacturing materials in various engineering discipline
Topic 4: Engineering Principles and practices	**Lesson 1:** Engineering principles **Lesson 2:** Engineering practices **Lesson 3:** Engineering materials
Topic 5: Occupational Health & safety	**Lesson 1:** OHS legislations and regulations for Engineers **Lesson 2:** Hazards & Risk Control Measures **Lesson 3:** Risk Assessment & Management **Lesson 4:** Basic First –Aid and CPR
Topic 6: Engineering Design Process	**Lesson 1:** Steps of Engineering Design **Lesson 2:** Management skills **Lesson 3:** Problem-solving skills
Topic 7: Engineering Communication	**Lesson 1:** Effective communication **Lesson 2:** Interpersonal and intrapersonal communication skills **Lesson 3:** Telephones, emails, directories **Lesson 4:** Report writing, **Lesson 5:** Memorandums **Lesson 6:** Incident reports
STRAND 4: COMMUNICATION TECHNOLOGY **UNIT 1: DATA COMMUNICATION AND NETWORK**	
Benchmarks	**9.4.1.1 – 9.4.1.7**
Topic 1: Data Communication Systems	**Lesson 1:** Introduction to Data Communication Systems **Lesson 2:** Elements of Data Communication systems
Topic 2: Computer Networks	**Lesson 1:** Introduction to Computer Networks **Lesson 2:** Functions of Computer Network Components
Topic 3: OSI Model	**Lesson 1:** Introduction OSI Model **Lesson 2:** Functions of the OSI Model
Topic 4: Communication Technology Terminologies Basic Scientific and Mathematical Concepts in creating media products	**Lesson 1:** Communication Technology Terminologies **Lesson 2:** Application of Terminologies **Lesson 3:** Media Products.
Topic 5: Media Communication	**Lesson 1:** Introduction to Media Communication **Lesson 2:** Techniques and Skills for application purposes
Topic 6: Design Brief-Simple Network	**Lesson 1:** Introduction to Design Brief **Lesson 2:** Research and apply Design **Lesson 3:** Brief in simple Networking
Topic 7: Authoring Software Multimedia	**Lesson 1:** Introduction to Multimedia, Authoring Software **Lesson 2:** Categories of Authoring Software **Lesson 3:** Features of Multimedia, Authoring Software
STRAND 4: COMMUNICATION TECHNOLOGY **UNIT 2: COMPUTER SECURITY AND SAFETY**	
Benchmarks	**9.4.2.1 – 9.4.2.6**
Topic 1: Postures in Computer Equipment Usage	**Lesson 1:** Introduction to Ergonomics **Lesson 2:** Correct Posture or Positions **Lesson 3:** Case Study - Posture
Topic 2: Health and Safety in ICT	**Lesson 1:** Types Health Hazards associated with use of ICT **Lesson 2:** Good ergonomics practices to minimise Health hazards associated in ICT usage
Topic 3: Effects of Computer Usage	**Lesson 1:** Introduction to computer technology **Lesson 2:** Effects of Computer Technology Usage on society
Topic 4: Emerging Technological Impact	**Lesson 1:** The evolution of emerging technologies **Lesson 2:** Impact of emerging technologies on society and

	environment **Lesson 3:** Case-Study (Music)
Topic 5: Safe Working Practices/ Habits	**Lesson 1:** Introduction to Work Place Safety **Lesson 2:** Safe Work Practices
STRAND 5: COMPUTER TECHNOLOGY **UNIT 1: COMPUTER ARCHITECTURE**	
Benchmarks	**9.5.1.1 – 9.5.1.5**
Topic 1: Computer System	**Lesson 1:** Information-Processing- Cycle **Lesson 2:** Computer Hardware and Software **Lesson 3:** Types of Computer
Topic 2: History of Computers	**Lesson 1:** History of Computers **Lesson 2:** Generation of Computers **Lesson 3:** Classification of Computers
Topic 3: Design Brief	**Lesson 1:** Introduction to Design Brief **Lesson 2:** Stage Design Brief **Lesson 3:** Case Study of Design Brief
Topic 4: Computer Electronics	**Lesson 1:** Fundamentals of Computer Electronics **Lesson 2:** Functions of computer electronic components
Topic 5: Binary	**Lesson 1:** Introduction to Binary Numbers **Lesson 2:** Binary Numbers **Lesson 3:** Digital Logic Circuitry
Topic 6: Troubleshooting	**Lesson 1:** Introduction to Computer Troubleshooting Lesson **Lesson 2:** Troubleshooting **Lesson 3:** Case Study of Troubleshooting
STRAND 5: COMPUTER TECHNOLOGY **UNIT 2: COMPUTER SOFTWARE**	
Benchmarks	**9.5.2.1 – 9.5.2.5**
Topic 1: Software Programming	**Lesson 1:** Introduction to Programming. **Lesson 2:** Types of Programming software and applications **Lesson 3:** Example of Software Programs and associated programming languages
Topic 2: Operating System	**Lesson 1:** Introduction to Operating System **Lesson 2:** Categories of Operating Systems Software **Lesson 3:** File Management
Topic 3: Keyboarding	**Lesson 1:** Introduction to Keyboard **Lesson 2:** Keyboard Techniques **Lesson 3:** Hands on Typing
Topic 4: Microsoft Office	**Lesson 1:** Introduction to Microsoft Word **Lesson 2:** Introduction to Microsoft Excel **Lesson 3:** Introduction to Microsoft PowerPoint/Publisher
Topic 5: Authoring Software/ Multimedia	See **Strand 4**, Benchmark **9.4.1.7**

Step 5: Expand and plot the distributed content into the complete 16 Week 3-Part Yearly Content Overview for the grade

The strand, Units and Benchmarks are further unpacked into Topics and Lesson Titles in the Teacher Guides.Because the Teacher Guide is not available now, the Grade 9 content overview has been adopted and expanded in this facilitators and in-service guide in the absence of the Grade 9 teacher guides to help you plan a Grade 9 Technology and industrial Art Teaching Program

- The Yearly Content Overview for the Technology and Industrial Arts is a 16 week 3-part Content Overview which is Yearly Content Overview for the Technology and Industrial Arts Subject. .
- It outlines the Strands, Units, Content Standards, Benchmarks, Topics and Lessons to be taught in 16 weeks for each part. Teachers have the option of outlining the their Yearly Content Overview in a template that can be easily read and understood by all who will be using the Yearly Overview to derive their Termly teaching programs. (a sample template is provided below)
- In the sample below, the Strands, Units, Content Standards, Benchmarks, Topics and Lesson Titles are distributed evenly across the 16 weeks for each part that must be programmed
- A sample is given below for your convenience to help you plan for your termly program.

GRADE 9 TEXTILE AND FOOD TECHNOLOGY YEARLY CONTENT OVERVIEW

Week	Textile Technology and Food Technology	Content Standard	Benchmark	Topic	Lesson Title
1	Textile Technology: Fibres and Fabrics: CS: 9.11 BMs: 9.1.1.1 and 9.1.1.2, 9.1.1.3,	**CS1.1** Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.	**9.1.1.1** Compare and contrast social, economic, cultural and technological changes to textiles, fashion and clothing	Impact of changes on textiles, fashion and clothing	**Lesson 1**: Exploring Textiles? **Lesson 2:** Origins of textiles, fashion and clothing **Lesson3:** Factors affecting changes in textile, fashions and clothing
			9.1.1.2 Distinguish the properties and characteristics of fibres and fabrics	Introduction to fibres and fabrics	**Lesson 1:** What are fibres and fabrics? **Lesson 2:** Characteristics and properties of fibres and fabrics **Lesson 3:** From fibres to fabrics.
			9.1.1.3 Explore the elements of design and the design and construction of fashion ideas	Designing and Construction	**Lesson 1:** Elements of design and design types. **Lesson 2:** Sources of fashion ideas. **Lesson 3:** Basic construction processes
2	Textile Technology: Fibres and Fabrics: CS: 9.11 BMs: 9.1.1.4, 9.1.1.5, 9.1.1.6	**CS1.1** Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.	**9.1.1.4** Describe the functions of tools and equipment and their safe usage	Functions and safe usage of tools and equipment	**Lesson 1:** Textile Construction methods tools and their functions. **Lesson 2:** Safety when using textile tools and equipment. **Lesson 3:** Care and maintenance of textile products.
			9.1.1.5 Explore the range of textile construction techniques	Techniques in textile construction	**Lesson 1:** Textile construction methods **Lesson 2:** Colouring and decorating methods **Lesson 3:** Fabric finishes
			9.1.1.6 Apply appropriate safety practices in fashion design and	Safety practices in fashion designing	**Lesson 1:** Differentiating between textile designing and construction processes **Lesson 2:** Safety practices

			construction	and construction	in textile.
3	Textile Technology: Textile and Clothing: CS: 9.1.2 BMs:9.1.2.1, 9.1.2.2,	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions	**9.1.2.1** Describe historical influences, technological progression and emerging trends as inspirational sources of design	Sources of Design	**Lesson 1:** Sources of design **Lesson 2:** Technological progression **Lesson 3:** Emerging trends
			9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions	Fundamentals of design process	**Lesson 1:** Importance of design process **Lesson 2:** Skills in the design process **Lesson 3:** Various artistic version
4	Textile Technology: Textile and Clothing: CS: 9.1.2 BMs: 9.1.2.3, 9.1.2.4,	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions	**9.1.2.3** Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects	Tools and techniques in project designs	**Lesson 1:** Fashion and types of garments **Lesson 2:** Transferring patterns from garment to garment **Lesson 3:** Patterning techniques
			9.1.2.4 Describe how the properties of textile fibres affect textile wear and care	Textiles wear and care	**Lesson** Types of tools for textile projects **Lesson** Safe uses of special tools **Lesson** Care for tools
5	Textile Technology: Textile and Clothing: CS: 9.1.2 BMs: 9.1.2.5,	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and	**9.1.2.5** Apply the design process to respond to needs and opportunities in textile design projects	Designing a textile project	**Lesson** What is design process **Lesson** Phases in Textile Project development **Lesson** Textile Projects
			9.1.2.6 Select and use appropriate technology to	Documenting a project	**Lesson** People and textile industry **Lesson** Textile technology

	9.1.2.6,	garment construction for a variety of needs and occasions	creatively document, communicate and present design and project work	portfolio	equipment **Lesson** Textile Project exhibit
6	Food Technology: Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.1. 9.2.1.2	**CS 2.1** Students will be able to examine and analyze the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.1** Compare and contrast the nature and properties of food	Nature and properties of food	**Lesson 1:** Introduction to food –(Nature and sources of food) **Lesson 2:** Food groups and dietary guidelines **Lesson 3:** Properties of starch, carbohydrates, fats and oil **Lesson 4:** Introduction to food product development
			9.2.1.2 Practice safety and hygiene procedures in tool and equipment, food handling, meal preparation and food development	Safety and hygienic practices in food product development	**Lesson 1:** Personal hygiene and safety practices **Lesson 2:** Kitchen hygiene **Lesson 3:** Hygiene practices and safety in food development (preparation etc.)
7	Food Technology: Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.3, 9.2.1.4	**CS 2.1** Students will be able to examine and analyze the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and	**9.2.1.3** Examine the nutritional components of food and food development and the impact of food consumption on nutrition.	Food and nutrients	**Lesson 1:** Functions of nutrients and food sources **Lesson 2:** Eating practices **Lesson 3:** Meal planning
			9.2.1.4 Explore nutrition as integral to making food choices	Food metabolism	**Lesson 1:** Digestion and absorption of food **Lesson 2:** Functions of food and nutrients in human body **Lesson 3:** Over nutrition and malnutrition (anorexia, bulimia, obesity, hypertension etc.)

		standards			
8	Food Technology: Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.5, 9.2.1.6,	**CS 2.1** Students will be able to examine and analyze the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.5** Discuss economic, social and technological influences of food, food product and food sciences	Influences on food product development	**Lesson 1:** Food ingredients **Lesson 2:** Principles of cooking methods **Lesson 3:** Food management **Lesson 4:** Economic, Social and technological influences on food product development
			9.2.1.6 Explore ways of meeting nutritional requirements to maintain optimum nutrition or manage nutritional issues	Food composition and energy metabolism	**Lesson 1:** Food composition **Lesson 2:** Food labelling **Lesson 3:** Energy metabolism **Lesson 4:** Meals for special needs
9	Food Technology: Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.7	**CS 2.1** Students will be able to examine and analyze the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.7** Apply the design process to create food items using combinations of basic ingredients with variations using a selection of techniques and food preparation equipment	Food product development	**Lesson 1:** Introduction to food product development **Lesson 2:** Design process **Lesson 3:** Design Brief **Lesson 4:** Sensory analysis
10	Food Technology: Food	**CS 2.2** Students will be able to investigate	**9.2.2.1** Identify and describe the cultural, physical, biological and	Characteristics and properties of cereals,	**Lesson 1** Cooking methods in food product development **Lesson 2** Physical and

	Science: CS: 9.2.2 BMs: 9.2.2.1, 9.2.2.2	and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions,	nutritional characteristics of food that influence food development	vegetables, fruits, legumes, fats and oils	biological properties of cereals, vegetables and fruits **Lesson 3** Physical and biological properties of fruits, legumes, fats and oils
			9.2.2.2 Describe the nutritional and sensory characteristics of food to meet the needs, health and occasions.	Sensory characteristics of food	**Lesson 1** Sensory analyses of food **Lesson 2** Nutritional functions of food **Lesson 3** Functional foods
11	Food Technology: Food Science: CS: 9.2.2 BMs: 9.2.2.3, 9.2.2.4,	**CS 2.2** Students will be able to investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions,	**9.2.2.3** Apply management strategies in food selection, meal preparation, product development, storage and preservation	Food management	**Lesson 1** Food management **Lesson 2** Trends, fashion and food **Lesson 3** Seasons and food
			9.2.2.4 Explore safety and hygiene practices relating to food, and changes that occur in the functional properties of food	Food safety and hygienic practices	**Lesson 1** Food borne diseases **Lesson 2** Contamination **Lesson 3** First Aid
12	Food Technology: Food Science:	**CS 2.2** Students will be able to investigate and analyse the cultural,	**9.2.2.5** Examine the social, economic and environmental impact of food processing	Factors influencing food processing and	**Lesson 1** Factors that influence food processing **Lesson 2** The role of food packaging

	CS: 9.2.1 BMs: 9.2.2.5 9.2.2.6	physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions,	technology, and the role packaging plays in the distribution of food from the point of production to consumption	packaging	**Lesson 3** Developments in packaging and distribution **Lesson 4** Techniques to evaluate products and processes
			9.2.2.6 Apply the design process to create food solutions.	The technology design	**Lesson 1** Design brief and the technological process **Lesson 3** Evaluate the new product **Lesson 2** Using a design product to create a new product
13	Textile and Food Summative Assessment				

GRADE 9 CONSTRUCTION TECHNOLOGY YEARLY CONTENT OVERVIEW

Week	Construction Technology	Content Standard	Benchmark	Topic	Lesson Title
1	Building Technology CS: 9.3.1 BMS: 9.3.1.1. 9.3.1.2, 9.3.1.3,	**CS 3.1** Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.	**9.3.1.1** Investigate the history and theory of buildings	The history and theory of buildings	**Lesson 1:** Introduction to Building **Lesson 2:** Definition of Building **Lesson 3:** Different Types of Building **Lesson 4:** Types of material used **Lesson 5:** Importance of building and career paths.
			9.3.1.2 Identify and describe a variety of construction materials, components, and processes	Building construction materials	**Lesson 1:** Define Building materials **Lesson 2:** Timber Building Materials **Lesson 3:** Bricks and Concrete materials **Lesson 4:** Metal and steel materials
			9.3.1.3 Describe the elements of drawings, and their application in technical drawings.	Trade drawing	**Lesson 1:** Define trade drawing **Lesson 2:** Types of trade drawing **Lesson 3:** Isometric drawing **Lesson 4:** Pictorial drawing **Lesson 5:** Orthographic drawing **Lesson 6:** Types of lines use
2	Building	**CS 3.1**	**9.3.1.4** Identify	The Elements	**Lesson 1:** Define

	Technology CS: 9.3.1 BMs: 9.3.1.4, 9.3.1.5, 9.3.1.6,	Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.	and describe the elements of safety	Occupational Health and Safety	occupational Health and safety **Lesson 2:** The regulations of OHS **Lesson 3:** The standards of OHS
			9.3.1.5 Describe the scope and purpose of building codes, and identify other regulations and standards that apply to construction projects	Building Codes, Standards and regulations	**Lesson 1:** Define Building legislations and regulations **Lesson 2:** Types of building codes **Lesson 3:** Types of building regulations
			9.3.1.6 Apply mathematical skills and scientific concepts in the planning and building of a variety of construction projects	Trade Maths	**Lesson 1:** Define Applied maths **Lesson 2:** Formulae to calculate substructure **Lesson 3:** Define sub-structure member (footings, post, bearers) **Lesson 4:** Define super -structure members (Floor joist, studs, roofing frame) **Lesson 5:** Types of building defect
3	Electrical Technology CS: 9.3.2 BMs: 9.3.2.1, 9.3.2.2, 9.3.2.3,	**CS 3.2** Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with	**9.3.2.1** Describe the historical development of electricity	History of Electricity	**Lesson 1:** Electrical Energy Production & Supply **Lesson 2:** Modern Power Generation methods **Lesson 3:** Renewable and sustainable energy practices.

		regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	**9.3.2.2** Investigate and communicate OHS legislation and regulation and assess and employ emergency procedures whilst observing safety	Workplace and Electrical safety	**Lesson 1:** Electrical Energy Production & Supply **Lesson 2:** Renewable and sustainable energy practices. **Lesson 3:** Career Pathway in Electrical Technology
			9.3.2.3 Identify, design, develop and evaluate processes and products related to electrical technology and communicate the findings through the use of appropriate electrical and electronic terminology.	Electrical or Electronic processes and products	**Lesson 1:** OHS legislation & Regulation **Lesson 2:** Personal Safety **Lesson 3:** Emergency procedures.
4	Electrical Technology CS: 9.3.2 BMs: 9.3.2.4, 9.3.2.5,	**CS 3.2** Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	**9.3.2.4** Define electricity and conductivity and differentiate insulators from conductors	Fundamentals of electricity	**Lesson 1:** Electrical or Electronic processes **Lesson 2:** Electrical or Electronic products
			9.3.2.5 Identify symbols used and explain the functions of components and devices in electrical circuit diagrams	Components and devices used on circuit diagrams	**Lesson 1:** Electricity **Lesson 2:** Conductivity **Lesson 3**: Conductors and Insulators

5	Electrical Technology CS: 9.3.2 BMs: 9.3.2.6, 9.3.2.7	**CS 3.2** Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	**9.3.2.6** Identify the different types of circuits and explain the parts and operation of a simple practical circuit.	Circuits	**Lesson 1**: Electrical components & devices **Lesson 2:** Electrical symbols used in circuit diagrams
			9.3.2.7 Investigate the concepts, principles and practices related to electrical	Electrical Fundamentals	**Lesson 1:** OHMs LAW **Lesson 2**: Kirchhoff's Law **Lesson 3:** Circuit Calculations
6	Plumbing Technology CS: 9.3.3 BMs: 9.3.3.1, 9.3.3.2	**CS 3.3** Investigate and analyse fundamental concepts of plumbing and theories, OHS, Occupational Health and safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in (DWV) Drain, waste, vent system, and water	**9.3.3.1** Describe and explain the fundamentals, concepts, and their relevance in the plumbing trade	Fundamental concept and relevance of plumbing trade	**Lesson 1:** Introduction to plumbing trade. **Lesson 2:** Importance of plumbing trade. **Lesson 3:** Career pathways of plumbing trade.
			9.3.3.2 Analyse and describe OHS Regulations and standards in the plumbing trade and work places.	Topic 2: Occupational Health and Safety regulations and standard	**Lesson 1:** Define Occupational Health Safety regulations and standards. **Lesson 2:** Types of regulations and standards.

		distribution system.			
7	Plumbing Technology CS: 9.3.3 BMs: 9.3.3.3, 9.3.3.4,	**CS 3.3** Investigate and analyse fundamental concepts of plumbing and theories, OHS, Occupational Health and safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in (DWV) Drain, waste, vent system, and water distribution system.	**9.3.3.3** Demonstrate and apply basic plumbing tools and equipment and their specifications and practice in trade math.	Plumbing tool and equipment	**Lesson 1:** Define plumbing tools and equipment. **Lesson 2:** Types of manual tools and equipment. **Lesson 3:** Types of plumbing materials and specifications.
			9.3.3.4 Explore and apply basic concepts of trade drawings in plumbing.	Trade Drawing	**Lesson 1:** Define trade drawing. **Lesson 2:** Methods of Isometric drawing. **Lesson 3:** Methods of Pictorial drawing. **Lesson4:** Types of lines used.
8	Welding Technology CS: 9.3.4 BMs: 9.3.4.1, 9.3.4.2,	**CS 3.4** Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles	**9.3.4.1** Investigate safe workshop setup and safety procedures in welding	Workshop Organisation	**Lesson 1:** Workshop Set-up **Lesson 2:** Workshop safety procedures
			9.3.4.2 Explore and interpret welding principles, codes and standards	Welding Standards	**Lesson 1:** Welding Principles **Lesson 2:** Welding Codes **Lesson 3:** Welding Standards

		and apply fundamentals of fabrication.			
9	Welding Technology CS: 9.3.4 BMs: 9.3.4.3, 9.3.4.4, 9.3.4.5	**CS 3.4** Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.	**9.3.4.3** Demonstrate knowledge in fundamental print reading, measurement and layout or fi t-up techniques	Measurement Techniques	**Lesson 1:** Measurement **Lesson 2:** Print reading **Lesson 3:** Layout/ fit-up Techniques
			9.3.4.4 Investigate and analyse the properties of metals	Metals	**Lesson 1:** Types of metals **Lesson 2:** Metal Properties
			9.3.4.5 Investigate the various welding techniques and cutting processes	Cutting and Welding	**Lesson 1:** Types of Welding **Lesson 2:** Thermal cutting, heating and gouging **Lesson 3:** Brazing **Lesson 4:** Welding processes
10	Engineering Technology CS: 9.3.5 BMs: 9.3.5.1, 9.3.5.2,	**CS 3.5** Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate	**9.3.5.1** Describe how history and society has influenced the engineering field and critically analyse innovations.	Historical aspects of Engineering Design Process	**Lesson 1:** Engineering, past, present & Future **Lesson 2:** Engineering Innovations **Lesson 3:** Influence of Engineering in the society.
			9.3.5.2 Investigate the scope of engineering, roles and responsibilities of an engineer and	Introduction to Engineering	**Lesson 1:** Introduction to Engineering **Lesson 2:** Scope of Engineering **Lesson 3:** Roles and responsibilities of

		to any engineering field.	recognise current innovations		Engineers
11	Engineering Technology CS: 9.3.5 BMs: 9.3.5.3, 9.3.5.4,	**CS 3.5** Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	**9.3.5.3** Explore and distinguish the different types of the Engineering fields.	Engineering Fields	**Lesson 1:** Types of engineering fields **Lesson 2:** Specific terminologies for the different types of engineering. **Lesson 3:** Processes of manufacturing materials in various engineering discipline
			9.3.5.4 Explore and discuss engineering principles and practices and the appropriate materials in engineering.	Engineering Principles and practices	**Lesson 1:** Engineering principles **Lesson 2:** Engineering practices **Lesson 3:** Engineering materials
12	Engineering Technology CS: 9.3.5 BMs: 9.3.5.5, 9.3.5.6, 9.3.5.7	**CS 3.5** Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	**9.3.5.5** Explore and analyse the general safety practices in engineering.	Occupational Health & safety	**Lesson 1:** OHS legislations and regulations for Engineers **Lesson 2:** Hazards & Risk Control Measures **Lesson 3:** Risk Assessment & Management **Lesson 4:** Basic First –Aid and CPR
			9.3.5.6 Outline management and problem solving skills using the engineering design process.	Engineering Design Process	**Lesson 1:** Steps of Engineering Design **Lesson 2:** Management skills **Lesson 3:** Problem-solving skills
			9.3.5.7. Explore and utilise communication practices appropriate to engineering.	Engineering Communication	**Lesson 1:** Effective communication **Lesson 2:** Interpersonal and intrapersonal communication skills **Lesson 3:** Telephones, emails,

					directories **Lesson 4:** Report writing, **Lesson 5:** Memorandums **Lesson 6:** Incident reports
13	**SUMMATIVE ASSESSMENT**				

GRADE 9 COMMUNICATION AND COMPUTER TECHNOLOGY YEARLY CONTENT OVERVIEW

Week	Communication and Computer Technology	Content Standard	Benchmark	Topic	Lesson Title
1	Communication Technology Data Communication and Network CS: 9.4.2 BMs: 9.4.1.1, 9.4.1.2, ,	**CS 4.1** Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.1** Define the elements of data communication system.	Data Communication Systems	**Lesson 1:** Introduction to Data Communication Systems **Lesson 2:** Elements of Data Communication systems
			9.4.1.2 Describe the functions of the different components of a computer network.	Computer Networks	**Lesson 1:** Introduction to Computer Networks **Lesson 2:** Functions of Computer Network Components
2	Communication Technology Data Communication and Network CS: 9.4.1 BMs: 9.4.1.3, 9.4.1.4,	**CS 4.1** Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.3** Define the OSI (Open Systems Interconnect) model and how it functions.	OSI Model	**Lesson 1:** Introduction OSI Model **Lesson 2:** Functions of the OSI Model
			9.4.1.4 Explore the use of technical terminology, basic scientific concepts,and mathematical concepts used in communications technology and apply them to the creation of media	Communication Technology Terminologies Basic Scientific and Mathematical Concepts in creating media products	**Lesson 1:** Communication Technology Terminologies **Lesson 2:** Application of Terminologies **Lesson 3:** Media Products.

			products.		
3	Communication Technology Data Communication and Network CS: 9.4.1 BMs: 9.1.4 .5, 9.1.4 .6, 9.1.4 .7	**CS 4.1** Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.5** Explore and articulate the core concepts, techniques, and skills required to produce a range of communicatio ns media products or services.	Media Communicati on	**Lesson 1:** Introduction to Media Communication **Lesson 2:** Techniques and Skills for application purposes
			9.4.1.6 Research and apply the design brief to design, configure and manage simple network.	Design Brief- Simple Network	**Lesson 1:** Introduction to Design Brief **Lesson 2:** Research and apply Design **Lesson 3:** Brief in simple Networking
			9.4.1.7 Explore the Authoring Software or Multimedia associate software	Authoring Software Multimedia	**Lesson 1:** Introduction to Multimedia, Authoring Software **Lesson 2:** Categories of Authoring Software **Lesson 3:** Features of Multimedia, Authoring Software
4	Communication Technology Computer Security and Safety CS: 9.4.2 BMs: 9.4.2.1,	**CS 4.2** Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control	**9.4.2.1** Investigate and demonstrate appropriate posture in using computer equipment	Postures in Computer Equipment Usage	**Lesson 1:** Introduction to Ergonomics **Lesson 2:** Correct Posture or Positions **Lesson 3:** Case Study - Posture
			9.4.2.2 Identify health hazards	Health and	**Lesson 1:** Types Health Hazards associated with

	9.4.2.2,	system for both hardware, software and information security in society.	associated with the use of ICT and propose good ergonomic practices	Safety in ICT	use of ICT **Lesson 2:** Good ergonomics practices to minimise Health hazards associated in ICT usage
5	Communication Technology Computer Security and Safety CS: 9.4.2 BMs: 9.4.2.3, 9.4.2.4,	**CS 4.2** Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society	**9.4.2.3** Identify effects of the widespread use of computers and associated technologies on society	Effects of Computer Usage	**Lesson 1:** Introduction to computer technology **Lesson 2:** Effects of Computer Technology Usage on society
			9.4.2.4 Evaluate the impact of past, current and emerging technologies on the Individual, society and environments.	Emerging Technological Impact	**Lesson 1:** The evolution of emerging technologies **Lesson 2:** Impact of emerging technologies on society and environment **Lesson 3:** Case-Study (Music)
6	Communication Technology Computer Security and Safety CS: 9.4.2 BMs: 9.4.2.5,	**CS 4.2** Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society	**9.4.2.5** Demonstrate an understanding of and apply safe work practices in communications technology activities	Safe Working Practices/Habits	**Lesson 1:** Introduction to Work Place Safety **Lesson 2:** Safe Work Practices
7	Computer Technology Computer Architecture	**CS 5.1** Explore and analyse computer fundamentals, the skills to manage and	**9.5.1.1** Comprehend and explain the Computer System and types of	Computer System	**Lesson 1:** Information-Processing- Cycle **Lesson 2:** Computer Hardware and Software

	CS: 9.5.1 BMs: 9.5.1.1, 9.5.1.2	maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	computer.		**Lesson 3:** Types of Computer
			9.5.1.2 Explore generations of computer	History of Computers	**Lesson 1:** History of Computers **Lesson 2:** Generation of Computers **Lesson 3:** Classification of Computers
8	Computer Technology Computer Architecture CS: 9.5.1 BMs: 9.5.1.3, 9.5.1.4	**CS 5.1** Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	**9.5.1.3** Investigate and describe the design brief of solving problems.	Design Brief	**Lesson 1:** Introduction to Design Brief **Lesson 2:** Stage Design Brief **Lesson 3:** Case Study of Design Brief
			9.5.1.4 Identify and describe the functions of, as well as important advances related to, electronic and computer components;	Computer Electronics	**Lesson 1:** Fundamentals of Computer Electronics **Lesson 2:** Functions of computer electronic components
9	Computer Technology Computer Architecture CS: 9.5.1	**CS 5.1** Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose,	**9.5.1.5** Demonstrate a basic understanding of binary numbers and digital logic	Binary	**Lesson 1:** Introduction to Binary Numbers **Lesson 2:** Binary Numbers **Lesson 3:** Digital Logic Circuitry

	BMs: 9.5.1.5, 9.5.1.6	troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	**9.5.1.6** Explore and describe hardware and software troubleshooting principles	Troubleshooting	**Lesson 1:** Introduction to Computer Troubleshooting Lesson **Lesson 2:** Troubleshooting **Lesson 3:** Case Study of Troubleshooting
10	Computer Technology Computer Software CS: 9.5.2 BMs: 9.5.2.1, 9.5.2.2	**CS 5.2** Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.	**9.5.2.1** Explore programming software and applications	Software Programming	**Lesson 1:** Introduction to Programming. **Lesson 2:** Types of Programming software and applications **Lesson 3:** Example of Software Programs and associated programming languages
			9.5.2.2 Demonstrate the understanding of Operating Systems/ Software and File Management	Operating System	**Lesson 1:** Introduction to Operating System **Lesson 2:** Categories of Operating Systems Software **Lesson 3:** File Management
11	Computer Technology Computer Software CS: 9.5.2 BMs: 9.5.2.3, 9.5.2.4	**CS 5.2** Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge	**9.5.2.3** Apply typing skills with speed (20wpm) and accuracy (80%)	Keyboarding	
			9.5.2.4 Create documents using Microsoft Office	Microsoft Office	**Lesson 1:** Introduction to Keyboard **Lesson 2:** Keyboard Techniques **Lesson 3:** Hands on Typing

		in the various software.			
12	Computer Technology Computer Software CS: 9.5.2 BMs: 9.5.2.5,	**CS 5.2** Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.	**9.5.2.5** Explore the Authoring Software or Multimedia associate software	Authoring Software/ Multimedia	**Lesson 1:** Introduction to Microsoft Word **Lesson 2:** Introduction to Microsoft Excel **Lesson 3:** Introduction to Microsoft PowerPoint/Publisher
13	**SUMMATIVE ASSESSMENT**				

Step 6: Develop the Termly Programs

- Extract the terms content from the Yearly Overview to expand the content into the termly teaching program.
- Note that the TIA program is developed in 3-parts and 1 of the 3 parts is the program to be used all year around for the different lots of students rotating to take all 5 strand s of TIA. Below is a proposed Template to develop a Teaching Program for a Term.(13 weeks)

Subject: _____Grade _____Term:____ Year: _____

Week	**Content Standards**	**Bench mark**	**Unit**	**Topic**	**Learning Objective**	**Knowledge**	**Skill**	**Attitude / Values**	**Performance Standa d**
Write the week number	Write the Coding only	Write the Coding only	Write the Unit number and Name	Write the Topic number and Name	By the end of this Topic, Students will be able to: Write the learning Objectives for the Topic	Write the essential knowledge to be learnt in this topic	Write the essential skill to be learnt in this topic	Write the essential attitude and values to be learnt in this topic	By the end of this Topic, student will be able to: Write the Performance Standard (if the Benchmark carries one)

Note: A Performance Standard will only be included if the Benchmark has been nominated to carry

a Performance Standard (Assessment). Otherwise, it is not very necessary for all Benchmarks to have a Performance Standard.

Step 7: Develop the Weekly Teaching Program (Proposed Template) and Daily Lesson Plan (SBC Template)

Template 1: Using Topics to develop Weekly Teaching Program

- You can use the Topics to develop the weekly teaching program
- Below is a proposed Template to develop a Teaching Program for a week

Subject: _____ Grade: ____ Term:_____ Week: ____ Date: _____Year: _____

CS	BM	Unit	Topic	Learning Objective	Knowledge	Skill	Attitude / Values	Suggested Learning Activities	Performance Standard
Write the Coding only	Write the Coding only	Write the Unit number and Name	Write the Topic number and Name	By the end of this Topic, Students will be able to: Write the learning Objectives for the Topic	Write the essential knowledge to be learnt in this topic	Write the essential skill to be learnt in this topic	Write the essential attitude and values to be learnt in this topic	List down the learning activities that will be done in this topic	By the end of this Topic, students will be able to; Write the Performance Standard (only if the Benchmark carries a performance standard)

Template 2: Using Lesson Titles to develop Weekly Teaching Program

- Use the unpacking process to derive lesson titles and lesson objectives to be able to expand your weekly teaching program.
- Below is a proposed Template to develop a Teaching Program for a week

Subject: _____ Grade: ____ Term:_____ Week: ____ Date: _____Year: _____

CS	BM	Unit	Topic	Learning Objective	Knowledge	Skill	Attitude/ Values	Performance Standard	Lesson Number and Titles	Lesson Objectives	Suggested Learning Activities
Write the Coding only	Write the Coding only	Write the Unit number and Name	Write the Topic number and Name	By the end of this Topic, Students will be able to: Write the learning Objectives for the Topic	Write the essential knowledge to be learnt in this topic	Write the essential skill to be learnt in this topic	Write the essential attitude and values to be learnt in this topic	By the end of this Topic, students will be able to; Write the Performance Standard (if the Benchmark carries one)	Lesson 1:	L1 Objectives	
									Lesson 2:	L2 Objectives	
									Lesson 3: Etc.	L3 Objectives	

Timetabling of Technology and Industrial Arts

The teaching and learning of TIA can be organized in the manner of class rotational basis. There are three teachers who will be teaching the subject TIA.

1: The Home Economics Teacher,
2: The Practical Skills Teacher, and
3. The Math /Science/Computing Teacher.

These three teachers will be timetabled to teach TIA during the term. Then the planning and programming will be organised in this same manner only each strand teacher will extract the strand program for teaching as these are subject specific content. This is to ensure that teachers are on contact throughout the terms and to maintain their teaching loads.

Sample 1st Rotational Program for the First 13 Weeks (Term1 Week 1-10 and Term 2 Week 1-2)

Class	Strand	Content Teacher	
Class 1 and Class 2	Food and Textile Technology	Home Economics Teacher	These classes can be rotated so they all cover all the strands of TIA
Class 3 and 4	Construction Technology	Practical Skills Teacher	
Class 5 and Strand 6	Communication and Computer Technology	Computing ICT Teacher	

Sample 2nd Rotational Program for the Next 13 Weeks (Term 2 Week 4 – Term 3 Week 6)

Class	Strand	Content Teacher	
Class 1 and 2	Construction Technology	Practical Skills	These classes can be rotated so they all cover all the strands of TIA
Class 3 and 4	Communication and Computer Technology	Computing ICT Teacher	
Class 5 and 6	Food and Textile Technology	Home Economics Teacher	

Sample 3rd Rotational Program for the Next 13 Weeks (Term 3 Week 7 – Term 4 Week 9)

Class	Strand	Content Teacher	
Class 1 and 2	Communication and Computer Technology Food and Textile Technology	Home Economics	These classes can be rotated so they all cover all the strands of TIA
Class 3 and 4	Food and Textile Technology	Home Economics Teacher	
Class 5 and 6	Construction Technology	Practical Skills	

Step 8: Review, Evaluate and Re-plan the yearly, termly, weekly Programs.

This Process MUST BE DONE COLLABORATIVELY BY ALL WHO TEACH THE SUBJECT.

IT MUST BE DONE PROGRESSIVELY

Type of Programming: Sequential Programming

Sample

The second type of programming is the Sequential Programming. This is done when the school has limited teachers to teach the subject TIA and cannot teach using the rotational teaching plan. Therefore, all TIA Classes will be learning the same strand at the same time. The Construction Technology strand has been used to show you how a strand is programmed for the term.

Stand: Construction Technology	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Benchmarks	6	7	4	5	7

1. Calculate the total number of Benchmarks for the strand.

2. Divide the total number of Benchmarks by the number of weeks in the term.
3. Distribute the number of benchmarks throughout the weeks.
4. For Construction Technology Grade 9, the total number of Benchmarks is 29 and will be divided by 10 weeks of a term.
   Note that Units will overlap the 3 Benchmarks per week plan.

Term 1	Strand: Construction Technology	Benchmark
Week 1	Uni1 1 Building Technology	9.3.1.1- 9.3.1.3
Week 2		9.3.1.4- 9.3.1.6
Week 3	Unit 2 Electrical Technology	9.3.2.1-9.3.2.3
Week 4		9.3.2.4- 9.3.2.6
Week 5	Unit 3 Plumbing Technology	9.3.2.7, 9.3.3.1 - 9.3.3.2
Week 6		9.3.3.3 - 9.3.3.4
Week 7	Unit 4 Welding Technology	9.3.4.1-9.3.4.3
Week 8		9.3.4.4 – 9.3.4.5, 9.3.5.1
Week 9	Unit 5 Engineering Technology	9.3.5.2 – 9.3.5.4
Week 10		9.3.5.5 – 9.3.5.7

Sample 2 Integration Programming

The Integration programming involves the teaching of the TIA Strands simultaneously within a term. All the benchmarks (BM) are distributed by weeks. In grade 9 there are 77 Benchmarks for all the strands.

1. Collect the total number of Benchmarks for the grade.
2. Divide the total number of Benchmarks by the number of terms.
3. Distribute the 20 Benchmarks to the 4 terms, indicate the Units by the weeks as they are programmed.

Grade 9 Technology and Industrial Arts Content

	Food Technology	Textiles Technology	Construction Technology	Communication Technology	Computer Technology
Unit 1	6	7	6	7	6
Unit 2	6	6	7	5	5
Unit 3			4		
Unit 4			4		
Unit 5			7		
Total no of Benchmarks	12	13	29	12	11
	77				

Example

		Term One	Term Two	Term Three	Term Four
Week	Strand	Units /Benchmarks	Units /Benchmarks	Units /Benchmarks	Units /Benchmarks

1	1. Food Technology	**Unit 1** BM 9.1.1.1 BM 9.1.1.2	**Unit 1** BM 9.1.1.5 BM 9.1.1.6	**Unit 2** BM 9.1.2.3 BM 9.1.2.4	Unit
2	2. Textiles Technology	**Unit 1** BM 9.2.1.1 BM 9.2.1.2	**Unit 1** BM 9.2.1.5 BM 9.2.1.6	**Unit 2** BM 9.2.2.2 BM 9.2.2.3	**Unit 2** BM 9.2.2.6
3	3. Construction Technology	**Unit 1** BM 9.3.1.1 BM 9.3.1.2	**Unit 1** BM 9.3.1.5 BM 9.3.1.6	**Unit 2** BM 9.3.2.3 BM 9.3.2.4	**Unit 2** BM 9.3.2.7 Unit 3 BM 9.3.3.1
4	4. Communication Technology	**Unit 1** BM 9.4.1.1 BM 9.4.1.2	**Unit 1** BM 9.4.1.5 BM 9.4.1.6	**Unit 2** BM 9.4.2.2 BM 9.4.2.3	Unit
5	5. Computer Technology	**Unit 1** BM 9.5.1.1 BM 9.5.1.2	**Unit 1** BM 9.5.1.5 BM 9.5.1.6	**Unit 2** BM 9.5.2.3 BM 9.5.2.4	Unit
6	1. Food Technology	**Unit 1** BM 9.1.1.3 BM 9.1.1.4	**Unit 2** BM 9.1.2.1 BM 9.1.2.2	**Unit 2** BM 9.1.2.5 BM 9.1.2.6	Unit
7	2. Textiles Technology	**Unit 1** BM 9.2.1.3 BM 9.2.1.4	**Unit 1** BM 9.2.1.7 Unit 2 BM 9.2.2.1	**Unit 2** BM 9.2.2.4 BM 9.2.2.5	Unit
8	3. Construction Technology	**Unit 1** BM 9.3.1.3 BM 9.3.1.4	**Unit 2** BM 9.3.1.5 BM 9.3.1.6	**Unit 2** BM 9.3.2.5 BM 9.3.2.6	Unit
9	4. Communication Technology	**Unit 1** BM 9.4.1.3 BM 9.4.1.4	**Unit 1** BM 9.4.1.7 **Unit 2** BM 9.4.2.1	**Unit 2** BM 9.4.2.4 BM 9.4.2.5	Unit
10	5. Computer Technology	**Unit 1** BM 9.5.1.3 BM 9.5.1.4	**Unit 2** BM 9.5.2.1 BM 9.5.2.2	**Unit 2** BM 9.5.2.5 BM	Unit

Fact: When using the integration programming the strands; Food Technology, Textiles Technology, Communication Technology and Computer Technology contents will have been completed by Term 3 and Term 4 week 2. The remaining 8 weeks must be used to complete the Construction Technology Units 3, 4 and 5 (16 Benchmarks) and Projects for the other strands that needed completion. In doing so the TIA content is covered, thus, completing the content in the required time allocation and qualifying for TIA certification.

Standards_Based Lesson Planning

What are Standards-Based Lessons?

In a Standards-Based Lesson, the most important or key distinction is that, a student is expected to meet a defined standard for proficiency. When planning a lesson, the teacher ensures that the content and the methods of teaching the content enable students to learn both the skills and the concepts defined in the standard for that grade level and to demonstrate evidence of their learning.

Planning lessons that are built on standards and creating aligned assessments that measure student progress towards standards is the first step teacher must take to help their students reach success. A lesson plan is a step-by-step guide that provides a structure for an essential learning.

When planning a standards-based lesson, teacher instructions are very crucial for your lessons. How teachers instruct the students is what really points out an innovative teacher to an ordinary teacher. Teachers must engage and prepare motivating instructional activities that will provide the students with opportunities to demonstrate the benchmarks. For instance, teachers should at least identify 3-5 teaching strategies in a lesson; teacher lectures, ask questions, put students into groups for discussion and role play what was discussed.

Why is Standards-Based Lesson Planning Important?

There are many important benefits of having a clear and organised set of lesson plans. Good planning allows for more effective teaching and learning. The lesson plan is a guide and map for organising the materials and the teacher for the purpose of helping the students achieve the standards. Lesson plans also provide a record that allows good, reflective teachers to go back, analyse their own teaching (what went well, what didn't), and then improve on it in the future.

Standards-based lesson planning is vital because the content standards and benchmarks must be comparable, rigorous, and measurable and of course evidence based and be applicable in real life that we expect students to achieve. Therefore, teachers must plan effective lessons to teach students to meet these standards. As schools implement new standards, there will be much more evidence that teachers will use to support student learning to help them reach the highest levels of cognitive complexity. That is, students will be developing high-level cognitive skills.

Components of a Standards-Based Lesson Plan

An effective lesson plan has three basic components;

- aims and objectives of the course;
- teaching and learning activities;
- assessments to check student understanding of the topic.

Effective teaching demonstrates deep subject knowledge, including key concepts, current and relevant research, methodologies, tools and techniques, and meaningful applications.

Planning for under-achievers

Who are underachieving students?

Under achievers are students who fail or do not perform as expected. Underachievement may be caused by emotions (low self-esteem) and the environment (cultural influences, unsupportive family)

How can we help underachievement?

Underachievement varies between students. Not all students are in the same category of underachievement.

Given below a suggested strategies teachers may adopt to assist underachievers in the classroom.

- Examine the Problem Individually

It is important that underachieving students are addressed individually by focusing on the student's strengths.

- Create a Teacher-Parent Collaboration

Teachers and parents need to work together and pool their information and experience regarding the child. Teachers and parents begin by asking questions such as;

  - In what areas has the child shown exceptional ability?
  - What is the child's preferred learning styles?
  - What insights do parents and teachers have about the child's strengths and problem areas?

- Help student to plan every activity in the classroom
- Help students set realistic expectations

- Encourage and promote the student's interests and passions.
- Help children set short and long-term academic goals
- Talk with them about possible goals.
- Ensure that all students are challenged (but not frustrated) by classroom activities
- Always reinforce students

To help teachers plan effective lessons, there are sample lessons provided here. Teachers are encouraged to study the layout of the different components of these lessons and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher in maintaining a standard teaching pattern and does not let the class deviate from the topic.

Sample of Standards-Based Lesson Planning

The following sample lesson can help teachers to plan effective lessons. Teachers are encouraged to study the layout of the different components of these lessons and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher in maintaining a standard teaching pattern which should not deviate students' learning of the concept from the topic.

Strand 3 Construction Technology
Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 9.3.2.1 Describe the historical development of electricity

Topic: History of Electricity

Lesson 1: History of Electrical energy production and supply

Lesson Objective: Students will be able to:
1. Describe the history of the development of electricity.
2. Explain electrical energy production and supply.

Knowledge	Skills	Values	Attitudes
• History of the development of electricity • Electrical energy	Research describe and explain	Appreciate history of the development of electricity structures, principles and technology	Appreciate and value the history of the development of electricity and take care of structures

production and supply			and be responsible in using them

Essential Knowledge, Skills, Values and Attitudes

Teaching Strategies

- Students engage in brainstorming exercise to discover the supply and production of Electrical Energy.
- They then are allowed to design guiding questions that will enable them to conduct research on the history of electricity
- Discussions in groups on the research findings and facilitate students' research findings as a class discussion.

Learning Strategies

Activity 1 Brainstorming activity on the development of electricity and its advancement. Design guiding questions for their research.
Activity 2 Conduct research on the invention and advancement of electricity into the modern power generation.
Activity 3 Discussions and presentation of research findings on the Invention and advancement of Electricity generations, and the modern power generation.

Teacher	Students
Introduction	
1.Tell a story of ancient times of how people survived without power comparing it in today's electricity world to capture students' attention that will lead students to the topic discovery. 2.Present pictures of sources of electricity then and today 3.Introduce key questions (What is the electricity? Who invented Electricity? How far have we gone in the electrical energy supply and production?)	1. Students listen attentively and work out where the story is leading. 2. Look through the pictures to understand how electricity has come about. 3. Brainstorm on the key questions to lead into the lesson.
Body	
Lesson Body	**Modeling**
Introductory to Body: Teachers present a timeline video on the history of the development of electricity	Watch and take notes of important timelines
Lesson Body	**Guided Practice**
***Guided Practice of the body* Activity 1:** Present video review questions for group discussions	Group discussion on the video review questions
Lesson Body	**Independent Practice**

Independent practice of the body **Activity 2:** Assign one or two question to each group to answer **Activity 3:** Group Presentation	Focus discussions on the assigned questions and prepare presentation. Present and share the group answers of the video review questions on the timeline of electricity development.
Conclusion	
Conclude lesson with main concepts being explained and recapped	Take lesson notes
Assessment	
Task: Students individually create a history of electricity development chart using A3 paper, markers, Strip Card boards and glue. Allow 20 minutes for students to create the chart that has the timeline in correct order of the development and history of Electricity. Then assess them by marking the chart to see if the timeline is correct.	Complete assessment task using the steps below. 5. Draw a timeline on the chart 6. Write year and events on small cardboards and stick them on the timeline on the chart. 7. The completed timeline chart should tell the history of electricity from then to now. 8. Submit after 20 minutes

Criteria

Area of assessment	Tick off or put x
Timeline created tells the history of electricity learnt	
Content of the timeline is accurate	
Task is completed on time	
Chart is neat and presentable	

Resources

History of electricity notes. Video of the production of electricity, video review questions, A3 chart, markers or ink biros

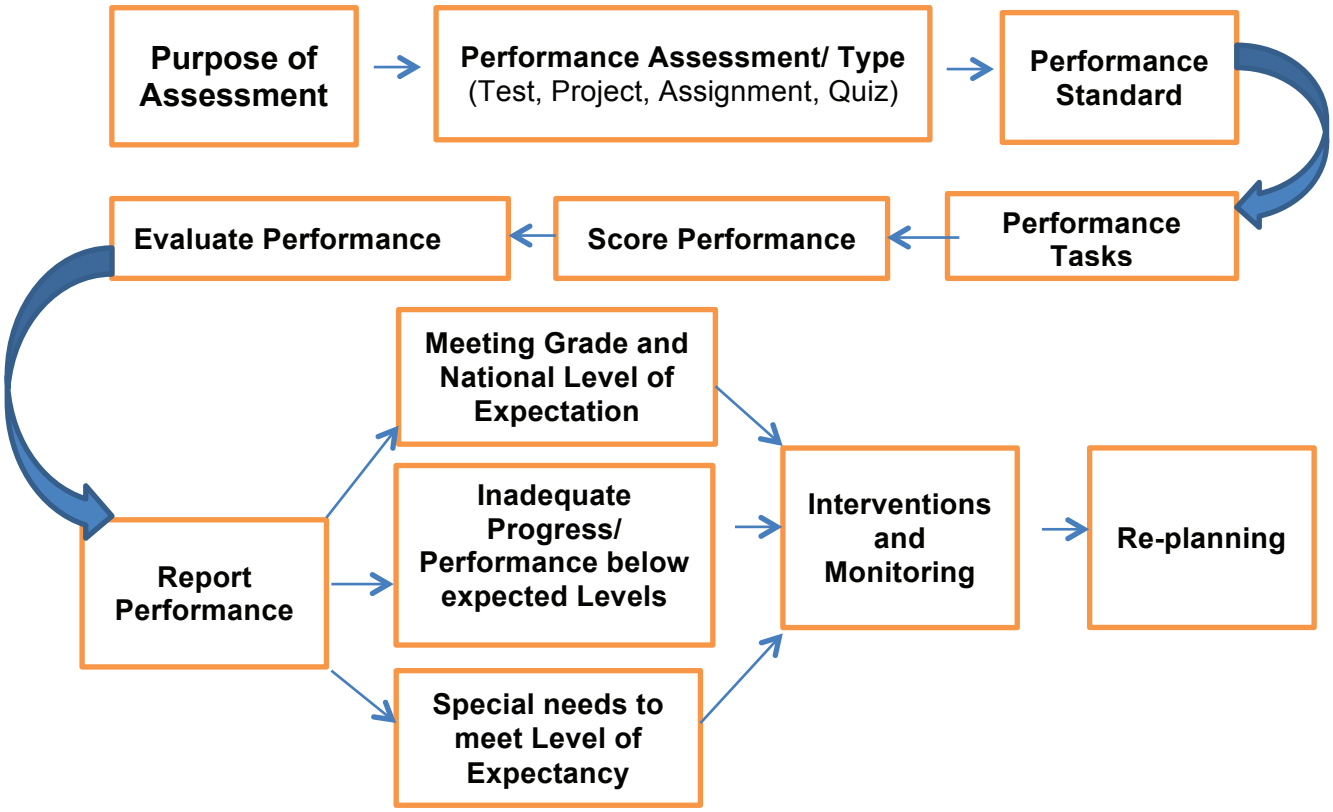
Assessment, Monitoring and Reporting

What is Standards-Based Assessment (SBA)?

Standards-Based Assessment is an on-going and a systematic process of **assessing**, **evaluating, reporting** and **monitoring** students' performance and progression towards meeting grade and national level expectations. It is the measurement of students' proficiency on a learning objective of a content standard and progression towards the attainment of that content standard and benchmark.

Standards-Based Assessment Cycle

The Standards-Based Assessment Cycle begins with the purpose to assess learning. Teachers must always clearly define the purpose and expectations of the assessment tasks or activities before starting the assessment. The cycle consist the delivery of the assessment, scoring of performance, monitoring or learning, evaluating learning and performance, reporting of achievement and underachievement, developing interventions for underachievers and advance learners and replanning assessment as demonstrated below;



Purpose of Standards-Based Assessment

Standards-Based Assessment (SBA) serves different purposes. These include instruction and learning purposes. The primary purpose of SBA is to improve student learning so that all students can attain the expected level of proficiency or quality of learning.

Enabling purposes of SBA is to:

- measure students' proficiency on well-defined content standards, benchmarks and learning objectives.
- ascertain students' attainment or progress towards the attainment of specific component of a content standard.
- ascertain what each student knows and can do and what each student needs to learn to reach the expected level of proficiency.
- enable teachers to make informed decisions and plans about how and what they would do to assist weak students to make adequate progress towards meeting the expected level of proficiency.
- enable students to know what they can do and help them to develop and implement strategies to improve their learning and proficiency level.
- communicate to parents, guardians, and relevant stakeholders the performance and progress towards the attainment of content standards or its components.
- compare students' performances and the performances of other students.

Principles of Standards-Based Assessment

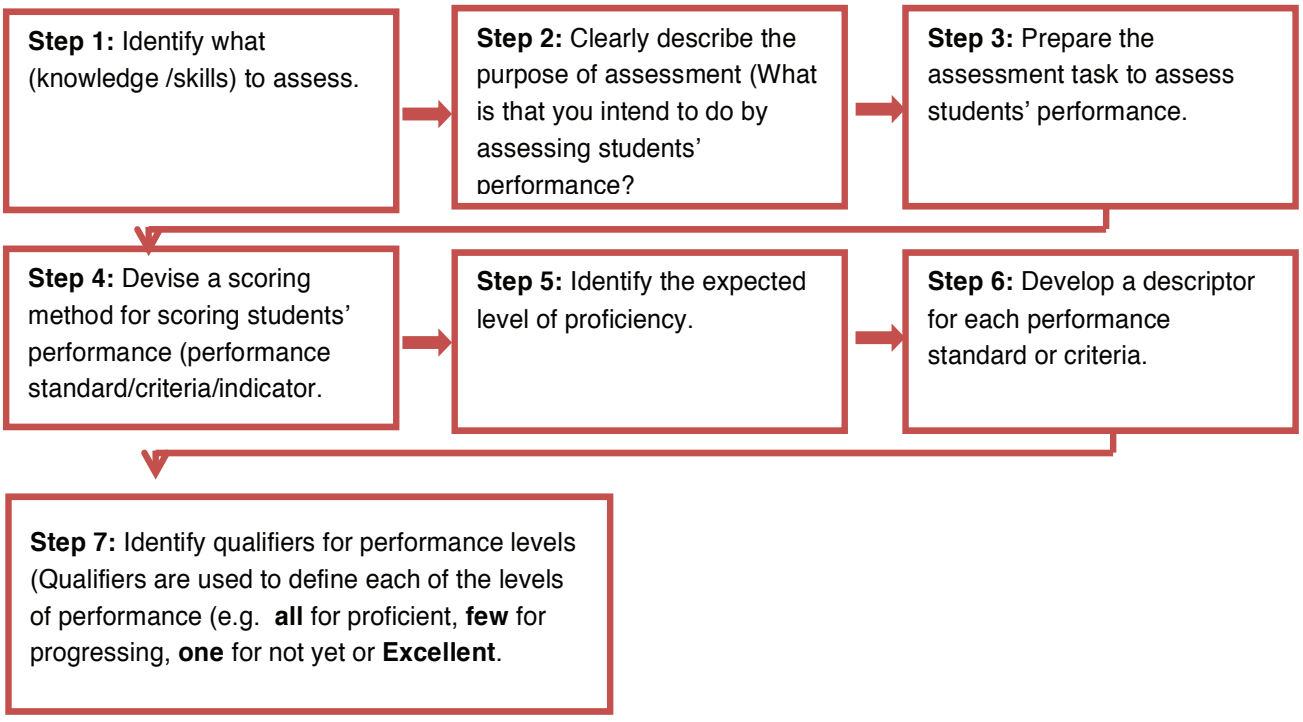
The principle of SBA is for assessment to be;

- emphasing on tasks that should encourage deeper learning,
- be an integral component of a course, unit or topic and not something to add on afterwards,
- a good assessment requires clarity of purpose, goals, standards and criteria,
- of practices that should use a range of measures allowing students to demonstrate what they know and can do,
- based on an understanding of how students learn,

- of practices that promote deeper understanding of learning processes by developing students' capacity for self-assessment,
- improving performance that involves feedback and reflection,
- on-going rather than episodic,
- given the required attention to outcomes and processes,
- be closely aligned and linked to learning objectives, benchmarks and content standards.

Standards-Based Assessment Process

Teachers are required to use the steps outlined below when planning assessment. These steps will guide you to develop effective assessments to improve student's learning as well as evaluating their progress towards meeting national and grade –level expectations.



Authentic Assessment

Authentic Assessments in Standards-based Assessment directly measure student's performance through "real life tasks" or "situations" that resemble "real life situations." Authentic assessment;

- Is performed in a real life context that approximates as much as possible, the use of a skill or concept in the real world.
- Is based on the development of a meaningful *product, performance or process*
- Students develop and demonstrate the application of their knowledge, skills, values and attitudes in real life situations which promote and support the development of deeper levels of understanding.
- Is mostly associated with assessment as or while learning and assessment for learning but occasionally or contextually in summative learning.
- includes assessment activities such as demonstrations, debates, field work, simulations, problem solving, project-based learning, Poster Presentations, Research, Laboratory work, Reflections, Problem-based activities, Role Play, Report/Essay, Field experience, Field report, Recounts etc.

Advantages of Authentic Activities

- Empower students to take ownership in their learning
- Appreciates Learning experience
- enables and encourages the Learning experiences to be used as a basis of learning
- Meaningful, relevant, practical
- Assess the actual learning experience which means; you do not need to "teach" and then assess, rather you assess actual learning experience while it is actually happening

Authentic Assessment Criteria

In standards-based Assessment, teachers are encouraged to step out of their traditional assessment and explore authentic assessment. The criteria in authentic assessment;

- Looks at students actively engaged in completing a task that represents the achievement of a learning objective or standard
- Takes place in real life situations
- Asks students to apply their knowledge, skills, values and attitudes in real life situations
- Students are given the criteria against which they are being assessed

A Comparison of Authentic and Traditional Assessment

Authentic Assessments	**Traditional Assessments**
• Portfolios, demonstrations, field work, case studies, assignments, lab reports • Students take an active role in process • Qualitative • Interpretive • Focuses on performance, process and product • High level thinking • Use of rubric • Use of criterion levels evaluation • Part of teaching and learning Process • Shows mastery and learning performance • Generally extends over time •	• Multiple choice tests, true-false, fill in the blanks, sentence completion, matching, diagram completions • External –(teacher driven – assessing performance of teacher rather than the student) • Teacher-centered (what is appropriate and convenient for the teacher and what teacher thinks is good for students and decides what should be and should not be learnt) • Quantitative (driven to collect marks) • Objective • End product (only looking for the end product and not concerned about the performance and process) • Standardised or norm referenced • Isolated facts • Low level content • Generally occurs in “one setting

Standards-Based Assessment Types

In standards-Based Assessment, there are three broad assessments types.

1. Formative Assessment

Formative assessment includes ‘assessment *for* and *as’* and is conducted during the teaching and learning of activities of a topic.

Purposes of assessment for Learning

- On-going assessment that allows teachers to monitor students on a day-to-day basis.

- Provide continuous feedback and evidence to the teachers that should enable them to identify gaps and issues with their teaching, and improve their classroom teaching practice.
- Helps students to continuously evaluate, reflect on, and improve their learning

Purposes of assessment as Learning

- Occurs when students reflect on and monitor their progress to inform their future learning goals
- Helps students to continuously evaluate, reflect, and improve their own learning
- Helps students to understand the purpose of their learning and clarify learning goals

2. Summative Assessment

Summative assessment focuses on '*assessment of learning'* and is conducted after or at the conclusion of teaching and learning of activities or a topic.

Purposes of assessment of Learning

- Help teachers to determine what each student has achieved and how much progress he/she has made towards meeting national and grade-level expectations
- Help teachers to determine what each student has achieved at the end of a learning sequence or a unit.
- Enable teachers to ascertain each student's development against the unit or topic objectives and to set future directions for learning.
- Help students to evaluate, reflect on, and prepare for next stage of learning.

Performance Assessment

Performance assessment is a form of testing that requires students to perform a task rather than select an answer from a ready-made list. For example, a student may be asked to explain historical events, generate scientific hypotheses, solve math problems, converse in a foreign language, or conduct research on an assigned topic. Teachers, then judge the quality of the student's work based on an agreed-upon set of criteria. It is an assessment which requires students to demonstrate that they have mastered specific skills and competencies by performing or producing something.

Types of performance assessment;

I. Products-Oriented

This refers to concrete tangible items that students create through either the visual, written or auditory media such as;

- Creating a health/physical activity poster
- Video a class game or performance and write a broadcast commentary
- Write a speech to be given at a school council meeting advocating for increased time for health and physical education in the curriculum
- Write the skill cues for a series of skill photo's
- Create a brochure to be handed out to parents during education week
- Develop an interview for a favourite sportsperson
- Write a review of a dance performance
- Essays
- Projects

II. *Process-Oriented Tasks*

It shows the thinking processes and learning strategies students use as they work such as;

- Survival scenarios
- Problem solving initiative/adventure/ activities
- Decision making such as scenario's related to health issues
- Event tasks such as creating a game, choreographing a dance/gymnastics routine, creating an obstacle course
- Game play analysis
- Peer assessment of skills or performances
- Self-assessment activities
- Goal setting, deciding a strategy and monitoring progress towards achievement

III. *Performances-Oriented*

It deals with observable affective or psycho-motor behaviours put into action such as;

- Skills check during game play
- Role plays
- Officiating a game
- Debates
- Performing dance/gymnastics routines
- Teaching a skill/game/dance to peers

Performance Standards

Performance standards are measurement standards that are observed through evidence outcomes and performance indicators. Evidence outcomes and Performance Indicators are used to measure students' performances, proficiency, competency, progression and achievement of the desired grade or level of expectation.

Performance Standards are concrete statements of how well students must learn what is set out in the content standards and benchmarks, often called the "be able to do" of "what students should know and be able to do." Performance standards indicate the quality that specifies how competent a students' demonstration or performance must be. They include explanations of how well students must demonstrate the content, explaining "how good is good enough."

Performance standards:

- measure students' performance and proficiency (using performance indicators) in the use of a specific knowledge, skill, value, or attitude in real life or related situations,
- provide the basis (performance indicators) for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude,
- are used to plan for individual instruction to help students not yet meeting expectations (desired level of mastery and proficiency) to make adequate progress towards the full attainment of benchmarks and content standards,

- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards,
- A stem statement for Performance Standards will begin with…."Students will be able to……"
- A stem statement for Performance Indicator will begin with …."Students can be able to……."

Assessment Strategies

It is important for teachers to know that, assessment is administered in different ways. Assessment does not mean a test only. There are many different ways to find out about student's strengths and weaknesses. Relying on only one method of assessing will not reflect student's achievement.

Provided in the appendices is a list of suggested strategies you can use to assess student's performances. These strategies are applicable in all the standards-based assessment types. ***Please refer to the Appendices to see the suggested strategies.***

Action Verbs to Assessment Strategies		
Cognitive Learning	**Action Verbs**	**Assessment Strategies**
Knowledge - to recall or remember facts without necessarily understanding them	Arrange, define, duplicate, label, memorise, name, order, recognise, relate, recall, reproduce, list, tell, describe, identify, show, label, collect, examine, tabulate, quote	• Prior knowledge inventory, misconception/preconception check • Focused listing, empty outlines • Pre-post test, quiz, quick poll
Comprehension – to understand and interpret learned information	Classify, describe, discuss, explain, express, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend, translate, review, restate, locate, recognise, report	• Minute paper, muddiest (or clearest) point • Observe and evaluate a student artifact or performance task using a rubric • Directed paraphrasing • Pre-post test, quiz • Interviews
Application – to put ideas and concepts to work in solving problems	Apply, choose, demonstrate, dramatise, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, calculate, complete, show, examine, modify, relate, change, experiment, discover	• Observe and evaluate a student artifact, performance, or task using a rubric • Directed paraphrasing, real-world application (apply learning in a new context) • Test, quiz • Job/internship evaluation, skill ratings
Analysis – to break information into its components to see interrelationships and ideas	Analyse, appraise, calculate, categorise, compare, contrast, criticise, differentiate, discriminate, distinguish, examine, experiment, question, test, separate, order, connect, classify, arrange, divide, infer	• Pro and con grid, categorizing grid, compare and contrast, concept maps • Observe and evaluate a student artifact, performance, or task using a rubric • Journaling • Job/internship evaluation, skill ratings

Evaluation – to judge the value of information based on established criteria	Appraise, argue, assess, attach, defend, judge, predict, rate, support, evaluate, recommend, convince, judge, conclude, compare, summarise	• Reflection component of a portfolio or experience • Journaling • Peer evaluation
Affective Learning	appreciate, accept, attempt, challenge, defend, dispute, join, judge, praise, question, share, support	• Reflection component of a portfolio or experience • Journaling • Observe and evaluate group work • Surveys, interviews, focus groups

ASSESSMENT STRATEGIES

Strategy	Description
Analogies	Students create an analogy between something they are familiar with and the new information they have learned. When asking students to explain the analogy, it will show the depth of their understanding of a topic.
Classroom Presentations	A classroom presentation is an assessment strategy that requires students to verbalize their knowledge, select and present samples of finished work, and organize their thoughts about a topic in order to present a summary of their learning. It may provide the basis for assessment upon completion of a student's project or essay.
Conferences	A conference is a formal or informal meeting between the teacher and a student for the purpose of exchanging information or sharing ideas. A conference might be held to explore the student's thinking and suggest next steps; assess the student's level of understanding of a particular concept or procedure; and review, clarify, and extend what the student has already completed
Discussions	Having a class discussion on a unit of study provides teachers with valuable information about what the students know about the subject. Focus the discussions on higher level thinking skills and allow students to reflect their learning before the discussion commences.
Essays	An essay is a writing sample in which a student constructs a response to a question, topic, or brief statement, and supplies supporting details or arguments. The essay allows the teacher to assess the student's understanding and/or ability to analyse and synthesise information.
Exhibitions/Demonstrations	An exhibition/demonstration is a performance in a public setting, during which a student explains and applies a process, procedure, etc., in concrete ways to show individual achievement of specific skills and knowledge.
Interviews	An interview is a face-to-face conversation in which teacher and student use inquiry to share their knowledge and understanding of a topic or problem, and

	can be used by the teacher to explore the student's thinking; assess the student's level of understanding of a concept or procedure and gather information, obtain clarification, determine positions, and probe for motivations.
Learning Logs	A learning log is an ongoing, visible record kept by a student and recording what he or she is doing or thinking while working on a particular task or assignment. It can be used to assess student progress and growth over time.
Observation	Observation is a process of systematically viewing and recording students while they work, for the purpose of making programming and instruction decisions. Observation can take place at any time and in any setting. It provides information on students' strengths and weaknesses, learning styles, interests, and attitudes.
Peer Assessment	Assessment by peers is a powerful way to gather information about students and their understanding. Students can use set criteria to assess the work of their classmates.
Performance Tasks	During a performance task, students create, produce, perform, or present works on "real world" issues. The performance task may be used to assess a skill or proficiency, and provides useful information on the process as well as the product.
Portfolios	A portfolio is a collection of samples of a student's work, and is focused, selective, reflective, and collaborative. It offers a visual demonstration of a student's achievement, capabilities, strengths, weaknesses, knowledge, and specific skills, over time and in a variety of contexts.
Questions And Answers (Oral)	In the question–and-answer strategy, the teacher poses a question and the student answers verbally, rather than in writing. This strategy helps the teacher to determine whether students understand what is being, or has been, presented, and helps students to extend their thinking, generate ideas, or solve problems.
Quizzes, Tests,	A quiz, test, or examination requires students to respond to prompts in order

Examinations	to demonstrate their knowledge (orally or in writing) or their skills (e.g., through performance). Quizzes are usually short; examinations are usually longer. Quizzes, tests, or examinations can be adapted for exceptional students and for re-teaching and retesting.
Questionnaires	Questionnaires can be used for a variety of purposes. When used as a formative assessment strategy, they provide teachers with information on student learning that they can use to plan further instruction.
Response Journals	A response journal is a student's personal record containing written, reflective responses to material he or she is reading, viewing, listening to, or discussing. The response journal can be used as an assessment tool in all subject areas.
Selected Responses	Strictly speaking a part of quizzes, tests, and examinations, selected responses require students to identify the one correct answer. The strategy can take the form of multiple-choice or true/false formats. Selected response is a commonly used formal procedure for gathering objective evidence about student learning, specifically in memory, recall, and comprehension.
Student Self-Assessments	Self-assessment is a process by which the student gathers information about, and reflects on, his or her own learning. It is the student's own assessment of personal progress in terms of knowledge, skills, processes, or attitudes. Self-assessment leads students to a greater awareness and understanding of themselves as learners.

Scoring Methods for Performance Assessment

Assessment can be scored during or after the students have completed the assessment task. However, it is best done during a lesson- using a checklist, rating scales & rubrics.

A rubric is a coherent set of criteria for students' work that includes descriptions of levels of performance quality on the criteria. Rubrics have two major aspects: coherent sets of criteria and descriptions of levels of performance. Rubrics include;

(1) Descriptions of the of task
(2) The scales to be used
(3) The dimensions of the task
(4) The description of each dimension on the scale

A Rubric

- is a scoring guide that helps teachers evaluate student performance, based on a range of criteria.
- A rubric lists the criteria, or characteristics, that student work should exhibit and describes specific quality levels for those criteria.
- Rubrics are a great way to improve communication, learning, and grading fairness.
- Knowing how to create and use rubrics gives you a better understanding of assessment and another option for assessing student performance.
- are descriptive and not evaluative.
- Of course, rubrics can be used to evaluate, but the operating principle is to match the performance to the description rather than "judge" it.
- Thus rubrics are as good or bad as the criteria selected and the descriptions of the levels of performance under each.
- Effective rubrics have appropriate criteria and well-written descriptions of performance

Purpose of Rubrics

Like any other evaluation tool, rubrics are useful for certain purposes and not for others. *The main purpose of rubrics is to assess performances*. For some performances, you observe the student in the process of doing something, like using an electric drill or discussing an issue. For other performances, you observe the product that is the result of the student's work, like a finished bookshelf or a written report.

1. Support authentic assessment
While traditional tests measure how well students recall content, rubrics measure how well students can apply knowledge to authentic contexts or real-world tasks.

2. Clearly communicate expectations
Because rubrics define student "quality" in terms of objective criteria and standards, they clearly communicate how instructors will evaluate student performance.

3. Improve performance

Rubrics lead to better student performance. When students understand assignments and expectations before they begin, they are more likely to fulfil them. They know what specific criteria and standards of excellence will be used to rate their performance.

4. To inspire fairness
Because rubrics have detailed assessment information, students don't feel that grades are assigned subjectively or arbitrarily. Also, when you have more than one grader, a rubric allows all graders to apply the same criteria in the same way.

Although rubrics have many benefits--and make grading faster and easier--a good rubric takes time, effort and patience to construct. You'll probably need to change (change, not add to) your grading and assessment methods, based on what you believe about learning assessment. Rubrics are best for critical assessments, major projects, and other assignments that require a multi-dimensional performance evaluation. The trick is to know what type of rubric to create for your situation.

Reasons for Creating Rubrics/Marking schemes

Rubrics or marking schemes are created for;

1. Categories to assess-different components or elements that will assess

    - Factual information
    - Application
    - Analysis
    - Writing Skills

2. Criterion for assessment

    - Accuracy
    - Completeness
    - Length or number of examples
    - Supported with research
    - Range of answer
    - Description and support

3. Levels or points 3-5 levels

    - Exemplary. Proficient, acceptable, not acceptable
    - Excellent, good, fair, poor
    - 10 points, 5 points, 1 point

Parts of a Rubric

- A rubric is a matrix of criteria and their descriptors.

- The left side of a rubric matrix lists the **criteria (performance standards)** for the expected product or performance.
- Across the top of the rubric matrix is the **rating scale** that provides a set of values for rating the quality of performance for each criterion.
- **Descriptors** under the rating scale provide examples or concrete indicators for each level of performance.
- The dimensions of the task that **qualifies** the achievement

Criteria	Performance Standards (Descriptors)
BEYOND	**Beyond Standard (s) -*Advanced in Performance and Understanding***
	Consistently demonstrates advanced conceptual mathematical understandings Consistently generates tasks that make connections between and among mathematical ideas Consistently applies strategies to unique situations Consistently demonstrated confidence to approach tasks beyond the proficiency level for grade Consistently initiates mathematical investigations
CONSISTENT	**Meet Standard (s)-*Proficient in Performance and Understanding***
	Consistently demonstrates understanding of mathematical standards and cluster at the grade level Consistently demonstrated conceptual understanding Consistently applies multiple strategies flexibly in various situations Understands and fluently applies procedures with understanding Consistently demonstrates perseverance and precision Constructs logical mathematical arguments of thinking and reasoning Uses mathematical language correctly and appropriately
INCONSISTENT	**Progressing-*Not Yet Proficient in Performance and Understanding***
	Inconsistently uses tools appropriately and strategically Demonstrates inconsistent understanding of key mathematical ideas at grade level Demonstrates inconsistent conceptual understanding of key mathematical ideas at grade level Inconsistent in understanding and application of grade level appropriate strategies Depends upon assistance of teacher and/or peers to understand and complete tasks Needs additional time to complete tasks Applies models of mathematical ideas inconsistently
SELDOM	**Not Yet -*Limited Performance and Understanding***
	Exhibits minimal understanding of key mathematic ideas at grade level Rarely demonstrates conceptual understanding Seldom provides precise response Seldom use appropriate strategies Consistently requires assistance and alternative instruction Use tools inappropriately to model mathematics

Types of Rubrics

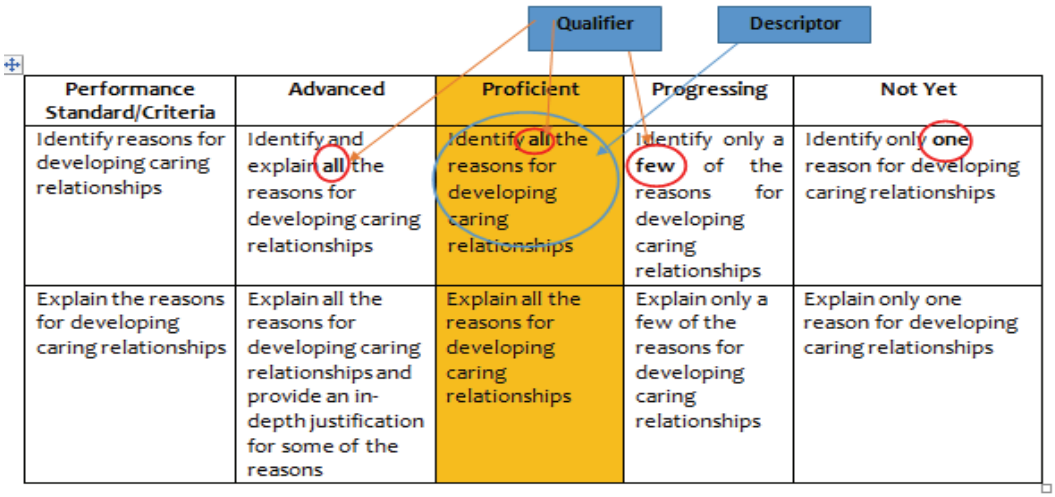
1. Analytic Rubric

Analytic rubrics describe work on each criterion separately. For most classroom purposes, analytic rubrics are best. Focusing on the criteria one at a time is better for instruction and better for formative assessment because students can see what aspects of their work need what kind of attention. Focusing on the criteria one at a time is good for any summative assessment (grading) that will also be used to make decisions about the future—for example, decisions about how to follow up on a unit or decisions about how to teach something next year.

Template for Analytic Rubrics

Criteria	Beginning	Developing	Accomplished	Exemplary	Score
Criteria 1	Description reflecting beginning	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 2	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 3	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 4	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	

Sample Analytic Rubric



Performance Standard/Criteria	Advanced	Proficient	Progressing	Not Yet
Identify reasons for developing caring relationships	Identify and explain **all** the reasons for developing caring relationships	Identify all the reasons for developing caring relationships	Identify only a **few** of the reasons for developing caring relationships	Identify only **one** reason for developing caring relationships
Explain the reasons for developing caring relationships	Explain all the reasons for developing caring relationships and provide an in-depth justification for some of the reasons	Explain all the reasons for developing caring relationships	Explain only a few of the reasons for developing caring relationships	Explain only one reason for developing caring relationships

Holistic Rubrics

Holistic rubrics describe the work by applying all the criteria at the same time and enabling an overall judgment about the quality of the work. Holistic rubrics are based on criteria for good work and on observation of how the work meets those criteria.

One classroom purpose for which holistic rubrics are better than analytic rubrics is the situation in which students will not see the results of a final summative assessment and you will not really use the information for anything except a grade. Some high school final examinations fall into this category. Grading with rubrics is faster when there is only one decision to make, rather than a separate decision for each criterion.

Decide on type of rubric to be used (Holistic or Analytic)

1. When to use Holistic Rubric
    - There is no single correct answer/response to a task
    - The focus has no the overall quality, proficiency, or understanding of a specific content or skills.
    - You are assessing large numbers (eg. 150 portfolios)

Holistic Rubric						
Score	**5**	**4**	**3**	**2**	**1**	**0**
Description	Demonstrate **complete** understanding of the problem. **All** requirements of task are **included in response**.	Demonstrate **considerate** understanding of the problem. **All** requirements of task are **included**.	Demonstrate **partial** understanding of the problem. **Most** requirements of task are **included**.	Demonstrate **little** understanding of the problem. **Many** requirements of task are **missing**.	Demonstrate **no** understanding of the problem.	**No** response/ **not** attempted task

2. When to use Analytic Rubric
    - Several subjects are assessing the student work.
    - Description promote consistent scoring.
    - Stakeholders will be examining the rubric scores.
    - Substantial feedback to students or the subjects is desired.

- Outlines of specific strengths/weaknesses are anticipated.

Analytic Rubric				
Criteria	**4**	**3**	**2**	**1**
Criteria # 1	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 2	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 3	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 4	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.

Scoring of Performance for Formative Assessment

(Assessment as/while learning and Assessment for learning)

1. Scoring Assessment using Rating Scale

Rating Scales are a type of checklists that judge the degree to which a criteria is met. They generally have a scale of between 1-6 options.

Types of Rating Scales

A. Frequency Rating Scales

A frequency rating scale scores how often a task is done to meet criteria.

Sample Rating Scale Descriptive Words

1. Words that describe the skill of ***selecting 'the right' information*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
Pertinent	relevant	suitable	trivial
Insightful	meaningful	appropriate	superficial
Significant	relevant	predictable	vague
Perceptive	thoughtful	basic	questionable
Precise	logical	partially correct	confusing
Purposeful	focused	appropriate	irrelevant

2. Words that describe the skill of ***selecting 'enough' information*** at varying levels of quality.

Excellent	Proficient	Adequate	Limited
comprehensive	thorough	cursory	superficial
in-depth	sufficient	partial	incomplete
rich & detailed	specific	simplistic	undeveloped
Extensive	substantial	partial	sketchy

3. Words that describe the skill of ***evaluating product or connecting insights to personal experience*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
insightful	thoughtful	predictable	trivial
astute	relevant	appropriate	unfocused
perceptive	thoughtful	routine	trivial
intuitive	logical	rudimentary	unsubstantiated
innovative	credible	predictable	trite
compelling	meaningful	obvious	tenuous

4. Words that describe the skill of ***designing or constructing*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
efficient	practical	viable	unworkable
innovative	effective	workable	ineffective

5. Words that describe the skill of ***organizing or formatting information*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
skillful	systematic	simplistic	haphazard
purposeful	logical	methodical	disorganized

6. Words that describe the skill of ***analyzing information or data*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
accurate	logical	partially accurate	flawed
insightful	logical	simplistic	unsupported
astute	credible	plausible	inaccurate
precise	relevant	basic	irrelevant

7. Words that describe the skill of ***presenting or communicating information or selecting appropriate visuals*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
vivid	interesting	simplistic	lacks appeal
compelling	effective	predictable	does little to sustain interest
enhances	supports	partially supports	interferes with
engaging	interesting	straightforward	ineffective
skillful	effective	appropriate	inappropriate
intriguing	interesting	predictable	ineffective

Sample Scoring using Rating Scale to assess "Collaboration"

Criteria	**Frequency**			
	Always = 4	**Sometimes = 3**	**Rarely = 2**	**Never - 1**
1. Embraces everyone's' abilities and encourages participation	Always Embraces everyone's' abilities and encourages participation	Sometimes Embraces everyone's' abilities and encourages participation	Rarely Embraces everyone's' abilities and encourages participation	Never Embraces everyone's' abilities and encourages participation
2. Ensures everyone is tasked to and activity	Always Ensures everyone is tasked to and activity	Sometimes Ensures everyone is tasked to and activity	Rarely Ensures everyone is tasked to and activity	Never Ensures everyone is tasked to and activity
3. Encourages everyone to achieve together	Always Encourages everyone to achieve	Sometimes Encourages everyone to achieve together	Rarely Encourages everyone to achieve	Never Encourages everyone to achieve

	together		together	together

2. Scoring assessment using a Checklist

Check lists are one of the easiest methods of scoring assessment tasks. The criteria i.e. skills, cues or tasks are considered separately according to whether they have been accomplished.

Types of Checklists include

- Yes/No
- Tick/Cross
- Circling
- Narrow scale, e.g. Sometimes, rarely, never
- Colouring
- Symbols (signifiers), e.g. pictures, facials, artifacts, signs, drawings, concept maps)

Sample Scoring using Yes/No Checklist Scale to assess "Collaboration"

No	***Criteria***	***Write Yes (score 2) or No (score 1)***
1	*Embraces everyone's' abilities and encourages participation*	
2	*Ensures everyone is tasked to an activity*	
3	*Encourages everyone to achieve together*	

Sample Scoring using Tick/Cross Checklist Scale to assess "Collaboration"

No	***Criteria***	***Place a tick(score 2) or and X (score 1)***
1	*Embraces everyone's' abilities and encourages participation*	
2	*Ensures everyone is tasked to an activity*	
3	*Encourages everyone to achieve together*	

Samples of other scoring methods are in the Appendix Reference. These are based on Business Studies but can be applied in Technology and Industrial Arts

Scoring of Performance for Summative Assessment

Grade rating scales are better scoring tools for summative assessment of students' performance. They indicate students' level of performance using such as; A, B, C, D etc

A Grade is given after the accumulated total for a number of assessments has been completed either at the end of and assessment period, a topic, a term, a grade or year.

The subject assessment components, tasks and weightings should be able to guide the grading of achievements as demonstrated in a rubric designed for this purpose.

Scoring of Performance for Summative Assessment

Grade rating scales are better scoring tools for summative assessment of students' performance. They indicate students' level of performance using such as; A, B, C, D etc.

A Grade is given after the accumulated total for a number of assessments has been completed either at the end of and assessment period, a topic, a term, a grade or year.

The subject assessment components, tasks and weightings should be able to guide the grading of achievements as demonstrated in a rubric designed for this purpose.

Sample Scenario to score Summative Assessment

For instance; If TIA/BS has an assessment plan for a 100 marks per term, then the grading shall be scored at the end of each term. As per the Assessment weighting, TIA/BS can plan to score assessment of students per term according to this components:

- 1 x Project = maximum of 50marks
- 1 x Moderation = maximum of 50 marks
- 2 x tests = maximum of 30 marks
- 1 x portfolio = maximum of 5 marks
- 1 x participation = maximum of 5 marks

Assessment Components and Task Weighting

The Assessment components and Task Weighting is intended for a Termly Assessment Schedule. It anticipated that the assessment components with their weightings may be changed by the teachers' Business Studies Termly Teaching Programs accordingly but the total scores allocated for the THEORY ASSESSMENT COMPONENTS (TAC) of 40 Marks and PRACTICAL ASSESSMENT COMPONENTS (PAC) 60 Marks should remain as it is the determined as the required 40/60 Moderation Components (i.e. 100 marks) for Business Studies Assessments per Assessment Period.

THEORY ASSESSMENT COMPONENTS (TAC) (40 Marks)	TOTAL SCORE/100	PRACTICAL ASSESSMENT COMPONENTS (PAC) (60 Marks)	TOTAL SCORE/100

		Project Portfolio No. 1	10
		STEAM Project Portfolio No. 1	10
Test No. 1	15	Project No. 1	25
		STEAM Project No. 1	25
Assignment No. 1	10		
Test No. 2	15		
TOTAL THEORY SCORE	**____/40**	**TOTAL PRACTICAL SCORE**	**____/60**
TOTAL SCORES OF TAC + PAC = TOTAL SCORES OUT OF 100	**_____/100**		

Sample subject assessment structure

The internal assessment for the Technology and Industrial Arts/ Business Studies subject is based on the Grade 9 & 10 and Grade 11 and 12 Technology and Industrial Arts Syllabus. The final assessment should be based on a range and balance of assessment strategies and instruments. Assessment must be both normative and criterion.

Component	Weighting	Tasks	Assessment Referencing
Practical Work in response to design brief (Moderation and Projects included here?)	60 % (of mandatory total)	Development and application of design ideas, safe and skillful use of materials, tools and equipment to make a product and the identified processes	Criterion Referencing Rubrics
Design folio with outcomes of research , investigations and planning	20 % (of mandatory total)	Folio showing results of investigation in response to design brief, rough notes or sketches of design ideas, timelines, final drawings or plans, processes used to make the product and evaluation reports	Criterion Referencing Rubrics
Tests	20 % (of	Theory and also applications in theory	Normative

	mandatory total)		
Marks	100 %	A combination of design folios, practical applications, moderations and tests.	

Sample Assessment

SBC embraces standards and as such, standards must also drive the administration of assessments to students. It is important that every student must be given the outline of the Assessment that has been planned for the term. Each Term will include 6 pieces (can have any number from 4-6) of assessment. Assessment is weighted accordingly.

Assessment Type	Description	Weighting
Topic Tests x 2	Students will be given two topic tests based on the content learnt in the term. 1 will be given mid-term and 1 at end-term. The test will be comprised of 10 multiple choice questions and 5 short written answers.	1 = 15 marks 1=10 marks
Portfolio	Individual Students will be assessed on creating portfolios	10 marks
Moderation	In groups of four - five, students work to critically engage with one another in the required design process. Students will address criteria provided in class and prepare and deliver a 5-10 minute presentation addressing the criteria.	30 marks
Project (Application)	In groups of three to four, students work to critically engage with one another in the assigned project. Students will address criteria provided in class and prepare and deliver a 5-10 minute presentation addressing the criteria.	20 marks
Participation	2 marks will be allocated each day for attendance. Another 3 marks will be awarded for active participation.	5 marks

STEAM Assessment

Steps in Developing a STEAM Activity

1. Identify the Real/Authentic Situations that can be solved through the STEAM Activity
2. Select a well-defined a Benchmark in your subject area that will carry the STEAM Activity
3. Identify related subject areas with their concepts to be used solve the Authentic Situation
4. Note down the Main parts of the Unit Of Work for the STEAM Activity
5. Write a Description of the Authentic Situation for the STEAM Activity based on the identified Authentic situation.
6. Write down the Task Descriptions for the STEAM Activity in order to approach the Authentic situation.
7. Develop the Rubric to Assess the STEAM Activity

1. Authentic Situation identified for this STEAM Activity

- Students spending too much time using their smart mobile phones on Facebook, WhatsApp and surfing the internet rather than their school work.
- Students still bringing their smart mobile phones to school despite the school rules telling them not to.
- Most schools need to fully utilise their School Rules, Mottos, Missions and Visions which determines the way they want to shape our students' Knowledge, Attitudes and Values, during and after, they leave the school at end of Grade 10 and Grade 12.
- Our schools in our country have been labeled as 'a very good school to a very bad school' due school student fights and vandalism of school properties.
- Stakeholders of the schools are blaming the school management for the school students behaviour problems and parents are transferring their students out of schools to others school in the country.

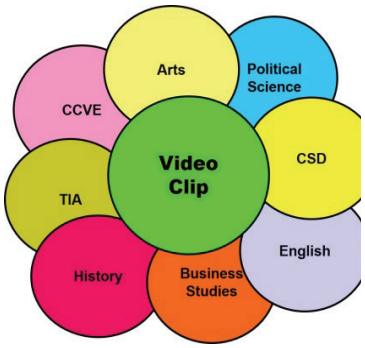
2. ***Select a well-defined Benchmark in your subject area that will carry/drive the STEAM Activity and its associated Big Idea (product, project etc.)***

   - ***Sample:***

     i. **SUBJECT:** BUSINESS STUDIES

     ii. **BENCHMARK 9.2.5.1.** Analyse the impact of information technology on society.

     iii. **Big idea/product:** Video Clip



3. ***Identify other related subject areas with the appropriate concepts to solve the Authentic Situation(s)***

   - Identify related subject areas with their concepts/Knowledge, Skills, Attitudes and Values to be used to solve the Steam Authentic Situation

SUBJECTS	BENCHMARKS	BIG IDEA/ PRODUCT	KNOWLEDGE	SKILLS	ATTITUDES	VALUES
1. Arts (Theatre Arts)	9.2.2.2		Video script	Script Writing		
2. Christian Civic Value Education (CCVE)	9.3.1.3		School Rules, Motto, Vision, Mission	Examine Civic values	Responsibility	Ownership, Love
3. Character Social Development (CSD)	9.1.5.1, 9.1.5.2, 9.1.5.3, 9.1.5.4, 9.1.5.5		School Rules, Motto, Vision, Mission	Asses experiences and mistakes	Caring, Positivity	Respect
4. English	9.2.2.1		Descriptive Writing	Descriptive Writing	Neatness	
5. Social Science (History)	9.2.2.3, 9.2.2.4		School history	Discuss school culture		Ownership
6. Social Science (Political Science)	9.3.3.1, 9.3.3.2		National development aspirations/demands of citizens	Anticipative skills		
7. Technology Industrial Arts (TIA)	9.4.1.4, 9.4.1.5, 9.4.1.6		Range of communications media products	Creative media communication	Alertness	
8. Business Studies	9.2.5.6.	Video clip	Media rich projects	Shooting with mobile	Creativity	Innovative

There must be an anchor subject benchmark for any STEAM assessment.

4. Descriptions of the Steam Authentic Situation

- Paragraph 1 describes the problem/situation
- Paragraph 2 describes the solution to the problem/situation and who will be responsible to take up the task
- Paragraph 3 would mention any rewards/awards for an adequate solution to the problem/situation as a booster to create a competitive competition and a promoter of critical thinking amongst the students so that they can come out with the best products.

5. Write down the Task Descriptions for the STEAM Activity

- Plan and write a short write-up for your video-clip.
- Use the notes to make a 2-minute video clip to advertise and market your school to the public.
- The short video clip must embrace the school rules, motto, and mission and vision statements.
- It must also contain messages of new and competent management.
- This video clip has to have the potential to positively change the image of the school
- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enroll at your school.
- This clip must not be more than 2 minutes (maximum time limit)
- Present your video clip to be assessed
- Submit both your write-up (on a chart) together with your video clip

6. Developing Rubrics to Assess the Steam Video Clips

1) Decide on type of rubric to be used (Holistic or Analytic)
2) Decide what point scale rubric to use (always use 3, 4 or 5 point-scale) and rating scales to use (descriptive words or numerals)
3) Plan the layout to develop the rubric
4) Decide what to assess from the Category of Tasks Description
5) Identify and list the Category of Tasks Description for the Criteria
6) Reword the Tasks Descriptions to create Criteria

    - Plan and write a short write-up for your video-clip. (***The write up of the video***)
    - Use the notes to make a 2-minute video clip to advertise and market your school to the public. (***The development of the video***)
    - The short video clip must embrace the school rules, motto, and mission and vision statements. (***The content of the video***)
    - It must also contain messages of new and competent management. (***The content of the video***)

- This clip must not be more than 2 minutes (maximum time limit) (***The presentation of the video***)
- Submit both your write-up (on a chart) together with your video clip. (***The product***)

7) List the criteria against the Task Descriptions in a table
8) Unpack the Task Descriptions and Identify the essential KSAV that can be assessed
9) Reword the Task Descriptions with the inclusion of KSAVs into a Descriptor statement for each criteria and distribute into each Competency Level/Level of Achievement
10) Determine appropriate variance of Qualifiers for each Descriptors of each Achievement Level
11) Determine the appropriate Descriptive Words or Number for Point Scales of the intended rubric.
12) Completed rubric sample: Video clip Assessment Rubric
13) Consider the Applications of the Steam Rubric

This is a sample for Business Studies and can be used to develop Technology and Industrial Arts Subject STEAM Assessment.

Sample 4

Strand 2: Business Management

Unit 5: Information Technology

Content Standard 2.5: Students will be able to explain the information technology concepts and examine the systems and tools needed to gather, access, analyse, synthesize, evaluate, manage, and disseminate information.

Benchmark: 9.2.5.1. Analyse the impact of information technology on society.

Topic: Impact of information technology on society.

Learning Objective: By the end of this Topic, students will be able to demonstrate a positive impact of information technology on society

Purpose of Assessing the Topic (Benchmark):
To assess whether students can be able to use mobile technology to positively Impact their society and analyse this impacts

How the Performance Task will be done: Group Project Presentation

Performance Standard: By the end of the project**,** students will be able to use mobile technology to positively impact their community/society.

Situation (Authentic)

A school has been faced with the challenge of behavioral issues for some time now and the public has lost its confidence in the school to be a good or genuine school. Most parents fear sending their children to his school and always opt to transfer their children in very first instances. The Board of Governors of the school has decided to raise the Behavior Standards or Benchmarks to a certain degree to improve its image and standards of learning.

To meet the expectations of the BOG, the principal and teachers intend to market the school to the public of NCD to lure students to have the interest to enroll at the school. With such a PAST bad reputation, the school will really need to convince the public that they have raised their standards and that their school is worth enrolling in it. The Principal and the teachers now have a task on hand to convince the public to enroll their children there and they have to try every means to do so.

To achieve this, the school is now requesting the Business and Technology Department to design an assessment Task for a certain Grade to assist with the situation. The Business & Technology Department has opted to design the task for Grade 9 students as one of their projects towards their assessments. The school principal also announces that the best video assessed by the B&T Department will be rewarded as it is also a competition.

Task Descriptions:

- Plan and write a short write-up for your video-clip.
- Use the notes to make a 2-minute video clip to advertise and market your school to the public.
- The short video clip must embrace the school rules, motto, and mission and vision statements.
- It must also contain messages of new and competent management.
- This video clip has to have the potential to positively change the image of the school
- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enrol at your school.
- This clip must not be more than 2 minutes (maximum time limit)
- Submit both your write-up (on a chart) together with your video clip
- Teacher will present your video clips for the whole class to observe and use the rubric below to assess the video clip.

Materials: Smartphone, butcher papers, markers

1. Developing Rubrics to Assess Video Clips

i. Decide on type of rubrics to be used (Holistic or Analytic)
ii. After you decide, plan the rubrics

iii. Planning to develop the rubric
iv. Categorise the Tasks Description into Criteria's

Sample of Categorising tasks for the rubric

- Plan and write a short write-up for your video-clip. (The write up of the video)
- Use the notes to Make a 2-minute video clip to advertise and market your school to the public. (The development of the video)
- The short video clip must embrace the school rules, motto, and mission and vision statements. (The content of the video)
- It must also contain messages of new and competent management. (The content of the video)
- This video clip has to have the potential to positively change the image of the school (The content of the video)
- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enrol at your school. (The content of the video)
- This clip must not be more than 2 minutes (maximum time limit) (The presentation of the video)
- Present your video clip to be assessed (The presentation of the video)
- Submit both your write-up (on a chart) together with your video clip. (The product)

2. Identify and list down categories of tasks

Category	Task Description
The write up of the video	Plan and write a short write-up for your video-clip.
The development of the video	Use the notes to Make a 2-minute video clip to advertise and market your school to the public.
The content of the video	• The short video clip must embrace the school rules, motto, and mission and vision statements. • It must also contain messages of new and competent management. • This video clip has to have the potential to positively change the image of the school • This 2-minute video clip must be captivating and totally convincing to attract students to want to enrol at your school.
The Presentation of the video	• This clip must not be more than 2 minutes (maximum time limit) • Present your video clip to be assessed
The product	Submit both your write-up (on a chart) together with your video clip.

3. **Unpack the Task Descriptions and Identify the essential KSAV that can be assessed**

Category	Task Description	Essential KSAVs
The write up of the video script	Plan and write a short write-up for your video-clip.	Skill : Procedural Writing
The development of the video	Use the notes to Make a 2-minute video clip to advertise and market your school to the public.	Values and attitudes: - Teamwork and cooperation - Creativity Knowledge: Know about the school
The content of the video	• The short video clip must embrace the school rules, motto, and mission and vision statements. • It must also contain messages of new and competent management. • This video clip has to have the potential to positively change the image of the school • This 2-minute video clip must be captivating and totally convincing to attract students to want to enrol at your school.	Knowledge: Adequate content about the school Skill: convincing and persuasive Values and attitude: Encouraging and luring
The Presentation of the video	• This clip must not be more than 2 minutes (maximum time limit) • Present your video clip to be assessed	Skill: - Time management - delivery skills (posture, language) and - communication skills - social skills (relativity and connectivity) Values and attitude: confidence
The product	Submit both your write-up (on a chart) together with your video clip.	EKSAVs in the Write up and Presentation :

4. **Reword the Task Descriptions with the inclusion of KSAVs into a Descriptor statement for each criteria and distribute into each Competency Level/Level of Achievement**

5. **Determine the appropriate Descriptive Words or Number for Point Scales of the intended rubric.**

Criteria:	Advanced	Progressing	Novice	Mark
The write up of the video script	**Skill:** Procedural Writing **Organised paper of video script writing procedures**	**Organised paper of video script writing procedures**	**Organised paper of video script writing procedures**	/3
The development of the video	Values and attitudes: - Teamwork and cooperation - Creativity **Knowledge:** Know about the school **The video corresponds to the 2-minutes script and illustrates teamwork**	**The video corresponds to the 2-minutes script and illustrates teamwork**	**The video corresponds to the 2-minutes script and illustrates teamwork**	/ 3
Content of the video	**Knowledge:** Adequate content about the school Skill: convincing and persuasive Values and attitude: Encouraging and luring **The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	**The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	**The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	/3
Presentation of the video	**Skill:** - Time management	**The video clip captures essence of vital messages of the**	**The video clip captures essence of vital messages**	/3

	- delivery skills (posture, language) and - communication skills - social skills (relativity and connectivity) **Values and attitude:** confidence **The video clip captures essence of vital messages of the new and competent management with potentials to positively change the image of the school and captivating and convincing to attract students to want to enroll at the school.**	**new and competent management with potentials to positively change the image of the school and captivating and convincing to attract students to want to enrol at the school.**	**of the new and competent management with potentials to positively change the image of the school and captivating and convincing to attract students to want to enrol at the school.**	
The product	**EKSAVs** in the Write up and Presentation: **Video clip submitted at the assessment deadline for presentations**	**Video clip submitted at the assessment deadline for presentations**	**Video clip submitted at the assessment deadline for presentations**	/3

6. Completed rubric sample: Video clip Assessment Rubric

Criteria	Achieved	Progressing	Novice	Marks
Video Script Write up	**Innovative** and **well** organised paper with **clarity** of video script writing procedures	**Well** organised paper with **clarity** of video script writing procedures	Organised paper with some **clarity** of video script writing procedures	/3
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated	**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork	**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork	/3

	teamwork			
Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision statements.	/3
Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at the school.	• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.	• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol at the school.	/3
Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations	• Video clip submitted **just before** the assessment deadline for presentations	• Video clip submitted **within** the assessment time for presentations	/3

1. How to Score using the rubric

Scoring Rubrics

Criteria	Achieved ~~3~~	Progressing ~~2~~	Novice ~~1~~	Scoring
Video Script Write up -	**Innovative** and **well** organised paper with **clarity** of video script writing procedures	**Well** organised paper with **clarity** of video script writing procedures	Organised paper with some **clarity** of video script writing procedures	2/3
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated teamwork	**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork	**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork	1/3
Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision	• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision	• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision	3/3

	statements.	statements.	statements.	
Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at the school.	• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.	• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol • at the school.	3/3
Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations	• Video clip submitted **just before** the assessment deadline for presentations	• Video clip submitted **within** the assessment time for presentations	2/3
11/15				

2. How to Grade using the rubric

Grading Rubrics

Score Range	Grade	Qualifier (Proficiency)	Descriptor	Percentage
13 – 15	**A**	**Advanced**	Description reflecting **highest** level of performance.	**76 - 100%**
9 - 12	**B**	**Achieved**	Description reflecting **mastery** level of performance.	**46 - 75%**
5 – 8	**C**	**Progressing**	Description reflecting **movement towards** mastery level of performance.	**26 - 45%**
0 - 4	**D**	**Novice**	Description reflecting **beginning** level of performance.	**0 - 25%**

3. How to Report using the rubric

A. Reporting an individual student's performance on the task

Assessment Task Report							
Assessment Task:			**Video Development Project**				
Name:		**Grade:**		**Class:**		**Score and Grade:**	**/15**
Criteria	**Achieved A**		**Progressing B**		**Novice C**		
Video Script Write up	**Innovative** and **well** organised paper with **clarity** of video script writing procedures		**Well** organised paper with **clarity** of video script writing procedures		Organised paper with some **clarity** of video script writing procedures		
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated teamwork		**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork		**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork		
Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision statements.		• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision statements.		• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision statements.		
Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at the school.		• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.		• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol at the school.		
Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations		• Video clip submitted **just before** the assessment deadline for presentations		• Video clip submitted **within** the assessment time for presentations		

Note: The shaded is the student's proficiency score for each task.

Related links to this Business Studies Benchmark in Business Studies with other subject areas:

Subjects	Reference Benchmark Codes
1. Arts (Theatre Arts)	9.2.2.2
2. Christian Civic Value Education (CCVE)	9.3.1.3
3. Character Social Development (CSD)	9.1.5.1, 9.1.5.2, 9.1.5.3, 9.1.5.4, 9.1.5.5

4. English	9.2.2.1
5. Social Science (History)	9.2.2.3, 9.2.2.4
6. Social Science (Political Science)	9.3.3.1, 9.3.3.2
7. Technology Industrial Arts (TIA)	9.4.1.4, 9.4.1.5, 9.4.1.6

The anchor subject in this sample STEAM assessment is Technology and Industrial Arts.

Sample Scenario to score Summative Assessment

Moderation in Technology and Industrial Arts

The sample provided is based on Textiles Technology.

What is moderation as assessment?

Moderation is the process of teachers sharing, working through and agreeing to expected standards of student achievement and progress. It supports teachers to compare their own judgments to either confirm or adjust them. The process involves teacher collaboration to establish a shared understanding of what achievement of standards looks like and whether or not the student has demonstrated achievement of the standard through the evidences of performance tasks. Teachers work towards making judgments of assessments of standards that are consistent and comparable.

Moderation Purposes

"Moderation is concerned with the consistency, comparability and fairness of professional judgments about the levels demonstrated by students." *(Maxwell, 2002).* Comparable judgments result from teachers understanding of the curriculum, and agreeing on benchmark assessed. The essence is that, there is common understanding of how to assess progress and achievement within and across schools.
Moderation helps teachers to make dependable, evidence-based decisions and leads to consistency.
There is a need for consistency of teacher judgments:

- over time – same evidence viewed at different times or different contexts leading to same judgment by same teacher
- against standards – equivalent application across different types of evidence
- by a teacher - between his/her students
- between teachers – within the same school and different schools
- between teaching years and levels.

Making consistent, reliable and valid decisions across different points in time is important when schools report on student progress, make decisions on school targets and resourcing, or compare different grades data with past information.

All schools experience variables that challenge the consistency of practice such as staff changes, changes in student numbers or changing education demands. Consistent moderation over time can prevent this in a number of ways.

- Always applying the same standardised criteria ensures consistency over time.
- Where nationally standards criteria or exemplars are available, these become the same external reference used each year or each time.

- Moderators will change over time but the same criteria and associated references will remain and continue to guide decisions.

The benefits of moderation

The benefits of involving students in moderation

- When students are actively involved they can participate in selecting evidence (e.g. samples of their work) that best demonstrate the intended learning outcomes.
- The process of assessment develops students' understanding of the desired outcomes and success criteria or expected rubrics developed.
- Making judgments is closely linked to developing the skills of self and peer-assessment.
- This can lead to shared expectations of learning and understandings of standards between teachers and students.
- Greater student confidence in teacher judgments.
- Provides greater transparency of the assessment process.

The benefits of moderation for teachers

- Brings together collective wisdom, resulting in greater consistency of judgment, and focused teaching.
- Provides greater confidence in teacher judgments and assurance that judgments are consistent with other professionals.
- Leads to shared expectations of learning and understandings of levels and progression of learning.
- Develops deeper understandings about content and progressions of learning.
- Improves quality of assessment.
- Alignment of expectations and judgments with curriculum expectations or progressions, and hence improved teaching and learning.
- Assurance to parents and others that interpretations of students' progress and achievement are in line with other professionals.

Process of Moderation

Purpose, learning area and context of the moderation:
It could be moderation of a proficiency based project or design portfolios or the understanding of how to take a running record or of judgments of student achievement and progress for reporting.

Who is involved?

Who needs to be involved? Who will be the coordinator?
It is preferable that the leader/coordinator has the authority to make decisions?
The timing, duration and frequency of moderation meetings:
Will they be extra meetings, or part of staff or team meetings, or non-contact days?
What is the attainment requirement for the moderation? School based certification?

The evidence of student learning that will be moderated:

- For a piece of writing, student writing samples will be used.
- For moderating a design portfolio, the task, text and questions the student responded to may be used, along with notes of student questions, samples of work done and annotated tasks in line with the assessment task and criteria .
- For supervision of an assessment tool: this could be a student's running record and the teacher
- For judgments of student achievement and progress for reporting to parents, a range will be required, covering both formal and informal collection of evidence.
- Developed rubrics written against national exemplar may be used as assessment tools of moderation which can be maintained and improved every year

When to use moderation in TIA

A. Moderation assessment for TIA will be project based and or evidence based assessment. This can be carried out in a year from grades 9-12. This could mean one project in one of the strands or an incorporation of all the strands of the subject TIA in grade 12 where each school makes the decision to undertake moderation as assessment. This could be the final moderation project that will incorporate all the strands in TIA. For grades 9,10, and 11, the moderated projects can be strand based.

Sample Grade 9 Moderation

Textiles Technology

Unit 2: Textiles and Clothing

Content Standard: 1.2 Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions

9.1.2.1 Describe historical influences, technological progression and emerging trends as inspirational sources of design
9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions.
9.1.2.3 Demonstrate an understanding of garment patterning techniques
9.1.2.4 Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects
9.1.2.5 Apply the design process to respond to needs and opportunities in textile design projects.
9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work

The main moderation benchmark is BM 9.1.2.5 as it is using the design process. However the moderation project is a combination of all benchmarks in a unit. All the other benchmarks in grade 9 unit 2 will provide the essential knowledge, skills, values and attitudes for the moderated project. There will be other evidence based assessments that will be carried out in the unit as well. In essence, the moderation for TIA is a unit based project.

Sample work Textiles Technology Student Textile Project

Description of activity
Students **design**, **produce** and **evaluate** an assigned textile project. The textile item needs to demonstrate a clear link to the inspiration and reflect appropriate ***choice of fabrics*** and ***construction techniques*** including ***tools and equipment.*** The supporting documentation [design portfolio] should include:

- sources of inspiration
- generation of final design ideas
- samples of resources
- an appropriate care label
- experimentation and justification of equipment and construction

Context

Students have a prior knowledge in designing and constructing textile projects and have managed a range of design and production learning experiences to completion. Students can recognise that appropriate time and resource management skills will ensure the production of a quality textile item. With tan upcoming arts production and fashion

Benchmarks

A student

9.1.2.1 Describe historical influences, technological progression and emerging trends as inspirational sources of design
9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions.
9.1.2.3 Demonstrate an understanding of garment patterning techniques
9.1.2.4 Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects
9.1.2.4 Apply the design process to respond to needs and opportunities in textile design projects.
9.1.2.5 Select and use appropriate technology to creatively document, communicate and present design and project work.

[Even though these are the grade level benchmarks, the essential KSAVS are drawn up in the assessment rubrics to eventually demonstrate proficiencies as having achieved the benchmarks.]

Criteria for assessing learning

(These criteria would normally be communicated to students with the activity.)

Students will be assessed on their ability to:

- produce a quality textile item with consideration to creativity, degree of difficulty, proficiency in manufacture and time management
- select and use appropriate textile equipment, techniques and materials to construct a quality textile item
- document project work and show evidence of:
  - inspiration and evaluation
  - generation of final sketch
  - collection and justification of resources
  - appropriate care label
  - Experimentation with and justification of techniques and equipment.

Assessment Rubrics,
The development of assessment rubrics will cover the three focus areas.
1. Design Portfolio
2. Textile Project Construction
3. The Design Process

1. THE DESIGN PORTFOLIO
As this is an ongoing or running file of student work the assessment criteria is developed formatively. This portfolio will show all evidence of work done in the designing, planning, making and evaluating the project.
The criteria are drawn from the description of assessment activity**.**

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
sources of inspiration	Shows precise evidence of sources of inspiration of the design selected with meticulous descriptions of design with complete evidence of the	Shows evidence of sources of inspiration of the design selected with meticulous descriptions of design with evidence of the elements of	Shows minimal evidence of sources of inspiration of the design selected with careless descriptions of design with minimal	Shows lack of evidence of sources of inspiration of the design selected with careless descriptions of design with sloppy evidence of

	elements of design.	design.	evidence of the elements of design.	the elements of design.
generation of final design ideas	Shows precise evidence of final design ideas with evidences (sketches) and clear justifications.	Shows precise evidence of final design ideas with evidences (sketches) and justifications.	Shows minimal evidence of final design ideas with evidences (sketches) and minimal justifications.	Shows lack of evidence of final design ideas with sloppy evidences (sketches) and no justifications.
samples of resources	Shows sufficient samples of resources with succinct and correct explanations.	Shows samples of resources with correct explanations.	Shows minimal samples of resources with few correct explanations.	Shows lack of samples of resources with no explanations.
an appropriate care label	Shows sufficient evidence of care label appropriate to the textile project design.	Shows evidence of care label appropriate to the textile project design.	Shows minimal evidence of care label appropriate to the textile project design.	Shows lack of evidence of care label appropriate to the textile project design.
experimentation and justification of equipment and construction	Shows exceptional and deliberate evidences of every step taken to experiment and justify all decisions and the construction of the textile project in the design portfolio.	Shows deliberate evidences of every step taken to experiment and justify all decisions and the construction of the textile project in the design portfolio.	Shows minimal evidences of every step taken to experiment and justify all decisions and the construction of the textile project in the design portfolio.	Shows lack and careless evidences of every step taken to experiment and not justify all decisions and the construction of the textile project in the design portfolio.

2. THE TEXTILE PROJECT CONSTRUCTION

The construction of the Textile product will include;
1. the design of the textile design.
2. inspirations that inspired the design
3. produce a quality textile item with consideration to creativity, degree of difficulty, proficiency in manufacture and time management
4. select and use appropriate textile equipment, techniques and materials to construct a quality textile item

For this phase of the project; an analytic as well as a holistic rubric will be developed.

1. The design of the textile design.

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Relevance to the focus of project	excellent description of item/s and individually designed patterns and technical sketches	description of item/s and individually designed patterns and technical sketches	poor description of item/s and individually designed patterns and technical sketches	no description of item/s and no individually designed patterns and technical sketches
Appropriate use of the elements of design	Excellent presentation as either graphic or free, and indicates mood, feel and emotion of the design and provides specific information about the design features	presentation as either graphic or free, and indicates mood, feel and emotion of the design and provide specific information about the design features	Poor presentation as either graphic or free, and poor indications of mood, feel and emotion of the design and provides few information about the design features	No presentation as either graphic or free, and does not indicate mood, feel and emotion of the design and provides lack of information about the design features
Appropriate design including aesthetic and functional aspects	critical analysis of the functional and aesthetic aspects of the design, considering strengths and weaknesses, with reference to the elements and principles of design	Good analysis of the functional and aesthetic aspects of the design, considering strengths and weaknesses, with reference to the elements and principles of design	Poor analysis of the functional and aesthetic aspects of the design, considering strengths and weaknesses, with reference to the elements and principles of design	No analysis of the functional and aesthetic aspects of the design, not considering strengths and weaknesses, with no reference to the elements and principles of design
Creative and innovative design	Outstanding design development reflects research, the process of creative thinking, and development of individual style.	Good development reflects the understanding of research, the process of creative thinking, and the development of individual	Design development reflects some attempt at research, creativity and originality. but some inappropriate choices made.	Design development lacks research demonstrate little creative thinking, and no development of individual style.

		style,		
Presentation and communication of design of the textile design	Excellent presentation of the development of ideas and concepts in a logical and sequential way	Presentation of the development of ideas and concepts in a logical and sequential way	Mediocre presentation of the development of ideas and concepts in less a logical and sequential way	Poor Presentation of the development of ideas and concepts in a non-logical and sequential way

2. Inspirations that inspired the design

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Relevance to focus of project	The product solution shows excellent relevance to the focus of the task	Clear relevance evident in the focus of the product.	The product solution shows minimal relevance to the focus of the project.	The product is not relevant to the focus of the project.
Theme used as inspiration for the design	Excellent representation of inspiration evident in the design chosen.	Clear representation of inspiration evident in the design chosen.	There is minimal representation of theme evident as inspiration for the design.	No representation of inspiration evident in the design
Technological innovations	An excellent use of technology tools and practice that are used to inspire the design	Making full use of technology innovations of colour, design, texture, line and shape to inspire design.	Minimal use of technological innovations to inspire the design.	No clear use of technological innovations in the design.

3. produce a quality textile item with consideration to creativity, degree of difficulty, proficiency in manufacture and time management

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Selection of appropriate Fabrics and materials, colours and textile equipment	An exceptional selection of appropriate fabrics and materials, considering colours and the textile equipment	selection of appropriate fabrics and materials, considering colours and the textile equipment	Poor selection of appropriate fabrics and materials, not much considering colours and the textile equipment	No selection of appropriate fabrics and materials, no consideriation colours and the textile equipment
Pattern Making Use of measurements and calculations	Pattern Making Use of measurements and calculations	Pattern Making Use of measurements and calculations	Pattern Making Use of measurements and calculations	Pattern Making, Use of measurements and calculations

to daft basic patterns and with pattern adaptations	to daft basic patterns and with pattern adaptations are excellently done.	to daft basic patterns and with pattern adaptations are done well.	to daft basic patterns and with pattern adaptations are done to minimal expectations	to daft basic patterns and with pattern adaptations are strictly not done well.
Construction/ of textile product and the Demonstration of sewing techniques, stitches, seams, fastening, pleats and darts	Excellent construction/ of textile product with excellent Demonstration of sewing techniques, stitches, seams, fastening, pleats and darts	Good construction/ of textile product and with good demonstration of sewing techniques, stitches, seams, fastening, pleats and darts	Poor construction/ of textile product and with poor Demonstration of sewing techniques, stitches, seams, fastening, pleats and darts	Very poor construction/ of textile product and with Demonstration of sewing techniques, stitches, seams, fastening, pleats and darts
Issues of challenges overcome and management of time	Issues of challenges are greatly overcome and excellent management of time	Issues of challenges are managed to be overcome and good management of time	Issues of challenges are partially overcome and slack in the management of time	Issues of challenges not overcome and management of time is not evident.
Appropriate for wear and market	Excellently made appropriate for wear and market	Very appropriate for wear and market	acceptable and appropriate for wear and market	Not appropriate for wear and market

4. select and use appropriate textile equipment, techniques and materials to construct a quality textile item

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Selection of the appropriate textile equipment	Excellent selection of the appropriate textile equipment	Good selection of the appropriate textile equipment	Poor selection of the appropriate textile equipment	Very poor selection of the appropriate textile equipment
Correct use of textile equipment	Excellent use of textile equipment	Correct use of textile equipment	Poor use of textile equipment	Incorrect use of textile equipment
Correct techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing	Excellent and correct techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing	Good and correct techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing	Poor techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing	Incorrect techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing
Correct construction and	Excellent and Correct	Good and correct	Poor construction and	Incorrect construction and

fitting of textile product	construction and fitting of textile product	construction and fitting of textile product	fitting of textile product	fitting of textile product

3. THE DESIGN PROCESS
The design process will be assessed as it is the driver of the design portfolio evolving into the textile design project.

Each stage of the design process will be assessed with their specific rubrics developed.

Engineering Design Process

1. Analyse the context and background, and clearly define the problem.

Context and background
There is an arts production and fashion show that is set in contemporary Papua New Guinea. PNG has gone through significant transitions from traditional to the modern with great influences from other cultures. Textiles, clothing and fashion have seen so much change which has also taken inspirations from other cultures, historical eras, fashion trends, street fashion or iconic people in the entertainment industries and sports. There is a need for the design and construction of contemporary textiles project to be showcased during the arts production and fashion show.

Students design, produce and evaluate an assigned textile project. The textile item needs to demonstrate a clear link to the inspiration and reflect appropriate *choice of fabrics* and *construction techniques* including *tools and equipment.* The supporting documentation [design portfolio] should include:

- sources of inspiration
- generation of final design ideas
- samples of resources
- an appropriate care label
- experimentation and justification of equipment and construction

The Design Process
Identify the Problem

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Analyse the context and analyse issue and the problem	Analyse the context and analyse issue and the problem with logical results, justifications and examples	Analyse the context and analyse issue and the problem with clear results and justifications	Analyse the context and analyse issue and the problem with no clear results	Do not analyse the context and analyse issue and the problem
Considerations of ideas, themes,	More considerations of ideas, themes,	A lot of considerations of ideas, themes,	Few considerations of ideas, themes,	No considerations of ideas, themes,

	with examples			
Propose design solutions	Propose design solutions with clear and realistic expectations of results	Propose design solutions with clear expectations of results	Propose design solutions with no clear results	Do not propose design solutions
Selection of the appropriate design solution	Excellent selection of the appropriate design solution	Very good Selection of the appropriate design solution	Poor selection of the appropriate design solution	Do not select of the appropriate design solution

Do Research

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Design research questions	Excellent design of research questions	Very good design of research questions	Poor design of research questions	Do not design research questions
Conduct research	Excellent Conduct of research	Very good Conduct of research	Few research done	Do not conduct research
Evidence of research findings	Excellent Evidence of research findings	Very good Evidence of research findings	Poor evidence of research findings	No evidence of research findings
Evidence of constraints and limits identified	Excellent evidence of constraints and limits identified	Very good evidence of constraints and limits identified	Poor evidence of constraints and limits identified	No evidence of constraints and limits identified
Evidence of critical considerations of how the solution is the most appropriate	Excellent evidence of critical considerations of how the solution is the most appropriate	Very good evidence of critical considerations of how the solution is the most appropriate	Poor evidence of critical considerations of how the solution is the most appropriate	No evidence of critical considerations of how the solution is the most appropriate

Develop Possible Solutions

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Brainstorm possible design solutions to address the problem identified	Excellent and logical brainstorm of possible design solutions to address the problem	Logical brainstorm of possible design solutions to address the problem identified	Some brainstorm done for possible design solutions to address the problem identified	No brainstorm of possible design solutions to address the problem identified

	identified			
Evidence of variations of design solution being proposed	A good collection of evidence of variations of design solution being proposed	Clear and sufficient evidence of variations of design solution being proposed	Some evidence of variations of design solution being proposed	No evidence of variations of design solution being proposed
Identify the pros and cons of a possible design solution	Clearly identify the pros and cons of a possible design solution with checklist done,	Clearly identify the pros and cons of a possible design solution	Does identify the pros and cons of a possible design solution	Do not identify the pros and cons of a possible design solution

Choose One Solution

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Presentation of proposed design solutions in detail	Excellent presentation of proposed design solutions in detail	Very good presentation of proposed design solutions in detail	Poor presentation of proposed design solutions in less detail	No presentation of proposed design solutions in detail
Study of details of proposed design	Meticulous In-depth study of the details of the proposed design	Good and in-depth study of details of the proposed design	Minimal study of the details of proposed design	No study of the details of the proposed design
Considerations of constraints, cost and time in making the design solution	Clear and justified considerations of constraints, cost and time in making the design solution	Clear considerations of constraints, cost and time in making the design solution	Minimal considerations of constraints, cost and time in making the design solution	No considerations of constraints, cost and time in making the design solution
Selecting the appropriate design solution	Clear and justified selection of the appropriate design solution	Clear selection of the appropriate design solution	No clear selection of the appropriate design solution	No selection of the appropriate design solution

Design and Construct a Prototype

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Technical sketches of design product complete with measurements	All technical sketches of design product are complete with and guided explanations	All technical sketches of design product complete with measurements	Few technical sketches of design product with some measurements	No technical sketches of design product

Sketches are in 2D and 3D	All sketches are in 2D and 3D drawings and have very clear details	All sketches are in 2D and 3D drawings with clear details	Not all sketches are in 2D and 3D drawings	Sketches are not in 2D and 3D drawings
Materials are selected	Appropriate materials are selected well considering criteria for performance in making the prototype	Appropriate materials are selected well for good performance when making the prototype	Materials are selected for performance but not considering performance when making the prototype	Materials are not selected for performance in the making of the prototype
The processes in making the prototype	The processes in making the prototype are outlined and followed	The processes in making the prototype are followed	The processes in making the prototype are followed but with some stages missed.	The processes in making the prototype are not followed
Testing the prototype	Complete and successful testing of the prototype	Complete testing of the prototype	Incomplete testing of the prototype	No testing of the prototype done
Design of questions asked when the prototype is tested	Very Clear and well design of questions for testing the prototype	Clear and direct Design of questions for testing the prototype	Few questions designed for testing the prototype	No design of questions for testing the prototype
Keeping a record of the process of testing the prototype	Excellent record kept of the process of testing the prototype	Good and clear record kept of the process of testing the prototype	Incomplete record kept of the process of testing the prototype	No record kept of the process of testing the prototype

Communicate Results

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Communicating the results of the prototype test using detailed diagrams	Very clear and detailed communication of the results of the prototype test using detailed diagrams	Clear communication of the results of the prototype test using detailed diagrams	No clear Communication of the results of the prototype test	No Communication the results of the prototype test
Use of mathematical evidence, sketches, graphs	Clear and detailed use of mathematical evidence, sketches, graphs including conclusions	Clear and detailed use of mathematical evidence, sketches, graphs	Minimal use of mathematical evidence, sketches, graphs	No use of mathematical evidence, sketches, graphs
Evidence of shared learning in analyzing the results of the test	Clear evidence of shared learning in analyzing the results of the test	Good evidence of shared learning in analyzing the results of the test	Minimal evidence of shared learning in analyzing the results of the test	No evidence of shared learning in analyzing the results of the test

Evaluate and Redesign

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Evaluate the results of the prototype test	Clear evaluation of the results of the prototype test with details shown	Clear evaluation of the results of the prototype test	No clear evaluation the results of the prototype test	No evaluation of the results of the prototype test
Considerations of what worked and what did not	Clear and confident considerations of what worked and what did not	Clear considerations of what worked and what did not	No clear considerations of what worked and what did not	No considerations of what worked and what did not
Evidence of decisions made after the prototype test, to re-modify or change the design solution	Clear and concrete evidence of decisions made after the prototype test, to re-modify or change the design solution	Very clear evidence of decisions made after the prototype test, to re-modify or change the design solution	No clear evidence of decisions made after the prototype test, to re-modify or change the design solution	No Evidence of decisions made after the prototype test, to re-modify or change the design solution

GRADING

The Grading of the Moderation Project will cover the three components.

Criteria	**A** **55-60**	**B** **45-54**	**C** **30-44**	**D** **0-29**
The Design Portfolio	An excellent and orderly compilation of all evidences of the project designing, making and evaluating.	An excellent compilation of all evidences of the project designing, making and evaluating.	A good compilation of evidences of the project designing, making and evaluating.	A poor compilation of evidences of the project designing, making and evaluating.
The Textile Product Construction	Completed construction of the textile product on time with controlled costs and time	Completed construction of the textile product on time	Completed construction of the textile product with no consideration for time, costs	Poorly completed construction of the textile product
The Design Process	Strictly followed the design process fulfilling all the stages.	Followed the design process fulfilling all the stages.	Followed the design process fulfilling some stages but yet incomplete	Not followed the design process and not fulfilling the stages.

CERTIFICATION

a. School based

b. Trade based/accreditation in line with TVET competency and proficiency tests

Practical experiences

To satisfy the requirements of the syllabus and teacher guides students must undertake a range of practical experiences that occupy the majority of course time. Practical experiences will be used to develop knowledge and understanding of and skills in designing, producing and evaluating. Student capability, confidence and expertise at their current stage of development are an important consideration in determining the teaching and learning sequences in the course. Students with disability may require adjustments and/or additional support in order to engage in practical experiences.

Safety

Schools have a legal obligation in relation to safety. Teachers need to ensure that they comply with relevant legislation as well as system and school requirements in relation to safety and risk management when implementing their programs. This includes legislation and guidelines relating to Work Health and Safety, and the handling and storage of chemicals and dangerous goods. Teachers need to be aware of activities that may require notification, certification, permission, permits and licences.

Schools need to be aware of legal, ethical and cyber security considerations of digital solutions, including copyright and intellectual property, cultural considerations, accessibility, privacy issues and digital footprints.

Recording, reporting, monitoring and evaluation are integral part of assessment for students from grades 9 to 12. Therefore, it is commended that recording, reporting, monitoring and evaluation of students achievements for Business and Technology Subjects must be done by grade levels in school based assessment or also referred to as internal school assessment.

The marks awarded to students in their internal assessment will be a combination of the internal assessment mark and the examination mark.

Internal assessment provides a measure of student's achievements based on a wider range of syllabus content and benchmarks than maybe covered by the external examination. Business and Technology subjects provide a summation of each student's achievement in Grades 9-12. The internal assessment mark must comply with the types of tasks and assessment rubrics specified in the holistic or analytic rubrics. The external examination provides a measure of student achievement of those aspects of the content standards that can be reliably measured in an examination setting.

Recording

Standards based recording and reporting is about student understanding and mastering a learning standard and less about grades. A standards based report card can list the most important skills students should learn in each subject at a particular grade level. Instead of letter grades, students receive marks or a code that show how well they have mastered the skills. The marks or codes that schools use to represent student progress are;

A- Advanced
B- Proficient
C- Progressing
D-Novice

The standards are basically the learning standards and expectations for each grade level. SBC requires a new and effective way of recording and reporting to measure progress of student's performance such as in Project Based Learning. Reporting progress is based on the teaching and learning strategies for performance based learning which are accurately assessing the performance towards mastery. The teaching model is changing therefore the performance measurements of Standards-Based Reporting will be more reflective of learning in the classroom. Hence, SBA allows students to be able to know against which criteria they will judge their work, and the standards attached to each of the criteria. It tells students what is required and allows teachers to gain a sense of how students are doing overall based on their achievement of the standards and promotes mastery learning.

Schools must maintain and submit student assessment records according to the school based assessment policy. Teachers can record the evidence of students' demonstrations' of achieving the content standards and benchmarks using assessment instruments that are manageable. Here are some recommended recording methods;

- Individual or class checklists or class grid to record observations

- Comments on students work indicating what they have done well and where they need to improve
- Work samples being added to a portfolio
- Test marks
- Students assessments of their own performances using rubrics or assessment criteria and
- Students assessment of their peers using the assessment criteria

Students are given constructive feedback by the teacher on what they can do well and what they need to improve on. Likewise, teachers are focused on the content they are assessing and are able to apply fair, precise and consistent judgment.

Reporting

Teachers are obliged to report on what students have done or how well they have performed and how they improve further. Formal reporting through written reports and interviews are done to inform parents and guardians of the students learning progress and other related areas such as behavior. Teachers must ensure that the student has demonstrated and achieved the standards independently on a number of occasions. These can be done formally or informally. The achievements are reported to respected stakeholders in relation to;

- Weaknesses in the learner
- Strengths in the learner
- Parent and guardian support and
- Evaluation

Purpose of Reporting

- **Students Are Provided with Appropriate Feedback that Will Improve their Skills**

In a standards-based learning approach, teachers are expected to provide their students with quality feedback that will improve student learning. As opposed to the traditional grading system that only provides students with a single numerical or letter grade, the standards-based grading system requires teachers to provide their students with meaningful and appropriate feedback that will accelerate mastery of learning standards. It is believed that standards-based grading allowed students to identify their areas of growth and to improve on their own competencies. Teachers need to communicate with their students what each proficiency score means and should be explained to the students' parents what each score means and how they can help their children demonstrate mastery of learning standards expected of them for the subject.

- **Students Can Track their Progress**

In a standards-based grading approach, students understand the meaning of each score that they receive. Because there are rubrics that explain the meaning of each proficiency score, students can easily monitor which standards need to be improved further and which learning standards have already been met. as such, students begin to monitor their progress and become accountable for their learning goals.

Interventions and Monitoring

Underachievement is poorer than expected performance. Students who consistently display performance demonstrative of underachievement are identified and interventions for regress are planned to promote learning. Such interventions should be planned not as a general aspect but should address individual students' limitations in learning and should encourage learning.

- **Monitoring of Students Learning**

Monitoring of students learning is done through strategies that teacher devise to track their teaching and students achievement. This is through the assessment program, classroom teaching, and performance in performance-based learning and students self- assessment in achieving the learning standards.

- **Re-planning**

Re-planning of teaching programs and lesson planning are addressed apart from the planning and programming for all other students. This is specifically addressing underachievers. Re-planning includes teaching and learning strategies, resources, remedial activities which can be planned into the normal teaching times instead of creating extra times after classes.

Certification

Certifying of students must be done through an awarding system which will determine the level of achievement. This will be in a form of achievement statements suggested below;

Levels of achievement

1. Very high achievement
2. High achievement
3. Satisfactory achievement
4. Low achievement
5. Below requirement level

All teachers responsible for grades 9-12 must consider school based assessment levels of achievements to be affected across all Business and Technology Subjects.

Glossary

Building Glossary	
Aesthetics	Characteristics of a product or system that makes it look beautiful and attractive.
Analyse	Look carefully at a problem or need in order to explain its causes and effects, or carefully look at information to determine its validity and importance, or examine an item (e.g. a structure) and see how it functions and what it consists of.
artefact	A manufactured object.
anthropometrics	(linked to ergonomics) Measurements of people's shapes and sizes. Such measurements are usually taken when products are designed for human use, e.g. furniture, eating utensils, hairdryers, sporting equipment cars, clothing, etc.
Biases	People's preconceived ideas or prejudices about some things or people before they actually meet or deal with them. These are normally in areas of human rights and inclusivity such as gender, race, ethics, religion, etc. For example most cameras are biased towards right-handed people, very few women enter the mechanical engineering industry , etc.
Biophysical environment	The land, air and water around us; it is also the space in which we find ourselves.
Building Code	A building code is a set of regulations written by city or county officials with the help of construction pros that governs the design, construction and modification of commercial buildings, homes and other structures in the jurisdiction
Building Standards	
Classify	Arrange in groups according to similar features or qualities.
Compare	Describe the similarities and/or differences between two products, or items, or solutions or situations.
Compression	A squeezing force.
Constraints	Aspects that limit conditions within which the work or solution must be developed, e.g. time, materials, tools, human resource, cost, etc.
Control	The means by which systems are regulated, i.e. an adjustment of the process, which makes the actual result conform more closely to the desired result.
Conventions	Ways of showing information on designs or working drawings that are understood and recognised to have specific meaning.
Craft	The repetitive production of artefacts, usually for sale. It requires skill in planning the production and making of items and needs manual dexterity and artistic skill. Craft occupations include carpentry, sewing and pottery. It typically involves repetition where many items, often using existing patterns or plans, are manufactured during a production run. Although there is common ground, craft should not be confused with Technology, nor with Art
Criteria	Statements of a particular standard or requirement that a solution must satisfy.
data	Raw facts and figures (statistics, rainfall figures, temperature readings,

	etc.). Data may be processed into information.
Demonstrate	Show key features of an item or product.
Describe	Tell in words listing features and/or functions
Discuss	Write or speak about a topic or event or item or problem in order to get feedback / opinions from others.
	design (noun) The plan, sketch, model, drawing, etc. that outlines or shows the intention of the proposed solution.
design brief	A short and clear statement that gives the general outline of the problem to be solved as well as the purpose of the proposed solutions.
design process	A creative and interactive approach used to develop solutions to identified problems or human needs. The associated skills are investigating, designing (development of initial ideas), making, evaluating and communicating. The design process is utilised by engineers, architects, industrial designers, and many others when developing original ideas to meet needs or wants, and to solve problems.
enabling tasks	Activities used to teach and then practice specific skills in preparation for a more advanced task – sometimes also called resource tasks.
Ergonomics	Features of a product or system that makes it user-friendly.
Explain	Make clear by giving more information.
Findings	Things that have been discovered after a process of investigation or research.
Fitness-for-purpose	A solution should be evaluated in terms of the design brief, specifications and constraints AND whether it will meet the purpose for which it was designed.
Force	Sometimes described as a push or a pull. However, in Physics, the force may be in contact or it may act across a space (e.g. gravity, magnetism). The scientist is specifically concerned with the effect of a force on the motion of a body, viz. unbalanced forces cause acceleration, 'deceleration' or direction change. In Technology, designers are concerned only with contact forces (e.g. a load), and is specifically concerned with the effect the force has on the integrity of a structure, viz. will it bend, stretch, twist or will joints break leading to structural failure?
Forming	Changing a material's shape without cutting it.
Identify	Establish who/what something is e.g. identify a type of structure.
Illustrate	Explain or make something clear by using examples or words or diagrams.
Input	The command/information entered into a system.
information	Data that has been processed (recorded, classified, calculated, stored, etc.). Knowledge is gained when different kinds of information are compared and conclusions are drawn.
isometric	A 3D drawing where the lines of sight are set at 30 degrees.
machine	A device made up of a combination of simple mechanisms linked so as to form a system for the purpose of doing work. It can be designed to increase the mechanical advantage and decrease the velocity ratio OR to increase the velocity ratio while decreasing the mechanical advantage.
materials	Physical substances used in technology, e.g. wood, textiles, fabric, plastic, food, etc
mechanical advantage	A concept that describes how much easier mechanisms or machines can make a particular task. The amount of work done is the same, and the

	amount of energy expended is the same, but the effort used (force) is less because it is applied over a greater distance, and for a longer period of time.
mechanism	Parts that can turn one kind of force into another and give mechanical advantage or a distance advantage. Mechanisms can be combined to form a machine. The basic mechanisms are the lever and the wedge/inclined plane. Cams/ cranks and pulleys/gears are adaptations of the wheel and axle – which is itself a special case of the first class lever.
Mode	A way or manner in which a thing is done.
modelling	The testing of a solution, (product or system). This could include using small replicas (scale models), and intangible representations of the solution (mathematical models, computer models, etc.).
need	A necessity for basic function, e.g. food is a need.
Oblique	A 3D drawing where the depth of an object is projected at a 45 degree angle to the 2D front view.
opportunity	The chance to do something about a need or a want.
Orthographic	A type of 2D drawing. It usually shows three separate views of the same object (e.g. front, top and left views). The technique is used to draw formal working drawings.
output	The actual result obtained from a system.
Perspective	A 3D artistic drawing in which the lines of sight converge to vanishing points on the horizon. It can be drawn either to a single vanishing point or to double vanishing points (at this level).
technological processes	Any process using technology to perform a task e.g. generating electricity, extracting iron from iron ore, galvanising steel by electroplating, injection moulding a plastic bucket, etc.
tension	A force that stretches an object or material, a pulling force.
technological literacy	technological solution A plan that arises by using a systematic problem solving process (ideas, flowcharts, models, etc.). The ability to use, understand, manage and evaluate technology.
Product	The physical/tangible artefact that results from the process (model, poster, chart, etc.).
Preserving	A process that prolongs the natural life of a product.
Process	The part of a system that combines resources to produce an output that is in response to input.
Problem	Something that leads to a need or want and that can give rise to an opportunity.
Pulley	A wheel with a groove on its circumference. It is used to transmit movement and is used with a belt or a rope.
Recycle	To reuse all or part of a substance, including breaking it down to raw material status.
recyclable	A material that can be recycled.
safety	The way that a person works with tools, materials and equipment that does not harm themselves or others physically.
Science	The study and description of natural phenomena.
Shaping	A process used to change the shape or contour of materials – shaping

	always involves the removal or addition of material.
Specification	An organised, detailed description of the requirements/criteria that the solution or product must meet, e.g. safety, size, material, function, human rights, environment, etc.Note: Once a product has been manufactured, the original design specifications become the features of the product, i.e. specifications before = features after.
structure	Something that has been built, made or been put together in a particular way.
system	Something that is made up of interlinked parts that function together as a whole to accomplish a goal. For example a mechanical system has a combination of mechanisms that make it function as a whole; an electrical system has interrelated electrical parts that work together to make the system do what it was designed to do.
Tabulate	Arrange data or information in the form of columns and rows.
technological capability	The ability to use a combination of skills, knowledge, resources in a variety of contexts, to solve a technological problem. Capability leads to technological literacy.
want	Something that people would like but do not actually need (a convenience or a luxury).

Electrical Glossary	
‘	a system where an input signal is altered (usually in amplitude)
amplitude modulation (AM)	a process of modulating the carrier wave in which the amplitude of the carrier wave is changed in sympathy with the modulating signal (information)
analogue	a system in which changing values are represented by a continuously variable electrical signal
audio	relating to a system concerned with frequencies within the range of human hearing
base	one terminal of a transistor through which 2% of the supply current will flow
binary logic	an assembly of digital logic elements which operate with two distinct states
binary number	a number system to the base 2
bandwidth	the range of frequencies to which a system will respond in the required manner
bipolar-transistor	a transistor in which current is carried through the semiconductor both by holes and electrons; it is a current operated device
bistable	a circuit which can have two stable states, and which can remain in either state indefinitely
Boolean algebra	a system of formal logic used for minimising complex digital systems
Capacitor	a component used in electronic circuits that has the ability to store electrical charge for a period of time
class A amplifier	a system of which the output is identical to the input in terms of frequency and shape but not in amplitude
class B amplifier	a system of which the output signal is altered in amplitude and shape representing half of the output signal
class C amplifier	a system of the output signal is altered in amplitude and shape to

	represent less than half of the input signal
collector	one terminal of a bipolar transistor through which 98% of the supply current will flow
conductor	a material through which an electric current can flow relatively easily
construction	encompasses the study of residential, commercial, industrial and recreational applications of Technology, including systems required to maintain and service them
conventional current	electric current, regarded as flowing from positive to negative
central processing unit (CPU)	the main number-processing and control section of a computer. In a microcomputer the CPU will be a microprocessor.
crystal	usually refers to quartz crystal, used as a precision timing element in many circuits; may refer to the term piezoelectric
Darlington pair	transistors used in cascade, giving high gain and high input impedance
decibel (dB)	one-tenth of a bell; a measure of power gain, on a logarithmic scale (e.g. a power level equal to 10 times the common logarithm of the ratio of the output power to the input power). The decibel is a convenient unit for representing a very large range of power gain.
delta network	a combination of three components connected to form a triangular configuration like the Greek letter delta; also known as a mesh connection
demodulation	the process of recovery of a modulating signal from a modulated carrier
design	includes the study of a variety of basic design processes that are used in solving technological challenges
diac	a bi-directional break over diode; often used for triggering a **triac**
digital electronics	the branch of electronics concerned with the processing of digital systems, usually in binary
diode	a component, either semiconductor or thermionic, that permits current to flow through it in one direction only
electron flow	regarded as the flow of electrons from negative to positive
emitter	one terminal of a bipolar transistor through which 100% of the supply current will flow
energy	focuses on domestic, industrial, generation and transmission services
farad	unit of capacitance; a very large unit, the largest practical unit being the microfarad
fibre-optic	a glass or plastic fibre used for the transmission of information through light
field-effect transistor	a type of transistor characterised by a very high input resistance that is a voltage operated device
flip-flop	general term for a **bistable, astable** or **monostable** circuit
frequency	the number of complete repetitions of a wave form in one second, expressed in Hertz
gain	the factor by which the output of a system exceeds the input
gate	a component in a digital logic circuit or one terminal of a field-effect transistor, or other semiconductor device
henry	unit of inductance
integrated circuit	an electronic system, or part of a system, produced on a silicon chip using microelectronic techniques

impedance	the ratio of the voltage applied to a circuit to the current flowing in the circuit; similar to resistance, but applicable to alternating currents and voltages
insulator	a material through which electric current will not easily flow
Karnaugh mapping	a visual technique used in the planning of digital systems for the minimisation of logic circuits
liquid crystal display (LCD)	a reflective display used in digital systems for the presentation of output; characterised by a very low power consumption
light-emitting diode (LED)	an electronic component in which electric current is converted directly into visible or infrared light
logic	the basic principles and applications of truth tables, interconnections of on/off circuit elements, and other factors involved in mathematical computation in a computer; also used as a general term for various types of **gates, flip-flops,** and other on/off circuits used to perform problem-solving functions in a digital computer
manufacturing and materials	product design, process and production planning, raw materials, manufacturing processes and quality control
microcomputer	a computer in which the central processing unit is a microprocessor
microprocessor	a central processing unit constructed using large-scale integration in which all the CPU circuits are fitted into a single integrated circuit
modulation	variation of the frequency, phase or magnitude of a high frequency waveform in accordance with a waveform of lower frequency
monostable	a circuit with a single stable state
multimeter	a general-purpose measuring instrument, usually able to measure resistance, current and voltage
negative feedback	feedback applied to a system in such a way that it tends to reduce the output
NPN	one of the two alternative types of bipolar transistors
Ohm	the unit of resistance (Ù)
operational amplifier	a highly stable, **gain,** DC amplifier, usually produced as a single integrated circuit
opto-electronics	electronic systems or devices that involve the use of light
Oscillator	an electronic system that produces a regular periodic output
Oscilloscope	an instrument for displaying electrical waveforms on a cathode ray tube
photo-resistor	also known as an LDR (light-dependent resistor); a resistor whose value depends upon the amount of light falling on it
piezoelectric effect	the direct conversion of electrical to mechanical energy or vice versa in some crystalline materials
programmable logic controller (PLC)	a control device, normally used in industrial control applications, that employs the hardware architecture of a computer and a programming language
PNP	one of the two alternative types of bipolar transistor
power supply	source of electrical energy
positive feedback	feedback applied to a system in such a way that it tends to increase the output
protective device	a particular type of equipment used in electric power systems to detect abnormal conditions and to initiate appropriate corrective action
rectification	the process of changing an alternating current to a unidirectional

	current
relay	an electromechanical device in which an electric current controls a switch
resistance	the property of a material that resists the flow of electrical current
speaker	an electromechanical device for converting electrical energy into sound (e.g. a loudspeaker)
star network	a set of three or more branches with one terminal of each connected at a common node to give the form of a star; also known as a Y connection
technological process	the identification, design, development and evaluation of processes and products related to Electrical Technology
thyristor	a component similar to a semiconductor diode but having in addition a gate connection by which the component, normally non-conducting, can be triggered into conduction
tolerance	generally the amount by which a specified component value can vary from the marked value
triac	a semiconductor component similar to the **thyristor** but which will conduct in either direction
uni-junction transistor	a semiconductor device used in some oscillators
voltage regulation	a process to maintain the terminal voltage within required limits despite variations in input voltage or load
wavelength	the physical distance between two similar and successive points on an alternating wave
zener diode	a semiconductor **diode**, used for voltage regulation. When the zener diode is reverse-biased, it exhibits a sudden increase in conductivity at a certain specific voltage

Plumbing Glossary	
Back Flow	The act of water traveling from one system back into any part of the main distribution system (usually by siphoning).
Back Flow Preventer	A device to prevent backflow i.e. into a potable water supply. Usually required for sprinkler systems, handheld showers, pullout faucet spouts, kitchen sprayers, etc..
Back Pressure	Pressure that resists the flow of fluid in a piping system
Back Siphonage	The negative pressure that causes backflow..
Back Vent	: Plumbing fixture's separate vent in a building drainage system
Back Wash	The process of cleaning a filter by reversing the flow of water through it. Accumulated sediments are sent to waste.
Black Water	The discharge from water closet and urinal is called Black water.
Building Drain (BD)	The building drain is the part of the lowest horizontal piping of a drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls of the building and conveys it to the building sewer beginning one meter outside the building wall...
Building drainage system	consists of plumbing fixtures, drainage pipes & fittings and septic tanks/public sewer
Building Sewer	The building sewer is the part of the horizontal piping of a drainage system which extends from the end of the building drain and which receives the discharge of building drain and convey it to a public

	sewer, private sewer, individual sewage disposal system or other point of disposal
Check Valve	A type of backflow preventer installed in a pipe run that allows water to flow in only one direction.
Drain/waste/soil pipes	are large pipes that carry waste water and other wastes away from the home and into appropriate places such as septic tanks or sewer mains.
DWV	In modern plumbing, a **drain-waste-vent** (or DWV) is a system that allows air to enter the plumbing system to maintain proper air pressure to enable the removal of sewage and greywater from a dwelling. Drain refers to water produced at fixtures such as sinks, and showers; waste refers to water from toilets. As the water runs down, proper venting is required to allow water to flow freely, and avoid a vacuum from being created. As the water runs down air must be allowed into the waste pipe either through a roof vent (external), or an internal vent
Faucet	a fixture for drawing or regulating the flow of liquid especially from a pipe
Frost Line	The line joining the points of greatest depths below ground level up to which the moisture in the soil freezes.
Galvanizing	The process of applying a coating of zinc to the finished product to provide corrosion protection. The coating can be applied by hot dipping or electrolytic deposition.
Grey Water	The discharge from bathtubs, showers, wash basins, kitchen sink, washing machine which does not contain human excreta is called Grey Water.
Hard Water	Natural water containing impurities in various proportions. Traditional hardness is a measure of calcium or dissolved solids in a solution, measured in parts per million. Hard water generally ranges from 100 to 250 ppm.
High Altitudes	Elevations higher than 1 500 m above mean sea level (MSL).
Hydraulic Pressure	Pressure that exists in a system containing non-compressible liquid.
Invert Level	The distance between the ground surface level to the base interior level of a sewer pipe
Lagging	. Thermal insulation on pipes.
Leach Field	Porous soil area, through which septic tank leach lines run, emptying the treated waste.
Leach Lines	Pipes that carry effluent from the septic system out to the leach field.
Leach pit	Leach pits/ Soak pits/ Seepage pits are used to remove contaminants and impurities from the liquid that emerges from the septic tank and safely disperses the same into the soil.
Leakage	Loss of fluid usually due to mechanical breakdown or gasket wear.
Manhole	Access opening to a hole, usually with a cover, through which a person may enter a sewer, boiler, drain, etc. (usually round to prevent the cover from falling into the opening).
Manhole Cover	A manhole cover is a removable plate forming the lid over the opening of a manhole, to prevent anyone or anything from falling in, and to keep out unauthorized persons and material.
Outlet / Discharge	The opening through which the water exits the pump
Outlet Sewer	Pipe section in a septic system which runs between the septic tank and the drainage field.
Overflow Tube	The vertical tube inside a toilet tank that directs water into the bowl in

	case the ballcock malfunctions. It is usually part of the flush valve. It prevents potential water damage caused by a tank overflow. A "constant-running" condition alerts the user to a problem. On most toilets, the overflow tube also has a refill tube flowing into it, which directs water from the ballcock through the overflow tube to the bowl, after a siphon break.
Pipes	a hollow cylinder used to move liquids, gases or oil. Pipes come in several types and sizes. They can be divided into three main categories: **metallic pipes, cement pipes and plastic pipes**. Metallic pipes include steel pipes, galvanised iron pipes and cast iron pipes. Cement pipes include concrete cement pipes and asbestos cement pipes
Pipe fittings	A **fitting** or **adapter** is used in pipe systems to connect straight sections of pipe or tube, adapt to different sizes or shapes, and for other purposes such as regulating (or measuring) fluid flow.[1] These fittings are used in plumbing to manipulate the conveyance of water, gas, or liquid waste in domestic or commercial environments, within a system of pipes or tubes.
Plumber	A plumber is a person who installs and maintains piping for water and their drains and waste systems in a dwelling, business or industrial facility. He installs bathroom appliances such as showers, toilets, sinks, kitchen appliances (e.g. dishwashers), water heaters required in a new or remodelled houses or buildings. Plumbers need various skills to perform their jobs successfully like blueprint reading, ability to locate through diagrams locations for installation of pipes, fitting pipes together for the correct functioning of plumbing systems. A plumber shall be aware of basic Plumbing Codes and Standards specified.
Plumbing	Pipes, fixtures and other apparatus inside a building for bringing in water supply and removing the waste water out of the building constitute plumbing system. Plumbing is a skilled trade of working with the above pipes, fixtures and apparatus for use with water and drainage.
Plumbing Fixture	A general term applied to any plumbing receptacle, device or appliance that can be temporarily or permanently fixed in place. It is connected to the drinking-water supply or to the drainage system either by an indirect or direct connection.
Plumbing Vent Pipes	are an integral part of a plumbing system as they allow the piping to "breathe". Air flow is necessary to equalize pressure in plumbing systems and plumbing vents allow for proper flow of air through the pipes.
Pressure Pipes	that carry fresh water to various fixtures.
Raw Water	Water supplied to the plant before any treatment.
Sanitary Fitting	Fitting that joins the assorted pipes in a drain, waste, and vent system, designed to allow solid material to pass through without clogging.
Sanitary Sewer	House drain that carries wastewater away from the house to a sewer system or septic tank.
Scale:	A thin coating or layer, usually calcium on the bottom of a tank or interior parts that may prevent heat transfer.
Sewer Gas:	Gases, esp. methane, which may be combustible and poisonous from the decay of organic materials in the sewer system.

Septic Tank (ST)	A Septic Tank is a watertight concrete box, buried in the ground just outside the home. The septic tank acts as a small-scale sewage treatment system common in areas where no connection to main sewerage system provided by the local body. It helps in disposing of household sewage / wastewater safely.
Septage	Black Water which undergoes treatment in septic tank is called Septage
Sewage	is the water, carrying body wastes including human excreta and other house hold waste. a) The discharge from water closet and urinal is called Soil or Black Water. b) The discharge from bathtubs, showers, wash basins, kitchen sink, washing machine which does not contain human excreta is called Waste Water / Sullage / Grey Water.
Sewerage system	Sewerage system is a closed system of pipes from the waste receptacle to the final disposal point either on land or into a body of water and the flow is gravitational or free flow and not under pressure as in the case of water supply pipes
Sovent Single Stack DWV System	The Sovent System is an engineered single stack drainage system. It offers a different concept of waste and venting by slowing the velocity of liquids and solids through a series of aerator fittings and double offsets. Before entering the building drain a deaerator fitting is placed at the base of the stack to minimize solid build up and slow the drainage before entering the building drain.
Stack	Any vertical pipe in the system like vertical soil or vent pipe is called stack.
Vent Stack	Upper portion of the soil stack above the topmost fixture through which gases and odours escape

Welding Glossary	
acceptable weld	A weld that meets the applicable requirements.
acetone	A colorless, flammable, volatile liquid used as a paint remover and as a solvent for oils and other organic compounds. Used in acetylene cylinders to saturate the monolithic filler material to stabilize the acetylene
acetylene feather	The intense white, feathery-edged portion adjacent to the cone of a carburizing oxyacetylene flame.
actual throat	The shortest distance between the weld root and the face of a fillet weld.
adhesion	A state of being stuck together. The joining together of parts that are normally separate.
aluminum	One of the chemical elements, a silvery, lightweight, easily worked metal that resists corrosion
ampere	A unit of electrical current measuring the rate of flow of electrons through a circuit. One ampere is equivalent to the current produced by one volt applied across a resistance of one ohm.
annealing	A process of heating then cooling metal to acquire desired qualities such as ductility
anode	The positive terminal of an electrical source.
alloy	A substance with metallic properties, composed of two or more

	chemical elements of which at least one is a metal
alloying element	Elements added in a large enough percentage to change the characteristics of the metal. Such elements may be chromium, manganese, nickel, tungsten, or vanadium; these elements are added to produce specific physical properties such as hardness, toughness, ductility, strength, resistance to corrosion, or resistance to wear.
alloy steel:	A plain carbon steel to which another element, other than iron and carbon, has been added in a percentage large enough to alter its characteristics
alternating current (AC)	An electric current that reverses its direction periodically.
alternative fuels	Propane, methylacetylene propadiene (MPS), natural gas, or fuel gases, other than acetylene, used for welding or cutting.
arc blow	The deflection of an arc from its normal path because of magnetic forces.
arc force	The axial force developed by an arc plasma.
arc gap	A nonstandard term used for the arc length.
arc gouging	Thermal gouging that uses an arc cutting process variation to form a bevel or groove.
arc plasma	A gas that has been heated by an arc to at least a partially ionized condition, enabling it to conduct electric current.
arc spraying	A thermal spraying process using an arc between two consumable electrodes of surfacing materials as a heat source and a compressed gas to atomize and propel the surfacing material to the substrate
arc strike	A discontinuity resulting from an arc, consisting of any localized re-melted metal, heat-affected metal, or change in the surface profile of any metal object.
arc time	The time during which an arc is maintained in making an arc weld.
arc welding	Arc welding is a group of welding processes in which fusion is produced by heating with an electric arc or arcs with or without the application of pressure and with or without the use of filler metal.
arc voltage	The voltage across the arc.
as welded	The condition of weld metal, welded joint, and weldments after welding, but prior to any subsequent thermal or mechanical treatment.
axis of a weld:	A line through the length of a weld, perpendicular to and at the geometric center of its cross-section.
backing	A material or device placed against the back side of the joint, or at both sides of a weld in electroslag and electrogas welding, to support and retain molten weld metal. The material may be partially fused or remain unfused during welding and may be either metal or nonmetal.
backstep sequence	A longitudinal sequence in which weld passes are made in the direction opposite to the progress of welding.
bare electrode	A filler metal electrode consisting of a single metal or alloy that has been produced into a wire, strip, or bar form and that has had no coating or covering applied to it other than that which was incidental to its manufacture or preservation.
base metal (material)	The metal (material) to be welded, brazed, soldered, or cut
butt joint	A joint between two members aligned approximately in the same plane.
concavity	The maximum distance from the face of a concave fillet weld perpendicular to a line joining the weld toes.

convexity	The maximum distance from the face of a convex fillet weld perpendicular to a line joining the weld toes.
covered electrode	A composite filler metal electrode consisting of a core of a bare electrode or metal cored electrode to which a covering sufficient to provide a slag layer on the weld metal has been applied. The covering may contain materials providing such functions as shielding from the atmosphere, deoxidation, and arc stabilization and can serve as a source of metallic additions to the weld.
crater	In arc welding, a depression at the termination of a weld bead or in the molten weld pool
depth of fusion	The distance that fusion extends into the base metal or previous pass from the surface melted during welding.
DC or direct current	Electric current which flows only in one direction. In welding, an arc welding process wherein the power supply at the arc is direct current.
fillet weld	A weld of approximately triangular doss section joining two surfaces approximately at right angles to each other in a lap joint, T-joint or corner joint.
fillet weld leg	The distance from the joint root to the toe of the fillet weld.
flat position	The welding position used to weld from the upper side of the joint; the face of the weld is approximately horizontal.
flux	Material used to prevent, dissolve, or facilitate removal of oxides and other undesirable surface substances
gas metal arc welding	(GMAW) An arc welding process that produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work. Shielding is obtained entirely from an externally supplied gas or gas mixture.
gas tungsten arc welding	(GTAW) An arc welding process that produces coalescence of metals by heating them with an arc between a tungsten (non-consumable) electrode and the work. Shielding is obtained from a gas or gas mixture. Pressure may or may not be used and filler metal may or may not be used. (This process has sometimes been called TIG welding, a non-preferred term.)
groove weld	A weld made in the groove between the work pieces.
heat-affected zone	That portion of the base metal that has not been melted, but whose mechanical properties or microstructure have been altered by the heat or welding, brazing, soldering, or cutting.
horizontal position	(a) fillet weld - The position in which welding is performed on the upper side of an approximately horizontal surface and against an approximately vertical surface. (b) groove weld - The position of welding in which the weld axis lies in an approximately horizontal plane and the weld face lies in an approximately vertical plane.
joint penetration	The depth a weld extends from its face into a joint, exclusive of reinforcement.
lap joint	A joint between two overlapping members in parallel planes
machine welding	Welding with equipment that performs the welding operation under the constant observation and control of a welding operator. The equipment may or may not load and unload the work pieces.
manual welding	A welding operation performed and controlled completely by hand.
melting rate	The weight or length of electrode melted in a unit of time
open circuit voltage	The voltage between the output terminals of the welding machine when no current is flowing in the welding circuit.

overhead position	The position in which welding is performed from the underside of the joint.
overlap	The protrusion of weld metal beyond the weld toe or weld root.
peening	The mechanical working of metals using impact blows.
porosity	Cavity type discontinuities formed by gas entrapment during solidification.
post heating	The application of heat to an assembly after welding, brazing, soldering, thermal spraying or cutting operation.
pre heating	The application of heat to the base metal immediately before welding, brazing, soldering, thermal spraying, or cutting
root opening	A separation at the joint root between the work pieces.
root penetration	The depth that a weld extends into the joint root.
seal weld	Threaded joint sealed, without thread compound, by back welding.
semiautomatic arc welding	Arc welding with equipment that controls only the filler metal feed. The advance of the welding is manually controlled
shielded metal arc welding	(SMAW) An arc welding process that produces coalescence of metals by heating them with an arc between a covered metal electrode and the workpieces. Shielding is obtained from decomposition of the electrode covering. Pressure is not used and filler metal is obtained from the electrode.
spatter	The metal particles expelled during fusion welding which do not form a part of the weld.
stress relief heat treatment	Uniform heating of a structure or a portion thereof to a sufficient temperature to relieve the major portion of the residual stresses, followed by uniform cooling.
stringer bead	A type of weld bead made without appreciable weaving motion.
tack weld	A weld made to hold parts of a weldment in proper alignment until the final welds are made.
tungsten electrode	A non-filler metal electrode used in arc welding or cutting made principally of tungsten
underbead crack	A crack in the heat-affected zone generally not extending to the surface of the base metal.
undercut	A groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by weld metal
vertical position	The position of welding in which the weld axis is approximately vertical.
weave bead	A type of weld bead made with transverse oscillation.
weld	A localized coalescence of metals or non-metals produced either by heating the materials to welding temperature, with or without the application of pressure, or by the application of pressure alone, and with or without the use of filler material.
weld face	The exposed surface of a weld on the side from which welding was done.
weld metal That	portion of a weld which has been melted during welding.
weld pass	A single progressional of welding or surfacing along a joint or substrate. The result of a pass is a weld bead, layer, or spray deposit.
weld pool	The localized volume of molten metal in a weld prior to its solidification as weld metal. weld root: The points, as shown in cross section, at which the back of the weld intersects the base metal surfaces
weld size	(a) groove weld size - The joint penetration of a groove weld. (b) fillet weld size - For equal leg fillet welds, the leg lengths of the largest

	isosceles right triangle which can be inscribed within the fillet weld cross section For unequal leg fillet welds, the leg lengths of the largest right triangle that can be inscribed within the fillet weld cross section.
weld toe	The junction of the weld face and the base metal
welding procedure	The detailed methods and practices involved in the production of a weldment.
welding rod	A form of welding filler metal, normally packaged in straight lengths, that does not conduct electrical current.
weldment	An assembly whose component parts are joined by welding.

Engineering Glossary	
Acceptance	The process of assessing whether a system satisfies all its requirements
Acceptance test	A test that assesses whether a system satisfies all requirements.
Activity Diagram	A diagram type in UML which models the flow of actions in a system or in a component including the data flows and areas of responsibility where necessary.
Actor	Generally in Requirements Engineering, a person, a system or a technical device in the context of a system that interacts with a system.
Adequacy (of a requirement)	The degree to which a requirement expresses the stakeholders true desires and needs.
Application domain	Those parts of the real world that are relevant for determining the context of a system.
Artifact	An intermediate or final result of system development; for example, a requirements specification.
Attribute	A characteristic property of an entity.
Baseline	A stable, change-controlled configuration of artifacts
Behaviour model	A model describing the behaviour of a system or component
Bug	A defect
Changeability (of an artefact)	The degree to which an artifact enables a required modification of the artifact.
Checking (requirements)	Comprises requirements validation and checking requirements for qualities such as unambiguity or comprehensibility.
Class	Represents a set of objects of the same kind by describing the structure of the objects, the ways they can be manipulated and how they behave.
Completeness (of requirements)	For a single requirement: the degree to which a requirement contains all necessary information which is necessary to for developing a system that satisfies a stakeholders' desires and needs.
Compliance	The capability of an artifact to adhere to standards, regulations, laws, or other formally imposed documents.
Component	In general; a delimit able part of a system.
Configuration	A consistent set of logically coherent units. The units are individually identifiable artifacts in at most one version per unit.
Conformity (of requirements)	A degree to which a requirements specification conforms to regulations given in some standard.
Consistency (of requirements)	The degree to which a set of requirements is free of contradicting statements.
Constraint	A requirement that limits the solution space beyond what is necessary

	for meeting the given functional requirements and quality requirements and quality requirements.
Context	In general; the network of thoughts and meanings needed for understanding phenomena. It is also the part of a system's environment being relevant for understanding the system and its requirements.
Context boundary	Boundary between the context of a system and those parts of the application domain that are irrelevant for the system and its requirements.
Context diagram	A diagrammatic representation of a context model.
Context model	A model describing a system in its context.
Correctness	The degree to which the information contained in an artifact is proven as true this is also a synonym of adequacy.
Customer	A person or organisation who receives a product or service.
Customer requirements specification	A course description of the required capabilities of a system from the customer's perspective.
Dataflow diagram	A diagram modelling the functionality of a system or component by processes (also called activities), data stores and data flows. Incoming data flows trigger processes which then consume the received data, transform them, read/write persistent data held in data stores and then produce new data flows which may be intermediate results that trigger other processes or final results that leave the system.
Defect	A spot in an artifact that is incorrectly described or crafted. It can also be called a fault or a bug.
Domain	A range of relevant things (for some given matter),
Effectiveness	The degree to which something actually happens in the way it ought to happen.
Efficiency	The degree to which a result is achieved with minimum consumption of resources.
End user	User
Entity	In general; an element or set of elements that may stand for any conceivable item, e.g., a system, a part of a reality, a thing, an organisation, a process etc.
Entity relationship diagram	A graphic representation of an entity relationship model.
Estimate	An estimate is the anticipated or probable cost of work and is usually prepared before the construction is taken up. It is indeed calculations or computations of various items of an engineering work.
Error	A discrepancy between an observed or result and the specified behaviour or result. AN error is typically a symptom for the existence of a fault or defect in some artifact. Though there may be not much distinction between the notions of error and fault.
Fault	Defect
Fault tolerance	The capability of a system to continue normal operations despite the presence of (hardware and software)faults.
Feature	A delimitable characteristic of a system that provides value for stakeholders.
Goal	A desired state of affairs that a stakeholder wants to achieve. They

APPENDIX 7: Portfolio

	describe the intentions of stakeholders that may conflict with one another.
Inspection	A kind of review where the artifact under review is inspected by a group of experts according to given criteria. The experts' findings are then collected and consolidated.
Language	A structured set of signs for expressing and communicating information. Signs are elements that are used for communication; expressions in a language, symbols, gestures etc.
Model	An abstract representation of an existing reality or a reality to be created.
Modeling language	A language expressing models of a different kind. Maybe textual, graphic or some combination thereof.
Patent	An intellectual property right granted by the government to an inventor for a limited time in exchange for public disclosure of the invention when the patent is granted. • Utility patents - may be granted to anyone who invents or discovers new and useful process, machine, article of manufacture, or composition of matter. • Design patents - may be granted to anyone who invents a new, original and ornamental design for an article of manufacture. • Plant patents - may be granted to anyone who invents or discovers and asexually reproduces any distinct and new variety of plant
Performance requirement	A requirement describing a performance characteristic (timing, speed, volume, capacity
Prototype	In manufacturing; a piece which is built prior to the start of mass production.
Quality	The degree to which a set of inherent characteristics of an entity fulfils requirements.
Redundancy	Multiple occurrence of the same information or resource.
Reliability	The capability of a system to maintain a specified level of functionality and performance when used under specified conditions.
Requirement	A condition or capability needed by a user to solve a problem or achieve an objective.
Requirements analysis	Analysis of elicited requirements in order to understand and document them.
Requirements baseline	A baseline for a set of requirements.
Requirements engineer	A person who- in collaboration with stakeholders-elicits, documents, validates and manages requirements.
Review	A formally organised endeavour for checking an artifact by a group of experts. Checking may be performed with respect to both contents and conformance.
Risk	AN event that threatens the success of an endeavour. A risk is assessed in terms of its probability and potential damage.
Safety	The capability of a system to achieve an acceptable level of probability that operating the system will not result in harming people, property or the environment.
Scope (of a system)	The range of things that can be shaped and designed when developing a system.
Security	The capability of a system to protect (a) its data and resources against unauthorised use and (b) its legitimate users against denial of service.
Sequence diagram	A diagram type in UML which models the interactions between a

	selected set of objects and/ or actors in the sequential order that those interactions occur.
Specification	A systematically represented description of the properties of an entity (a system, a device, etc.) that satisfies criteria.
Stakeholder	A person or organisation that has a (direct or indirect) influence on a systems requirements.
Standard	A uniform regulation for perceiving, manufacturing or executing something. Standards are voluntary guidelines but using them is highly recommended because they promote safety and are widely used across industry.
System context	A requirement
System requirements specification	A requirements specification pertaining to a system.
Technical report	Technical report describes the progress or results of technical or scientific research.
Tool (in software engineering)	A (software) system that helps develop, operate and maintain systems.
Traceability (of requirements)	The ability to trace a requirement(1) back to its origins, (2) forward to its implementation in design and code,(3) to requirements it depends on (and vice-versa). Origins maybe stakeholders, documents, rationales, etc.
UML	Abbreviation for Unified Modeling Language, a standardised language for modelling problems or solutions
Useability	The capability of a system to be understood, learned, used, and liked by its users.
Use case	A description of the interactions possible between actors and a system. The boundary between the actors and the use cases constitutes the system boundary.
Use case diagram	A diagram type in UML that models the actors and the use cases of a system.
User	A person who uses the functionality provided by a system. Also called an end user.
Validation (of requirements)	The process of checking whether documented requirements match the stakeholders' needs.
Verifiability (of requirements)	The degree to which the fulfilment of a requirement by an implemented system can be checked. E.g. by defining acceptance test cases, measurements or inspection procedures.
Version (of an entity)	If an entity exists in multiple exists in multiple, time ordered occurrences, where each occurrence has been created by modifying one of its predecessors, every occurrence is a version of that entity.
View	An excerpt from an artefact, containing only those parts one is currently interested in. A view can abstract or aggregate parts of the artefact.
Viewpoint	A certain perspective on the requirements of a system.
Walkthrough	A kind of review where the author of an artefact under review walks a group of experts systematically through the artefact. The experts' findings are then collected and consolidated.

Books

NDoE, (2019) *Technology and Industrial Arts Grades 9 and 10 Syllabus*, NDoE
NDoE, (2019) *Technology and Industrial Arts Grades 11 and 12 Syllabus*, NDoE

Websites

Building

https://silo.tips/download/carpentry-for-vocational-schools-a-teachers-handbook,Carpentry for vocational schools
Building Design and Construction hand book
Structural drawings
Manual for Occupational Health and safety
Estimating and costing text book

Electrical

https://en.wikipedia.org/wiki/Electricity_generation (Edition of 1st December 2019)
https://www.siyavula.com/read/science/grade-9/cost-of-electrical-energy/21-cost-of-electrical-energy
https://www.dcccd.edu/cd/dcc/constr/electech/pages/careers.aspx
(Dallas community college District)
https://science.howstuffworks.com/environmental/energy/circuit2.html
https://www.dfliq.net/blog/5-electrical-problems-everyone-must-know/ D&F Liquidators l Copyright © 2018 l All Rights Reserved
.(https://www.conserve-energy-future.com/sustainableenergy.php by Rinkesh)
(https://www.learnhowtobecome.org/electrical-engineer/
Katahira & Engineers International (http://open_jicareport.jica.go.jp/pdf/12286803.pdf)
https://www.arcadiaalive.com/human-factors-and-non-technical-skills-training/programmes-overview/personal-safety-workshop/
http://zebu.uoregon.edu/disted/ph162/lec04.html
https://www.thoughtco.com/what-is-electricity-4019643
https://circuitglobe.com/difference-between-conductor-and-insulator.html
https://circuitglobe.com/difference-between-conductor-and-insulator.html
https://isaacphysics.org/concepts/cp_kirchhoffs_laws
(https://en.wikipedia.org › wiki › Electrical_safety_standards)
https://www.ecmweb.com/code-basics/adequate-workspace-keeps-electricians-safe
http://electricsaverstips.blogspot.com/2012/02/tips-to-save-on-electricity-it-is.html
https://www.lifewire.com/microsoft-office-4156573
https://study.com/what_is_auto_cad.html
https://www.inc.com/business-insider/email-etiquette-rules.html
https://www.business.com/articles/types-of-phone-systems
https://blog.hubspot.com/service/phone-etiquette
https://www.enggarena.net/classification-of-engineering-materials/

Plumbing

Plumbing- Better Homes and Gardens, https://en.wikipedia.org/wiki/Plumbing)

Plumbing- Better Homes and Gardens, https://en.wikipedia.org/wiki/Plumbing)
Plumbing –Better Homes and Gardens; Step-by-step Instructions)
Plumbing, Better Homes and Gardens-Step-by-step Instructions.
Basic Building and construction skills -4th edition, https://en.wikipedia.org/wiki/Plumbing)
(https://www.careersinconstruction.ca/.../pdf/Essential_skills/es_using_trades_math.pdf)
https://www.homedepot.com/c/ab/impact-drivers-vs..

Welding

https://weldingheadquarters.com/how-to-read-welding-blueprints/
https://www.highspeedtraining.co.uk/hub/welding-hazards-in-the-workplace/
MFW (Metal Fabrication and Welding) Industry standards, Setting up a safe welding shop, Workshop rules and safety considerations
https://en.wikipedia.org/wiki/List_of_welding_codes
https://www.interexchange.org/articles/career-training-usa/2012/05/24/imperial-vs-metric-system/
file:///C:/Users/Able%20Valued%20Client/Desktop/Assigned%20Task-Welding%20Tech/measurements_05_measurements_of_length_time_and_mass_compatibility_mode1.
https://www.lincolntech.edu/news/skilled-trades/welding-technology/types-of-welding-procedures

Engineering

https://www.linkengineering.org/Explore/what-is engineering/engineerhttps://en.wikipedia.org/wiki/Engineering
https://pressbooks.bccampus.ca/engineeringinsociety/chapter/chapter-1/
Chen Wai-Fah, (1999) Front matter"*Structural Engineering Handbook,* Ed. Boca Raton: CRC Press LLC,
Fiona Cobb, (2017)Structural Engineer's Pocket Book, CRC Press,
https://www.linkengineering.org/Explore/what-is-engineering/engineer
https://www.linkengineering.org/explore/engineerinring/dictionary
https://fileadmin.cs.lth.se/cs/Education/ETS170/IREB_CPRE_Glossary_14.pdf

APPENDIX 1: BLOOM'S TAXONOMY

LEVEL OF UNDERSTANDING	KEY VERBS
CREATING **Can the student create a new product or point of view?**	Construct, design, and develop, generate, hypothesize, invent, plan, produce, compose, create, make, perform, plan, produce, assemble, formulate,
EVALUATING **Can the student justify a stand or decision?**	Appraise, argue, assess, choose, conclude, critique, decide, defend, evaluate, judge, justify, predict, prioritize, provoke, rank, rate, select, support, monitor,
ANALYZING **Can the student distinguish between the different parts?**	Analyzing, characterize, classify, compare, contrast, debate, criticise, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organize, outline, relate, research, separate, experiment, question, test,
APPLYING **Can the student use the information in a new way**	Apply, change, choose, compute, dramatize, implement, interview, prepare, produce, role play, select, show, transfer, use, demonstrate, illustrate, interpret, operate, sketch, solve, write,
UNDERSTANDING **Can the student comprehend ideas or concepts?**	Classify, compare, exemplify, conclude, demonstrate, discuss, explain, identify, illustrate, interpret, paraphrase, predict, report, translate, describe, classify,
REMEMBERING **Can the student recall or remember the information?**	Define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, tell, write, duplicate, memorise, recall, repeat, reproduce, state,

APPENDIX 2: 21ST CENTURY SKILLS

WAYS OF THINKING	**Creativity and innovation** • Think creatively • Work creatively with others • Implement innovations **Critical thinking, problem solving and decision making** • Reason effectively and evaluate evidence • Solve problems • Articulate findings **Learning to learn and meta-cognition** • Self-motivation • Positive appreciation of learning • Adaptability and flexibility
WAYS OF WORKING	**Communication** • Competency in written and oral language • Open minded and preparedness to listen • Sensitivity to cultural differences **Collaboration and teamwork** • Interact effectively with others • Work effectively in diverse teams • Prioritise, plan and manage projects
TOOLS FOR WORKING	**Information literacy** • Access and evaluate information • Use and manage information • Apply technology effectively **ICT literacy** • Open to new ideas, information, tools and ways of thinking • Use ICT accurately, creatively, ethically and legally • Be aware of cultural and social differences • Apply technology appropriately and effectively
LIVING IN THE WORLD	**Citizenship – global and local** • Awareness and understanding of rights and responsibilities as a global citizen • Preparedness to participate in community activities • Respect the values and privacy of others **Personal and social responsibility** • Communicate constructively in different social situations • Understand different viewpoints and perspectives **Life and career** • Adapt to change • Manage goals and time • Be a self-directed learner • Interact effectively with others

APPENDIX 3: TEACHING AND LEARNING STRATEGIES

STRATEGY	TEACHER	STUDENTS
CASE STUDY **Used to extend students' understanding of real life issues**	Provide students with case studies related to the topic of the lesson and allow them to analyse and evaluate.	Study the case study and identify the problem addressed. They analyse the problem and suggest solutions supported by conceptual justifications and make presentations. This enriches the students' existing knowledge of the topic.
DEBATE **A method used to increase students' interest, involvement and participation**	Provide the topic or question of debate on current issues affecting a bigger population, clearly outlining the expectations of the debate. Explain the steps involved in debating and set a criteria/standard to be achieved.	Conduct researches to gather supporting evidence about the selected topic and summarising the points. They are engaged in collaborative learning by delegating and sharing tasks to group members. When debating, they improve their communication skills.
DISCUSSION **The purpose of discussion is to educate students about the process of group thinking and collective decision.**	The teacher opens a discussion on certain topic by asking essential questions. During the discussion, the teacher reinforces and emphasises on important points from students responses. Teacher guide the direction to motivate students to explore the topic in greater depth and the topic in more detail. Use how and why follow-up questions to guide the discussion toward the objective of helping students understand the subject and summarise main ideas.	Students ponder over the question and answer by providing ideas, experiences and examples. Students participate in the discussion by exchanging ideas with others.
GAMES AND SIMULATIONS **Encourages motivation and creates a spirit of competition and challenge to enhance learning**	Being creative and select appropriate games for the topic of the lesson. Give clear instructions and guidelines. The game selected must be fun and build a competitive	Go into groups and organize. Follow the instructions and play to win

	spirit to score more than their peers to win small prices.	
OBSERVATION **Method used to allow students to work independently to discover why and how things happen as the way they are. It builds curiosity.**	Give instructions and monitor every activity students do	Students possess instinct of curiosity and are curious to see the things for themselves and particularly those things which exist around them. A thing observed and a fact discovered by the child for himself becomes a part of mental life of the child. It is certainly more valuable to him than the same fact or facts learnt from the teacher or a book. Students Observe and ask essential questions Record Interpret
PEER TEACHING & LEARNING ***(power point presentations, pair learning)*** **Students teach each other using different ways to learn from each other. It encourages; team work, develops confidence, feel free to ask questions, improves communication skills and most importantly develop the spirit of inquiry.**	Distribute topics to groups to research and teach others in the classroom. Go through the basics of how to present their peer teaching.	Go into their established working groups. Develop a plan for the topic. Each group member is allocated a task to work on. Research and collect information about the topic allocated to the group. Outline the important points from the research and present their findings in class.
PERFORMANCE-RELATED TASKS ***(dramatization, song/lyrics, wall magazines)*** **Encourages creativity and take on the overarching ideas of the topic and are able to recall them at a later date**	Students are given the opportunity to perform the using the main ideas of a topic. Provide the guidelines, expectations and the set criteria	Go into their established working groups. Being creative and create dramas, songs/lyrics or wall magazines in line with the topic.
PROJECT (individual/group) **Helps students complete tasks individually or collectively**	Teacher outline the steps and procedures of how to do and the criteria	Students are involved in investigations and finding solutions to problems to real life experiences. They carry out researches to analyse the causes and effects of problems to provide achievable solutions. Students carefully utilise the problem-solving approach to complete projects.
USE MEDIA & TECHNOLOGY to teach	Show a full movie, an animated one, a few	Viewing can provoke questions, debates, critical thinking, emotion and

and generate engagement <u>depending on the age of the students</u>	episodes form documentaries, you tube movies and others depending on the lesson. Provide questions for students to answer before viewing	reaction. After viewing, students engage in critical thinking and debate

APPENDIX 4: STEAM

This Sample STEAM Lesson Planning is for Business Studies but can be applied to Technology and Industrial Arts.

Strand 2: Business Management

Unit 5: Information Technology

Content Standard 2.5: Students will be able to explain the information technology concepts and examine the systems and tools needed to gather, access, analyse, synthesize, evaluate, manage, and disseminate information.

Benchmark: 12.2.5.2. Explain the steps involved in entering and manipulating text and data using a variety of input technologies.

Topic: Steps in entering and manipulating text and data using a variety of input technologies

Learning Objective: By the end of this topic, students will be able to explore the steps in entering and manipulating text and data using a variety of input technologies.

Purpose of Assessing the Topic (Benchmark):
To assess whether students can be able to use the MS Excel to positively explore the steps in entering and manipulating text and data using a variety of input technologies

How the Performance Task will be done: Group Project Presentation

Performance Standard: By the end of the project, students will be able to use the MS Excel application to positively explore the steps in entering and manipulating text and data using a variety of input technologies.

Situation (Authentic)

Your school should have been accounting for all the stock of the materials it has. The stocks of materials may include the materials like all the electronic equipment, the tools in the tool store, the sports equipment and materials and the departmental equipment and materials. There is a manual stock taking system (stock book) to take stock of all the equipment and materials in the

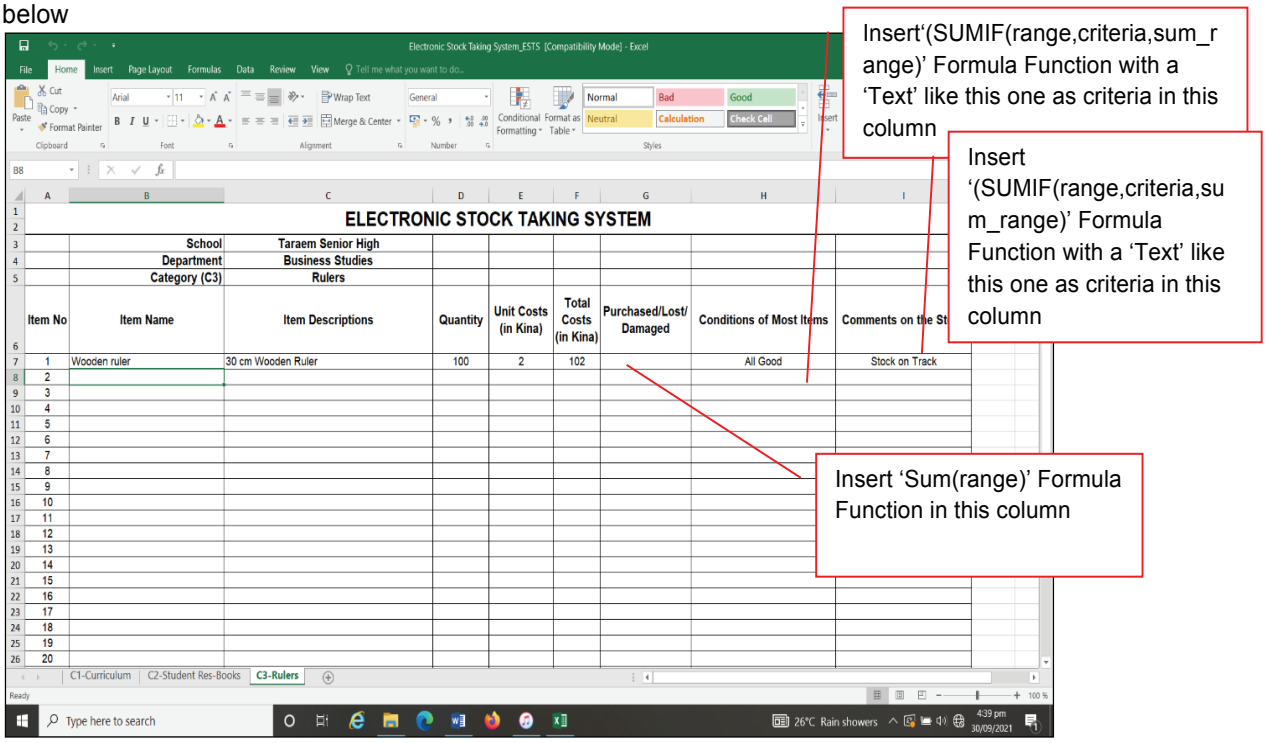
school. With the manual stock taking system currently used in schools, the Principal and the teachers have experiences with improper stocks quantity checks and stocks updates.

When this was report by the Principal in a BOG meeting, the BOG moved a motion for the development of a functional Electronic Stock Taking System (ESTS) using the current available technology. In order to meet the expectations of the BOG, the principal and teachers task the Grade 12 students to participate in the creation of the ESTS using the MS Excel application.

To achieve this, the school is now requesting the Business Studies Department to design an Assessment Task for a grade to assist and guide the activity. The Business Studies Department has opted to design the Task for Grade 12 students as one of their projects towards their assessments. The school principal also announces that the best ESTS assessed by the Business Studies Department will be rewarded as it is also a competition.

Task Descriptions:

- Select a Subject Department or a Specialist Room (Store-room, Tool-room) in your school to Collect Data of different items for your Electronic Stock Taking System (ESTS) project.
- Plan and write the steps of creating the Electronic Stock Taking System.
- Use the steps to design and create the ESTS using the MS Excel application like the sample format below



- The ESTS must contain appropriate contents and formulae functions.
- It must also contain comments to justify the status of the individual stocks.
- This ESTS has to be user-friendly to the school officials to use.
- Presentation of the MS Excel of ESTS must not be more than 2 minutes (maximum time limit)
- Submit your MS Excel ESTS for assessment.
- Whole class to observe and use the rubric below to assess the Presentation of the MS Excel of ESTS.

Materials: Computer, Tablets, Smartphones, MS Excel Application

Related Benchmarks to this Business Studies Benchmark in Business Studies and other Subject areas:

Subjects	Reference Benchmark Codes
8. Arts (Visual Arts)	12.3.2.2
9. Character Social Development (CSD)	12.1.5.2, 12.1.5.3
10. English	12.2.1.2
11. Business Studies	12.2.5.1
12. General Mathematics	12.4.1.3
13. Technology Industrial Arts (TIA)	12.4.1.4

A Sample Scoring Rubric

Annotation 1
A statement (descriptors) describing the expected the level of competency for each prescribed criteria

Annotation 2
Rating scales includes either numerical or descriptive labels

Annotation 3
Indicators or qualifiers ensures that the levels reflect variance in quality

Annotation 4
Shaded descriptors indicating Student's Marks for the corresponding

Criteria	Achieved 3	Progressing 2	Novice 1	Scoring
Collecting Data for Electronic Stock Taking System (ESTS)	**Well** organized paper with **clarity** identifying, classifying and enumerating the different items.	Organized paper with some **clarity** identifying, classifying and enumerating the different items.	**Poorly** organized paper that lacked **clarity** identifying, classifying and enumerating the different items.	2/3
Development of ESTS	**Collaboratively organise** and categorise data of different items. Illustrate the **most likeable** way the Data can displayed in the MS Excel Application format.	Display **some collaboration** to organise and categorise data of different items. Illustrate a **likeable** way the Data can displayed in the MS Excel Application format.	Display **very little collaboration** to organise and categorise data of different items. Illustrate a way the Data can displayed in the MS Excel Application format.	1/3
Content and Formulae Functions in ESTS	Typed **accurately all the appropriate contents** for each columns and typed in the **all correct** formulae function symbols for the 'SUMrange function'	Typed **most contents** in their **appropriate** columns and typed in **most** of the **correct** formulae function symbols for the 'SUMrange function' and 'SUMIF	Typed **very few contents** in their **appropriate** columns and typed in **very few** formulae function symbols for the 'SUMrange function' and 'SUMIF function'	3/3

	and 'SUMIF function' in **all** their correct MS Excel cell references	function' in **some** of their MS Excel cell references	in **very few** of their MS Excel cell references	
Presentation of ESTS	**Displayed time consciousness** with **adequate** delivery skills (posture, language), **expected** communication skills and social skill (relativity and connectivity)	**Mostly** time consciousness with **some adequate** delivery skills (posture, language), **some** expected communication skills and **some** social skill (relativity and connectivity) displayed	**Very little** time consciousness with **little adequate** delivery skills (posture, language), **little** expected communication skills and **little** social skill (relativity and connectivity) displayed	3/3
Portfolio of ESTS Developments and MS Excel ESTS – The Product	A **comprehensive** portfolio with **all** the Steps in planning, designing and developing the ESTS with a **complete** and **functional** MS Excel of the ESTS.	A portfolio with **most** of the Steps in planning, designing and developing the ESTS with a **complete** and **malfunctioned** MS Excel of ESTS.	A portfolio with **very few** of the Steps in planning, designing and developing the ESTS with an **incomplete** and **malfunctioned** MS Excel of ESTS.	3/3
				12/15

A Sample Portfolio

1. Idea Generation

a. Inform the students that most the projects (like shirt, bowl, furniture) are based on existing ideas to solve a problem. Ask the students to choose from these list words/phrase (**substitute, combine, adapt, modify, put to another use, eliminate, reverse/rearrange**) one word/phrase that provokes your thoughts about their project idea to solve an existing problem. The word/phrase selected by students will direct the approach the students take towards the ideas of the students projects.

Write this word/phrase in the space provided below.

_____

b. Guide the students to explain how this word/phrase is in line with their ideas of a project.

_____

_____

_____

c. Assist students to develop an inquiry question based on their project idea.

_____

2. Research

Inform the students that their project idea needs to be validated to ensure that the product get the people who will pay for it and that they won't waste time, money, and effort on an idea that won't sell.

a. Students to validate the product ideas by to conducting a survey to get feedbacks from the potential buyers. The students will have to prepare a survey questionnaire with a number of essential questions on their product ideas like the one below.

***Survey on Project Idea**: (Name of the project idea)*

1) Explain how useful is the furniture/garment to you?

_____

2) Explain how often do you have this dish?

_____

3) How much would you like to spend on this garment/furniture if you intend to buy it?

_____

b. At this stage, students should consider the **Safety precautions** to be taken in the stages of **Planning, Prototyping, Production and Marketing**. They can do this by responding to related questions as show in the examples below.

1) What is the First aid symbol?

Students draw the FIRST AID SYMBOL here

2) Explain what is workshop safety?

_____
_____
_____

3) How can safety be enforced in working practices to minimize the risks associated working environment?

_____
_____
_____

4) In the following stages (**Planning, Prototyping, Production and Marketing**), the students will draw 2 items/tools and describe the type of injury that may occur through the incorrect use of each of the items/tools

1. Planning Stage	
Item/Equipment/Tool	***Injury that may occur***
Name: _____ *(Drawing of the item/equipment/tool)*	*1.*
	2.
	3.
Name: _____ *(Drawing of the item/equipment/tool)*	*1.*
	2.
	3.
2. Prototyping Stage	
Name: _____ *(Drawing of the item/equipment/tool)*	*1.*
	2.
	3.
Name: _____ *(Drawing of the item/equipment/tool)*	*1.*
	2.
	3.

5) The students will have state what action they should take to assist the teacher next to each of the injuries described below.

Injury	***Action taken by student***
A student using knife a cuts his/her finger.	*1.*
	2.
A student cooking burns his/her hand on a hot pot	*1.*
	2.

3. Planning

Explain to the students that it is important to take the time to plan carefully before they begin to build your prototype. They need to decide on a number thing when building their prototype. Inform the students characteristics of materials/food to be used texture, design, hardness, durability and colour) etc. All of these is determine by the purpose and the function of the project.

a. Tasting

1) In terms food, students need to actually taste ingredients separately first and after the different ingredients are combined. They will also identify the various ways to cook them. Students will have find out ways to improve the taste for their intended project dish.

b. Sketching

1) In terms of fabric garments and construction technology projects, students have to sketches of the various prototypes needs to prepared and evaluated for their practicality and usefulness. They also need to consider the purpose and function of their project for they will determine the materials to be used, the characteristics for the materials to be used. Students have to determine ways to improve the design of their fabric garment and construction technology projects.

4. Prototyping

a. For Fabrics and construction technology, the students will have to select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards. Students evaluate their prototype and make appropriate changes on the detailed working diagrams/patterns/templates to meet the ergonomics standards.

b. As for food, students written up a recipe and cook sample dishes various ways. Students will make appropriate taste evaluation of each dish to select the one to use as the project.

5. Production

a. Students need to be selective gathering the required materials and food ingredients as per their materials/recipe list to for the project based on their prototypes and the ergonomics standards. This is because of the conditions of the raw materials to be used for their project. The materials have to be evaluated for defects or damages acquired by the materials to select the appropriate materials. Students should select the materials according to the descriptions of materials needed for their project.

b. For Food, students have to use the confirmed recipe from the prototype to prepare and create the dish.

c. Students will use the confirmed outlined garment patterns/templates to measure and cut out the material list for their project. For technology construction, students utilise the confirmed cutting list and the detailed working diagram to cut out the materials for their project like the one below.

Project Name	
Total Unit (No of Project)	

Material List				
Quantity	**Name of Material(s)**	**Description(s)**	**Unit Cost**	**Total Cost**

d. While working on the projects, the students will have to fill in and complete the table of the Procedures in the Production of their project

Procedure (How to make my Project)

NO	OPERATIONS	NEEDED TOOLS/EQUIPMENT
1		
2		
3		
4		
5		
6		
7		

6. Costing

a. The students are required to calculate the cost of their project. To calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per hour) and these adds up to the selling/marketing cost. Students have to add 30% markup of the selling/marketing cost to determine the selling price.

b. Students should also evaluate the responses from product research survey as they could influence the cost the project.

c. The cost for making the project are:

4) Material costs: K____

5) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____

6) Selling/Marketing cost: K____

g. Students will use the simple formula below to calculate a good markup percentage for their project:

MARKUP PERCENTAGE = (SELLING PRICE – UNIT COST) / UNIT COST x 100%

h. They simply take the sales price minus the unit cost, and divide that number by the unit cost. Then, multiply by 100 to determine the markup percentage.

For example, if the project costs K50 to make and the selling price is K75, then the markup percentage would be 50%: (K75 – K50) / K50 = 0.50 x 100 = 50%.

7. Marketing

a. Students need to review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project.

b. Students could put out flyers, brochures and posters to promote the completed project to the public.

c. Students could create promotional webpages on social media to market the product

A Sample Student Self-Assessment

Student Self-Assessment/Teacher Assessment				**Date: / /**
Project Name:				**Term:**
Student Name:		**Grade:**	**Class:**	**Total Score:**

		Give yourself a score of 3, or 2, or 1, or 0 for performances				Teacher scores of students' performances			
	CRITERIA	**Students' scores**				**Teacher's scores**			
		3	**2**	**1**	**0**	**3**	**2**	**1**	**0**
1	**Idea Generation** a. Selection of word/phrase in line with project idea								
	b. Explanation of the word/phrase in-line with project and development of main issue question								
2	**Research** a. Development of a survey questionnaire with a number of essential questions on their project ideas								
	b. Safety for stages of **Planning, Prototyping, Production and Marketing**. i. Draw safety precaution sign								
	ii. Tool/items and injuries that may occur								
	iii. Injuries and actions taken by students								
3	**Planning** a. Identify the various ways to cook them and find out ways to improve the taste for their intended project dish								
4	**Prototyping** a. Select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards								
5	**Production** a. Select the materials according to the descriptions of materials needed for their								

	project.								
6	**Costing** a. Calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per hour) and these adds up to the selling/marketing cost.								
7	**Marketing** a. Review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project. b. Create promotional webpages on social media to market the product								

A Sample Peer Student Assessment

Student Self-Assessment/Teacher Assessment									**Date: / /**			
Project Name:									**Term:**			
Student Name:					**Grade:**				**Total Score: /**			
Peer's Name:					**Class:**							
		Give yourself a score of 3, or 2, or 1, or 0 for performances				Give your peer a score of 3, or 2, or 1, or 0 for performances				Teacher scores of students' performances			
	CRITERIA	**Students' scores**				**Peer's scores**				**Teacher's scores**			
		3	**2**	**1**	**0**	**3**	**2**	**1**	**0**	**3**	**2**	**1**	**0**
1	**Idea Generation** c. Selection of word/phrase in line with project idea												
	d. Explanation of the word/phrase in-line with project and development												

	of main issue question												
2	**Research** c. Development of a survey questionnaire with a number of essential questions on their project ideas												
	d. Safety for stages of **Planning, Prototyping, Production and Marketing**. iv. Draw safety precaution sign												
	v. Tool/items and injuries that may occur												
	vi. Injuries and actions taken by students												
3	**Planning** b. Identify the various ways to cook them and find out ways to improve the taste for their intended project dish												
4	**Prototyping** b. Select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards												
5	**Production** b. Select the materials according to the descriptions of materials needed for their project.												
6	**Costing** b. Calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per												

	hour) and these adds up to the selling/marketing cost.												
7	**Marketing** c. Review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project. d. Create promotional webpages on social media to market the product												

Samples of Student Response System Applications

These are web based apps that work with a multitude of devices and operating systems. Here are the 4 best student response systems that interface with multiple devices.

1. Kahoot

Kahoot is a utility that allows teachers to create quizzes and surveys, and then send them to students. Teachers may allow students an unlimited amount of time to respond to questions, or they may set a time limit on each questions. Points are awarded to students both for correct answers and for responding quickly with those correct responses. Teachers can track students as they make progress.

2. Socrative

Socrative works excellently both for students working on their own or for students who are collaborating with one another. Socrative offers several different ways for instructors to engage their students. There are space races in which students can compete in teams or as individuals to answer questions as quickly and accurately as possible. Polls allow instructors to receive student feedback.

3. Infuse Learning
Infuse learning is (was!) an excellent student response system for teachers who must support students with a variety of learning styles. With infusion a teacher can create questions, quizzes and writing prompts and send them to students who are participating in virtual classrooms or in an online learning program. What makes Infuse Learning unique is that it allows the teacher to give the student multiple response options.

4. Verso

This is a free utility that teachers can use to create virtual classrooms. Verso works with the teacher's Google Drive account. This means that links, files, videos, images, and documents from the instructor's Google Drive can be added to the Verso classroom for students to access. Students who enter the classroom will be shown new items that have been added to the classroom since their last visit.

https://www.emergingedtech.com/2015/09/top-5-multi-platform-student-response-systems/

APPENDIX 5: LESSON PLAN TEMPLATE

Strand: ……

Unit: ……..

Content Standard: .....

Benchmark: ……..

Topic 1: ……..

Lesson Topic: ……

Instructional Objective (s): By the end of the lesson, students will be able to;

- ……
- ……
- ……

Essential Questions:

- ……..
- ……..
- ……....

Knowledge:

- ……..
- ……..

Skill(s):

- ……
- ……

Values:

- ……
- ……...

Attitudes:

- ……...
- ……...

Teaching and Learning Strategies

Teacher will …..	Student will ….
Introduction (time in minutes)	
Body (time in minutes)	
Modeling	
Guided Practice	
Independent Practice	
Conclusion (time in minutes)	

APPENDIX 6: ASSESSMENT TEMPLATE

Performance Assessment Template

Subject: _____

Strand:_____

Unit: _____

Content Standard: _____

Benchmark: _____

Topic: _____

Learning Objective: _____

Purpose of Assessment: _____

Assessment Strategy: _____

Duration: _____

Time/Date of Administration: _____

Due Date/Time: _____

Performance Standard: _____

Performance Tasks

Performance Assessment Criteria:_____

Assessment Scoring: _____

Scoring Tool: _____

APPENDIX 7: Portfolio

(Business Studies, Technology & Industrial Arts and CCVE subject Specific)

This refers to a collection of student work and additional information gathered over a period of time that demonstrates learning progress.

Sample Student Portfolio Template

STUDENT PROJECT PORTFOLIO NO: _____

NAME: _____ **CLASS**: _____ **TERM**: _____ **DATE**: ___/___/___

SUBJECT: _____

STRAND: _____

UNIT: _____

CONTENT STANDARD #: _____

_____
_____
_____

BENCHMARK #: _____

_____
_____
_____

5. **NAME OF PROJECT:** _____
6. **PURPOSE OF THE PROJECT**: (State briefly the reason why you will make the project. Have a complete visualization of any project you wish to make so as to know its usefulness)

   a) _____

   b) _____

7. **Idea Generation**

   a. Most projects are based on existing ideas. Choose from these list words/phrase (**substitute, combine, adapt, modify, put to another use, eliminate, reverse/rearrange**) one word/phrase that provokes your thoughts about your project and goes in line with your own ideas about your project. Write this word/phrase in the space provided below.

   _____

b. Explain how this word/phrase is in line with your ideas about your own project.

_____

_____

_____

8. Research

Your project idea needs to be validated to ensure you're creating a product people will pay for and that you won't waste time, money, and effort on an idea that won't sell. There are several ways you can validate your product ideas, including:

a. Talking about your idea with family and friends. If you decide to use this validation method, prepare a sheet to record your feedbacks like the one below.

Your Project Idea:	(*Write down your project idea*)

Family and friends Names	**Feedbacks/Responses**
1.	
2.	
3.	
4.	

b. Sending out a survey to get feedback. If you decide to use this validation method, prepare a survey questionnaire like the one below.

Survey on Project Idea: (*Write down your project idea*)

i) Explain how useful is the furniture/garment to you?

_____

ii) Explain how often do you have this dish?

_____

iii) How much would you like to spend on this garment/furniture if you intend to buy it?

_____

c. Consider **Safety precautions** to be taken in the stages of **Planning, Prototyping, Production and Marketing**.

i) Elementary first aid and procedures: What is the First aid symbol?

Draw the FIRST AID SYMBOL here

ii) Explain what is workshop safety?

_____
_____

iii) How can safety be enforced in working practices to minimise the risks associated working environment?

_____
_____

d) For each of the following stages (**Planning, Prototyping, Production and Marketing**), draw 2 items/tools and describe the type of injury that may occur through the incorrect use of each of the items/tools

3. Planning Stage	
Item/Tool	**Injury that may occur**
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
4. Prototyping Stage	
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.

e) For each of the injuries described below, state what action you should take to assist the teacher.

Injury	Action taken by student
A student using knife a cuts his/her finger.	1.
	2.
A student cooking burns his/her hand on a hot pot	1.
	2.

9. Planning

It's important to take the time to plan before you begin to build your prototype.

Tasting

In terms food, ingredients have to be tasted separately and combination of different ingredients needs to tasted together to select a prototype.

Sketching

In terms of fabric garments and technology projects, sketches of the various prototypes needs to prepared and evaluated for their practicality and usefulness

10. Prototyping

a. Selected projects sketches will be made into prototypes, be sampled and detailed.
b. As for food, a recipe would be outlined and cooked to make a sample dish. Make appropriate taste evaluation to improve the dish
c. Fabric garments and technology projects create detailed working diagrams from the prototype for patterns or templates if required.

11. Production

a. Gather the required materials and food items as per your list to for the project idea.

b. For Food, use the confirmed recipe from the prototype to prepare and create the dish.

c. Use the confirmed outlined garment patterns/templates to measure and cut out the material pieces for your project idea.

d. For technology construction, use the confirmed cutting list and the detailed working diagram to cut out the materials for your project

Product Name	
Total Unit (No of Project)	

Material List

Quantity	Name of Material(s)	Description(s)	Unit Cost	Total Cost

e. Complete the table of the Procedures in the Production

Procedure (How to make my Project)

NO	OPERATIONS	NEEDED TOOLS/EQUIPMENT
1		
2		
3		
4		
5		
6		
7		

12. Costing

d. The cost for making the T-shirt are:

7) Material costs: K____

8) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____

9) Selling/Marketing cost: K____

You could add a ____% markup on top of the K___ total it cost to make your product as the "plus" of cost-plus pricing. Here's what the formula looks like:

Cost (K____) x Markup (K____) = Selling price (K___)

13. Marketing

a. Review the responses/feedback from the Surveys done for the project idea and inform the interested people of the completed project

b. Put out fliers to advertise the project to public

c. Use social media to market the product

Scoring of Performance for Formative Assessment

(Assessment as/while learning and Assessment for learning)

1. Scoring Assessment using Rating Scale

Rating Scales are a type of checklists that judge the degree to which a criteria is met. They generally have a scale of between 1-6 options.

Assessment Performance Records for Term to give grading

Student's performance in any assessments must be recorded to obtain a final score to be able to give a grading.

Subject/Strand: _____Grade/Class:_____ Term____

NO	Name	Project 20 marks	Test 1 15 marks	Test 2 10 marks	Portfolio 10 marks	Moderation 30 marks	Participation 5 marks	Total Raw Score
1	Gill							/ 100
2	Jill							/ 100
3	Zill							/ 100
4	Bill							/ 100
Etc.								/ 100

‘ISSUE FREE NOT FOR SALE’