Technology and Industrial Arts

Food Technology

Senior High
Grade 11

Teacher Guide

Standards-Based

Department of Education

Technology and Industrial Arts

Food Technology

Junior High

Grade 11

Teacher Guide

Standards-Based

Papua New Guinea
Department of Education

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Content

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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

Secretary's Message

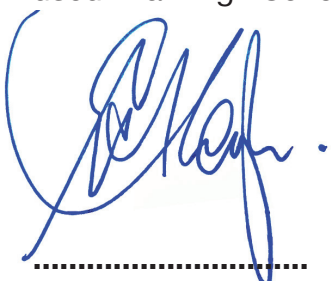
The ultimate aim of Standards-Based Education in Papua New Guinea (PNG) is to prepare students for careers, higher education, and citizenship. This means that education should focus on developing and equipping students with essential knowledge, skills, values, and attitudes that they can use in all aspects 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.

Food Technology is a rigorous and multidisciplinary field that applies science, engineering, and innovation to the production, processing, preservation, and distribution of food. As the country and the world faces various challenges such as population growth, climate change, food security, and consumer demands, the subject is designed to equip students with the skills, knowledge, and competencies to address these issues and create sustainable and nutritious food solution.

Food Technology as a subject 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 Food 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 learning needs of the students.

I commend and approve this Grade 11 Food Technology Teacher Guide to be used in all High Schools throughout Papua New Guinea.



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UKE W KOMBRA, PhD
Secretary for Education

Introduction

Food Technology aims to equip students with the 21st century skills in critical creativity, decision making and collaboration in producing design products.

The overall study of Food Technology in this guide caters for all students' needs and interest by which it promotes integral human development, provides both vocational and life experiences relevant to equip a student to apply in local, national, domestic, commercial, industrial and global settings. The growing introduction of processed food has contributed to the changes of food habits as a result of economic, social, cultural, technological and environmental factors. Students will be equipped with the fundamental concepts, knowledge, skills, values, attitudes and understanding of food properties, processing, preparation and their interrelationships, nutritional considerations and consumption patterns. It also provides students the ability and skills that can be applied in a range of contexts through which to examine the richness, pleasure and variety food adds to life. The broad set of skills in the course can be integrated to other study, work and life contexts that students may confront.

There are increasing lack of information and concerns about food issues, including hygiene and safety, nutritional quality of food, genetic engineering (food science), functional food and the environmental, social, physical, cultural, technological and economic impact of food production and security. Students will be given opportunities to explore food related issues through a range of theory and practical experience and develop the ability to solve problems, design and produce, and evaluate solutions to situations involving food.

Students' employability and career development 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: Food Technology curriculum.

Teachers of Food and Textile Technology will plan and program as per the teaching weeks in all the four (4) terms. The learning integration is more relevant including the STEAM approach to teach the essential knowledge, skills, values and attitudes, and processes.

Food Technology is to be timetabled for 200 minutes (5 periods) per week in Senior High School.

Structure of the Teacher Guide

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

1. General Information of the Subject

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

- Introduction of the Teacher Guide
- Structure of the Teacher Guide
- Purpose of the Teacher Guide
- How to use the 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
- Planning and Programming
- SBC Lesson Planning

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 students. 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 subject content, references outlined to guide the development of this teacher guide. The appendices section provides essential information to guide teachers on the content and the delivery of this subject.

Purpose of the Teacher Guide

This teacher guide describes what teachers should know and do to effectively plan, program, teach and assess Grade 11 Food Technology content to enable all students to attain the required learning and proficiency standards. Sufficient 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 Food Technology teacher guides to plan, program, teach and assess different Food Technology Teacher Guide units and topics, and the essential knowledge, skills, attitudes and values (KSAVs) described in the grade-level benchmarks,
- understand the Food Technology national content standards, grade-level benchmarks, and evidence outcomes,
- effectively make sense of the content (KSAVs) described in the Food Technology 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 Food Technology skills, processes, concepts, ideas, principles, practices, values and attitudes,
- confidently interpret, translate and use Food Technology 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 Food Technology Subject 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 to 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 with what is learnt in other subjects to add value 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 11 Food Technology 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.

Teachers should 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 11 Food Technology Strand in TIA Curriculum. Based on this understanding, teachers should be able to effectively use the teacher guide to 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. Lesson titles are deduced from the learning objectives. Teachers should familiarize themselves with this process as it is essential for lesson planning, instruction and assessment. However, depending on the context and students' learning abilities, teachers would be required to determine additional lesson objectives and lesson titles. Teachers should use the samples provided in the teacher guide to assist them to formulate additional lesson objectives and lesson titles to meet the educational or learning needs of their students.

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. This sequencing of content will enable students to progressively learn the essential knowledge, skills, values and attitudes as they further their education. What students learn in previous grades is reinforced and deepens in scope with an increase in the level of complexity and difficulty in content and learning activities. It is important to understand how the content is organised so that grade appropriate content and learning activities can be selected, if not already embedded in the benchmarks and learning objectives, to not only help students learn and master the content, but ensure that what is taught is rigorous, challenging and comparable. Teachers should use the units of work provided in this teacher guide to help them identify appropriate content for teaching and learning.

Integrate the Core Curriculum in Lesson Planning, Instruction and Assessment

Teachers should integrate the core curriculum - values, cognitive and high level skills, 21st Century Skills, STEAM principles and skills, writing and communication skills in their annual teaching program and give prominence to these skills in lesson planning, instruction, teaching and learning activities, performance assessment, and performance standards for measuring students' proficiency and application of these skills.
In this field of study, students are expected to learn, promote and use work, relationship, peace, health, social, personal, family, community, national and global skills and values in work and study environments as well as in their conduct as community, national and global citizens.

In addition, it is envisaged all students attaining expected proficiency levels in these skills and will be ready to pursue careers, and higher education academic programs that demand these skills, and use them in their everyday life. Teachers should refer to the core curriculum section in this teacher guide to source information where necessary to guide them in lesson planning, instruction and assessment.

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

STEAM teaching and learning requires both the teacher and student to participate as core investigators and learners and to work in partnership and collaboration with relevant stakeholders to achieve maximum results. Teachers should use the syllabus, teacher guides and other relevant resources to guide them to plan and implement this and other innovative and creative approaches to STEAM teaching and learning to make STEAM principles and skills learning fun and enjoyable and, at the same time, attain the intended quality of learning outcomes.

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

The selection of grade and contextually appropriate teaching and learning methodologies is critical to enabling all students to achieve the expected standard or quality of education. Teaching and learning methodologies must be aligned to content, learning objective, essential concepts, skills, values, attitudes and performance standard in order for the teacher to effectively teach and guide students towards achieving the desired learning outcome. They should be equitable and socially inclusive, differentiate, student-centered, and lifelong. Teachers are encouraged to 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.

Plan Standards-Based Lessons

SBC lesson planning is quite challenging and will become easier with more practice and experience over time. Effective SBC lesson plans must meet required standards or criteria so that the learning objectives and performance standards are closely aligned to attain the expected learning outcomes. If standards are not met, instruction will not lead to the attainment of intended performance and proficiency standards. The guidelines and standards for SBC lesson planning with samples are provided in the SBC lesson planning section of this teacher guide to assist teachers to plan their lessons.

Use Standards-Based Assessment

Standards-Based Assessment has a number of components. These components are intertwined and serve to measure, evaluate report and monitor students' achievement of the national and grade-level expectations, i.e., the essential knowledge, skills, values and attitudes they are expected to master and demonstrate proficiency on. Teachers should use the assessment guidelines and standards for SBA provided with samples in the assessment section of this teacher guide.

Make informed Judgements About Students' Learning and Progress Towards Meeting Learning Standards

It is important that teachers evaluate the performance of students in relation to the performance standards and progressively the grade-level benchmarks and content standards to make informed judgements and decisions about the quality of their work and their progress towards meeting the content standards or component of standards. Evaluation should not focus on only one aspect of students' performance. It should aim to provide a complete picture of each student's performance. The context, inputs, processes, including the teaching and learning processes, and the outcomes should be evaluated to make an informed judgement about each student's performances. Teachers should identify the underlying factors for poor performance, gaps in students' learning, gaps in teaching, teaching and learning resource constraints, and general attitude towards learning. Evidence-based decisions can then be made regarding the interventions for closing the gaps to allow students to make progress towards meeting grade-level and national expectations.
The assessment section in this teacher guide should guide the teacher to effectively evaluate students' performance and use the evidence to help students to continuously improve their learning as well as their classroom practice.

Prepare Students 'Performance Reports

Reporting of students' performance and progress towards the attainment of learning standards is an essential part of SBC Assessment. Results of students' performance should be communicated to the students and their parents or guardians to keep them informed of students' academic achievements and learning challenges as well as what needs to be done to enable the students make positive progress towards meeting the proficiency standards in achieving the desired level of education quality. Teachers should use the information on reporting of students' assessment results and the templates provided to report the results of students' learning. Teachers can refer to the assessment section of this teacher guide to assist them in reporting student's performances.

Monitor Students' Progress Towards Meeting the National Content Standards and Grade – Level Benchmarks

Monitoring of students' progress towards the attainment of learning standards is an essential component of standards-based assessment. It is an evidence-based process that involves the use of data from students' performance assessments to make informed judgements about students learning and proficiency on the learning standards or their components, identify gaps in students' learning and the casual factors, set clear learning improvement targets, and develop effective evidence-based strategies (including preplanning and re-teaching of topics), set clear time frames, and identify measures for measuring students' progress towards achieving the learning targets.

Teachers should use the teacher guide to help them use data from students' performance assessments to identify individual students learning weaknesses and develop interventions, in collaboration with each student and his/her parents or guardians, to address the weaknesses and monitor their progress towards meeting the agreed learning goals.

Develop Additional Benchmarks

Teachers can develop additional benchmarks using the examples in the teacher guide to meet learning needs of students and local communities. However, these benchmarks will not be nationally assessed as these are not comparable. They are not allowed to set their own content standards or manipulate the existing ones. The setting of national content standards is done at the national level to ensure that required learning standards are maintained and monitored to sustain the required level of education quality.

Avoid Standardisation

Teachers must use innovative, creative, culturally relevant, and differentiated teaching and learning approaches to teach the curriculum and enable their students to achieve the national content standards and grade-level benchmarks. And enable all students to experience success in learning the curriculum and achieve high academic standards.

What is provided in the syllabus and teacher guides are not fixed and can be changed. Teachers should use the information and suggested examples provided in the Syllabus and the Teacher Guide to guide them to develop, select and use the grade, context, and learner appropriate content, learning objectives, teaching and learning strategies, and performance assessment and standards. SBC is evidence-based hence decisions, about the content, learning outcomes, teaching and learning strategies, students' performance, and learning interventions should be based on evidence. Teaching and learning should be continuously improved and effectively targeted using evidence from students' assessment and other sources.

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 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 Food Technology is inclusive and fosters the learning needs of all students.

Syllabus and Teacher Guide Alignment

The Grade 11 Food Technology Strand Teacher Guide is closely aligned and complementary to 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 11 Food Technology Strand content.

Teachers should extract information from the syllabus (e.g., content standards and grade-level benchmarks) for lesson planning, instruction and is 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

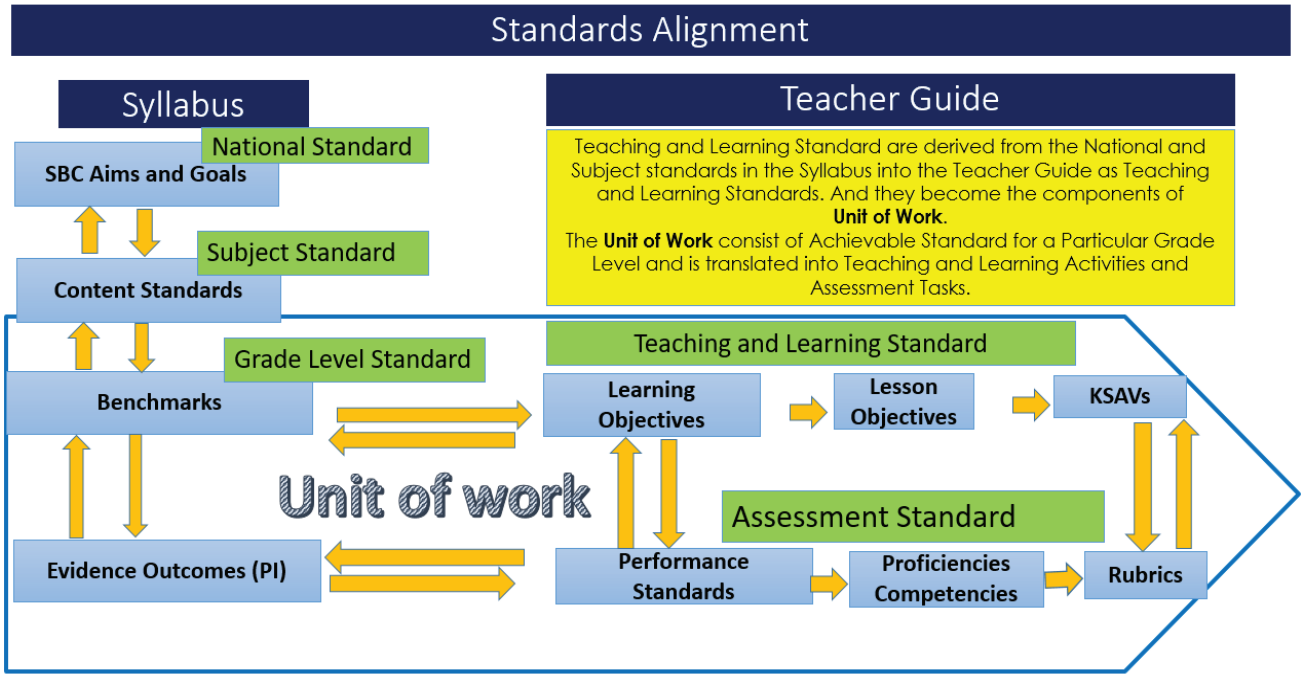
Standard Alignment

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 Standards 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 alignment of standards between standards in the Syllabus and the Teacher Guide.



Learning and Performance Standards

Standards-Based Education (SBE) and SBC are underpinned by the notion of quality. Standards define the expected level of education quality that all students should achieve at a particular point in their schooling. 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. When they are judged to have attained 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, benchmarks, and learning objectives are called learning standards while performance and proficiency standards (evidence outcomes) can be categorized 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.

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 contextualized 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:

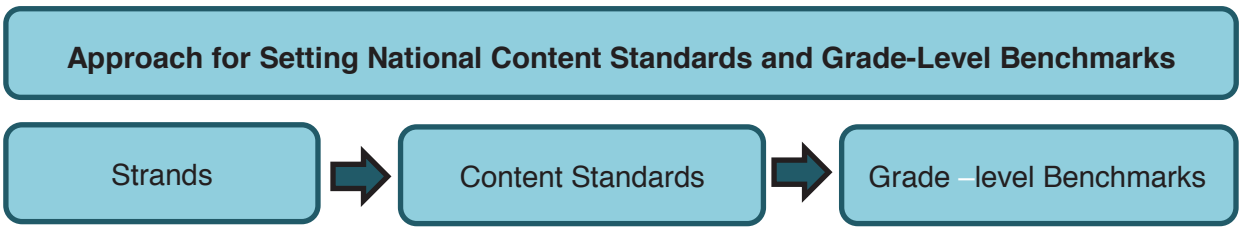
- are evidenced-based,
- are rigorous and comparable to regional and global standards,
- are set at the national level,
- state or describe the expected levels of quality or achievement,
- are clear, measurable and attainable,
- are linked to and aligned with the ultimate aim and goals of SBE and SBC 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, and
- 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;

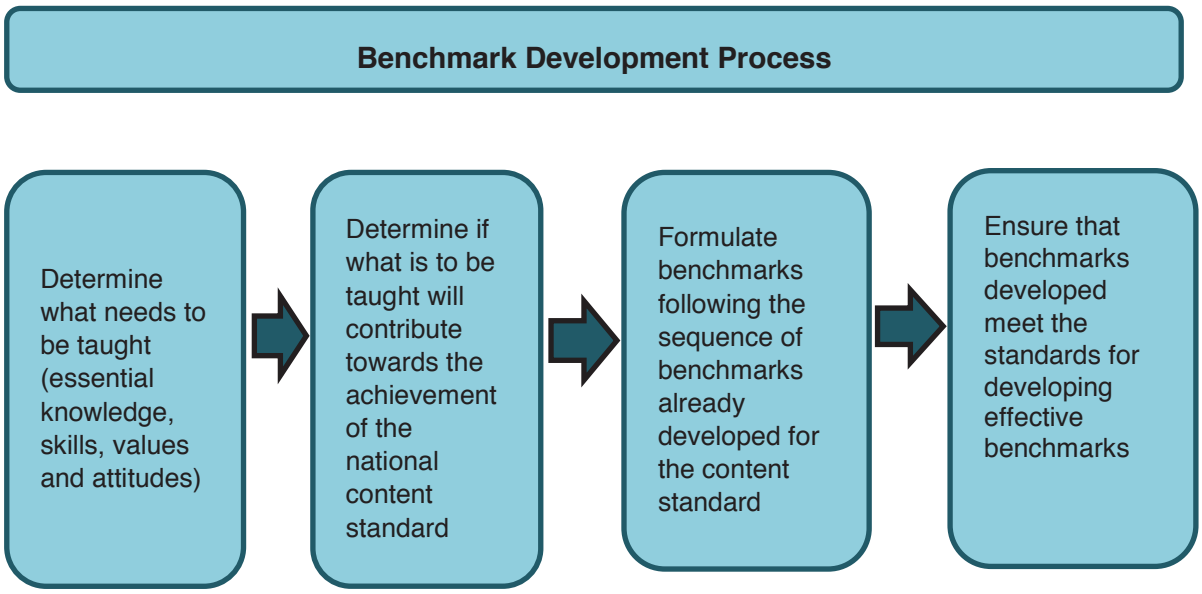
- are evidenced-based,
- are rigorous and comparable to regional and global standards,
- are set at the grade level,
- are linked to the national content standards,
- are clear, measurable, observable and attainable,
- articulate grade level expectations of what students are able to demonstrate to indicate 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 PNG students with students in other countries.



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, reflect, 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.



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 describes the products or behaviours that will be provided by students. They are stated in terms of measurable and observable student behaviour.

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 students' 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, and
- 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 categorized as benchmarks because that is what all students are expected to do before exiting a grade or are deemed ready for the next grade.

Core Curriculum

Core curriculum refers to a core set of common learning (knowledge, skills, values, and attitudes) that are integrated into the content standards and grade-level benchmarks for all subjects. This is to equip all students with the most essential and in-demand knowledge, skills, and dispositions they need to be successful in modern/postmodern work places, higher-education programs and to be productive, responsible, considerate, and harmonious citizens. Common set of learning are spirally sequenced from Preparatory to Grade 12 to deepen the scope and increase the level of difficulty in the learning activities so that what is learned is reinforced at different grade levels.

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,
- Essential values and attitudes (core personal and social values, and sustaining values), and
- Spiritual values and virtues.

Integrating Core Curriculum in the Teaching and Learning

Teachers can identify a set of core curriculum to teach in one lesson for example; in Food Technology, students may be posed with a dilemma to find solutions on how technology can be used to improve food security in their area.

Students will be required to use what they learnt in social science about the causal effects of climate change on the livelihood of people, they can use STEAM principles and skills in finding cause and solutions, use high level thinking skills to analyze and evaluate the effects and how to improve food security, use decision making and critical thinking skills to find the solutions for food security, use technology to design the best food security model.

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 integrating STEAM-based principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

Food 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.

Through STEAM education 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, analyze 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, and
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 problems-solving methods and approaches; they share some of the steps of problem-solving, for example;

- Identifying the problem,
- Understanding the problem by collecting data,
- Analyze 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.

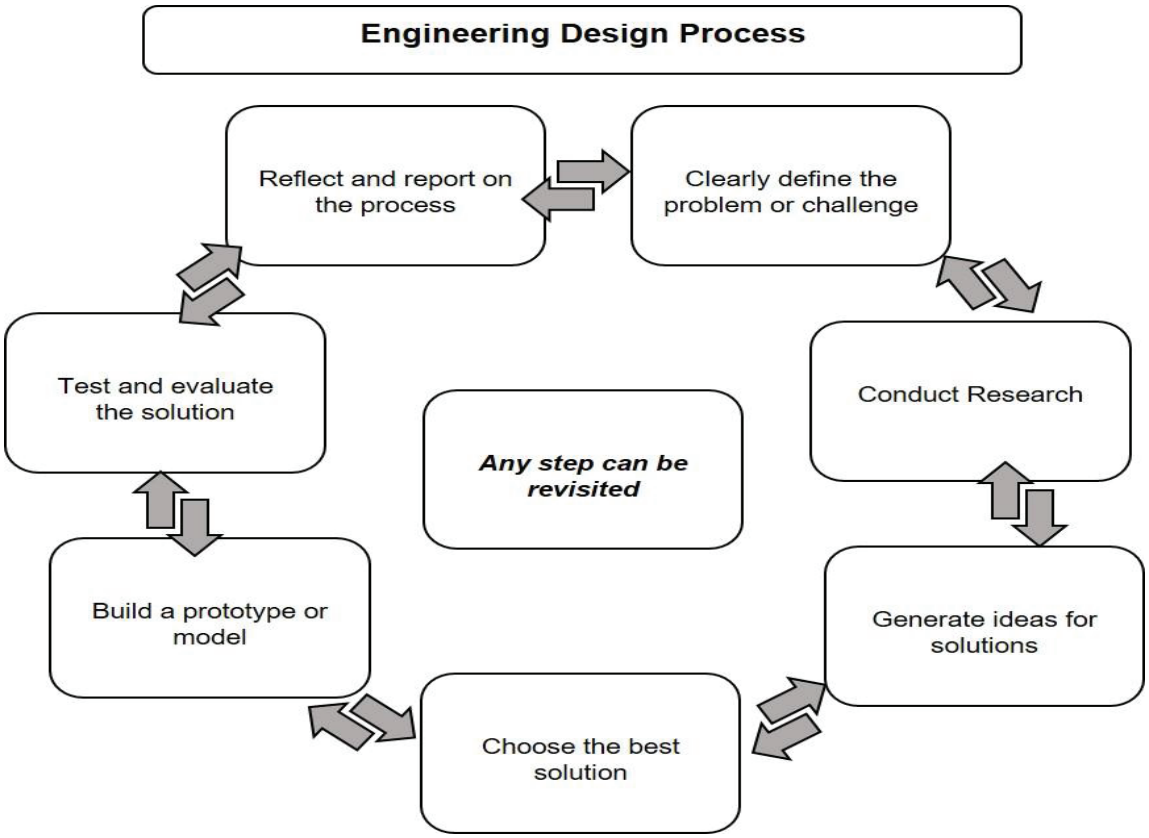
STEAM problem-solving processes go from simple and technical to advance and knowledge-based processes. However, regardless of the type of process used students should be provided opportunities to learn the essential principles and processes of problem solving and more significantly, to design and create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

- Analyze 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, and
- Reflect and report on the process.

This sequential engineering design process steps described 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

- 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: *Many Teenagers are not eating healthy food and spend most of their time on their mobile phones or other activities that do not encourage fitness activities.*

Step 2: Research

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

After the problem is identified and described, several questions should 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: *What they think and know about healthy eating and the effects of what they eat on their future health. What they feel about eating junk food and where they like to eat and with which people, how much exercise they take. Find out how food manufactures target teenagers for their food products and how manufacturers try to make their products appear healthy.*

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*

Design and produce an alternative food to any fatty or sweet foods that could be sold in fast–food outlets or street markets and it targeted at teenagers. Try to include a good source of calcium and iron in the ingredients or meal that is nutritious and healthy.
Specification:
Write what your food product will be like;
Will your product be healthy?
How will your product be prepared and cooked? How will your product be package? Etc.

Step 4: Prototyping

- Create a finished prototype product to use as a sample for production.
- The researcher will make or develop a prototype of the solution and test how it would be used to solve the problem.

Example: *Prototype – an alternative food product*
After the prototype has been produced, it is subjected to qualitative or sensory analysis such as;

- taste testing by the testing team and
- focus groups to evaluate
    - the appearance,
    - aroma,
    - flavour,
    - texture,
    - mouth feel of the product, and
    - suggestions for improvements are made.

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.

Example**:** *Producing the product when a successful prototype is developed. The group or team of people begins production trials in which the prototype is scaled up for production but in a smaller scale before the food product is certified by food experts or engineers. In this case the alternate food product for teenagers will follow the production line from being made or cooked, packaged and labelled.*

Step 6: Marketing/launch

- Launch product into market. A marketing awareness is developed to help launch the new product into the market place.

Product, Price, Place and Promotion

A key feature of the development of a successful marketing plan is establishing the marketing fundamentals for the campaign, the 4Ps – product, price, place and promotion. This means answering some key questions about the product:

Example:

- *What is the product and who is the target market?*
- *What price can it be marketed at to make a profit for the group etc. but still be acceptable to the target market?*
- *Where is the best market place or location to sell the product that it is accessible to the target market?*
- *What is the best way to promote the product so that it is widely recognized by consumers?*

Step 7: Evaluation of a New Product

- Evaluation of a new food product

Example: *One of the most important aspects of the food product development is to complete an evaluation of the physical and sensory properties of the product once the final prototype and scale-up have been completed.*

- **Valuation of the production process**

In manufacturing companies, or commercial food industries the process engineer and the production manager review all stages of the production. This includes:

- the resources used,
- the types of ingredients and availability, and
- other materials required to make the product.

Consideration is also given to the;

- suitability of the cooking methods,
- flavorings, and
- presentation of the food.

In addition, review is also done on;

- the technical expertise required to produce the product,
- whether staff require retraining or additional staff are needed,
- they evaluate the effectiveness of the production processes, and
- the problems that arose during the scale-up and full production process.

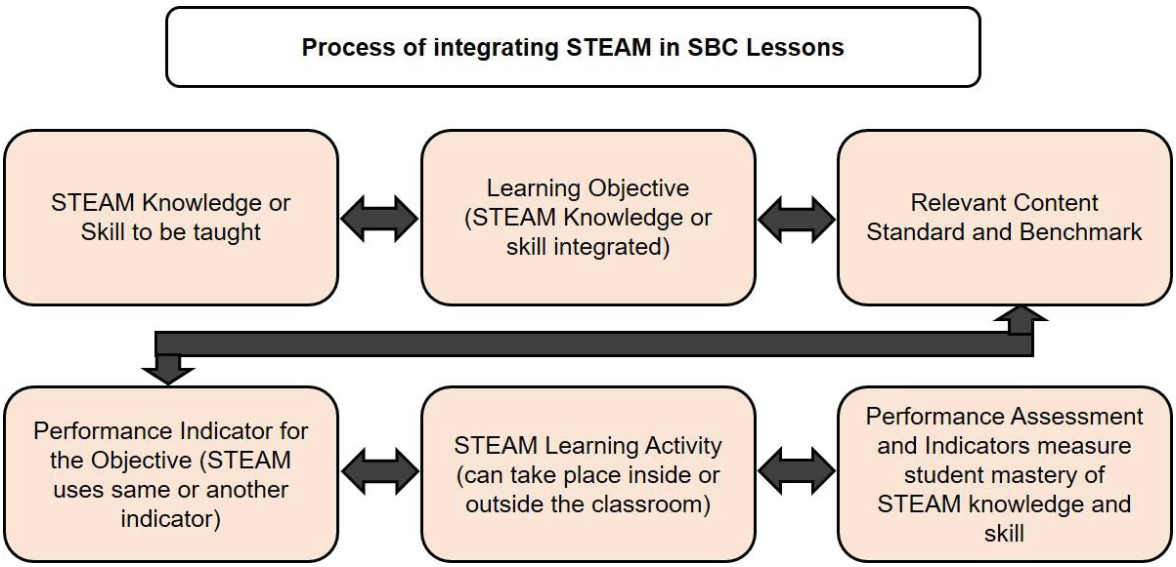
It is also important to review the **HACCP** system to determine if identified hazards were monitored effectively and the corrective actions were successfully implemented.

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.

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.

Step 1: Identify the STEAM knowledge or skill to be taught (From the table of KSAVs for each content standard and bench mark). **This is 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 inside or 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 Teaching Strategies

There are a variety of STEAM teaching strategies. However, teaching strategies selected must enable teachers to guide students to use the engineering and artistic design processes to identify and solve natural and physical environment problems by designing prototypes and testing and refining them to effectively mitigate the problems identified. The following are some of the strategies that could be used to utilise the STEAM approach to solve problems and coming up with technological solutions.

- Inquiry-Based Learning
- Problem-Based Learning
- Project-Based Learning
- Collaborative Learning

Collaborative learning involves individuals from different STEAM disciplines and expertise in a variety of STEAM problem solving approaches working together and sharing their expertise and experiences to inquire into and solve a problem.

Developing STEAM partnerships with external stakeholders e.g., high education institutions, private sector, research and development institutions, and volunteer and community development organizations can enhance students' learning and application of STEAM problem solving principles and skills.

Some examples of STEAM–related partnership experiences may include:

- Participatory Learning
- Group-Based Learning
- Task Oriented Learning
- Action Learning
- Experiential Learning
- Modelling
- Simulation

STEAM Learning Strategies

Teachers should include in their lesson plans STEAM learning activities. These activities should be aligned to principle or a skill planned for students to learn and demonstrate proficiency on at the end of the lesson to expose students to STEAM and giving them opportunities to explore STEAM-related concepts, they will develop a passion for it and, hopefully, pursue a job in a STEAM field. Providing real life experiences and lessons, for an example; by involving students to actually solve a scientific, technological, engineering, or mathematical, or arts problem, would probably spark their interest in a STEAM career path. This is the theory behind STEAM/ education.

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 including; portfolios, performances, projects, peer-review and self-assessment.

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 standardized test), it highlights student effort, development, and achievement over a period of time; portfolios measure a student's ability to apply knowledge rather than simply regurgitate. They are considered both student-centered and authentic assessments 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 is negotiated between the teachers and students, students are taught how to apply the criteria, students receive feedback on their self-assessments and teachers 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 assesses 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 system (CRS), audience response system (ARS) is 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 analyzing information quickly and then devising real-time instructional solutions to maximize students learning. This includes a suggested approach to help teachers and trainers assess learning.

Curriculum Integration

An integrated curriculum is described as one that connects different areas of study by cutting across subject-matter lines and emphasizing 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.

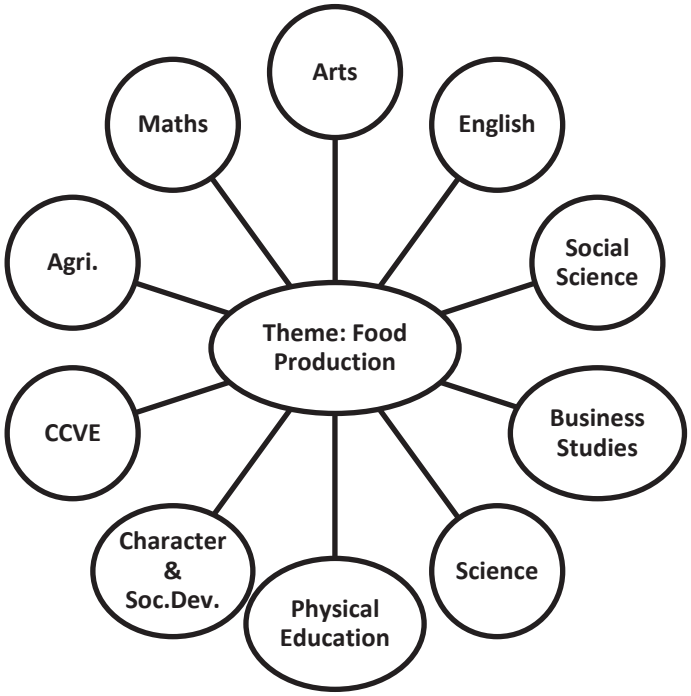
Curriculum integration is a holistic approach to learning thus curriculum integration in SBC will equip students with the essential 21st Century knowledge, skills, values and attitudes. Teachers must develop intriguing curriculum by going beyond the traditional teaching of content based or fragmented 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 students whereby they all can demonstrate proficiency at any point of exit. Adapting these approaches will have an immense impact on the lives of these students 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

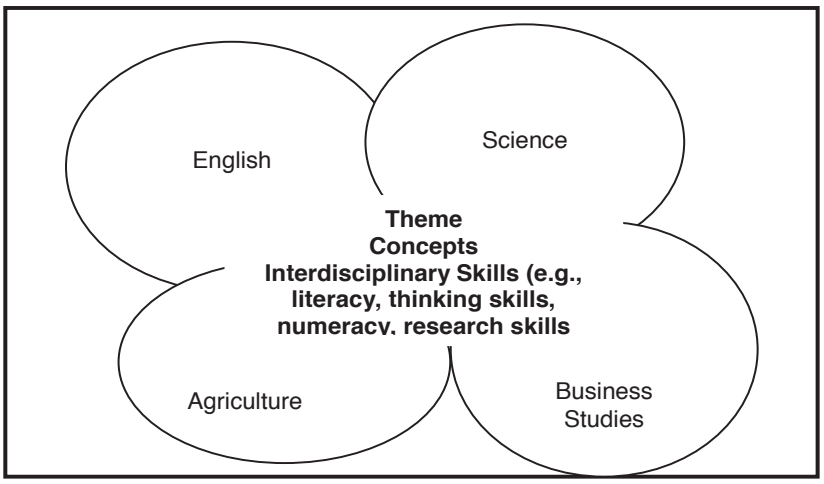
In this approach, learning involves a theme or concept that will be taught right across all subject area of study by students. For instance, if the theme is; “Food Production” all subject areas create lessons or project-based learning and assessment as per their subjects around this theme. The content of the theme, “Food Production” as shown in the diagram will be taught right across all the different subjects through the related concepts identified in the different benchmarks.



(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 a Food technology class, students work on a project on food product development. Apart from learning the process of developing a food product, students are expected to apply literacy skills relating to oral, written, and visual communications on the topic food product through speech delivery in debates, advocacies and awareness campaigns. In the same project, they acquire skills in other related subject disciplines such as; planning, developing and modifying their project including costing, quantities, measurement and time, developing competence in using mathematical and scientific ideas and skills. It is not seen as a single subject skill but a standard essential skill all students must know and do regardless.

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 Technology and Industrial Arts (TIA), the strands for food, textile, computing, communication and construction will all be captured studying a particular content for TIA. For example, under the strand food technology, students will study food for special needs and occasions, use computational skills to create a food app, use the social media platform to market their food product, draft a pattern and sew an apron to put on during food preparation and in the construction strand under building, students will construct a family dining table. Thus, students are well equipped with life-long skills to sustain themselves.

(iv) Trans-disciplinary Approach

In this approach learning goes beyond the subject area of study. Learning is organized 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 giving 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.

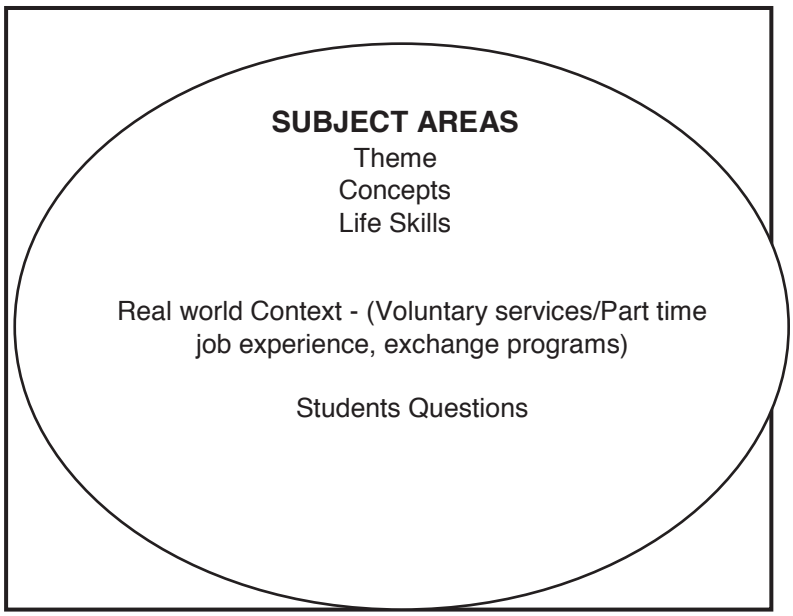
The three steps to planning project-based curriculum.

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 or authority and media to assist them especially to carry out awareness.

Studies 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.



These integrated learning approaches will demand for teaches 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.

Essential Knowledge, Skills, Values and Attitudes

Technology 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

Food Technology

The Food Technology strand encourages students to “think out of the box or beyond”. 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 products.

Examples of the types of knowledge for Food Technology

These are specific content knowledge for the subject. They include;	
• Nature and properties of food • Classification of food • Food preservation • Food storage and packaging • Menu considerations • Food selections • Food safety • Food Science	• Chemical, physical and sensory properties of n food when subject to product development • Food processing • Food sources and the role of nutrients of food sources in the body. • Food for special needs and occasions • Nutrition

Technology and Industrial Arts is a skills oriented subject, therefore embraces all the commonly recognised skills such as literacy, mathematical literacy, inquiry/research skills, and life skills, are critical to students' success in all subjects of the curriculum and in all areas of their lives.
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 • Organizational skills. • Problem solving skills • Mathematical skills • Language literacy skills • Leadership • Innovative skills • Transformational 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

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.

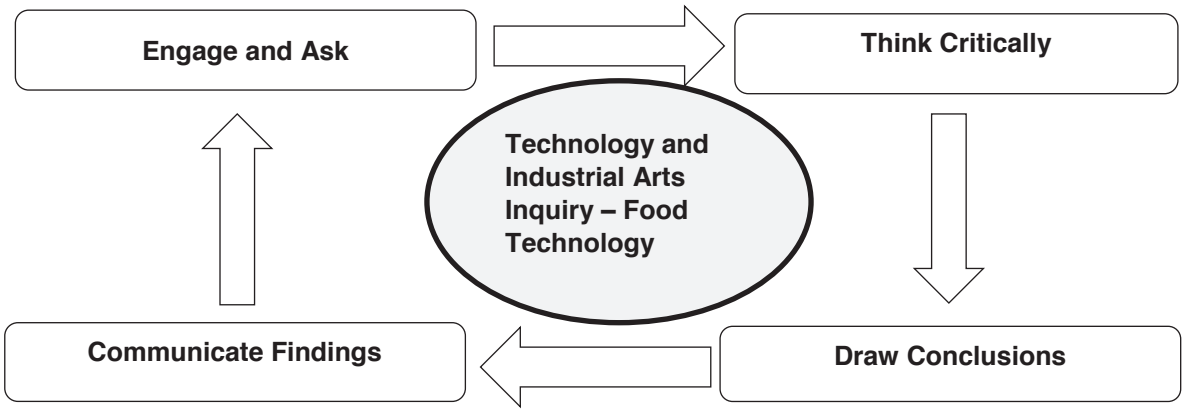
Types of Processes- Inquiry processes for Technology & Industrial Arts subject

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. • 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.
Communicate 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 11 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.

Types of Skills

There are different types of skills. These include:

1. Cognitive (Thinking) Skills
Thinking skills can be categorized into **critical thinking** and **creative thinking** skills.

i. Critical Thinking Skills

A person who thinks critically always evaluates an idea in a systematic manner before accepting or rejecting it. Critical thinking skills include:	
- Attributing - Comparing and contrasting - Grouping and classifying - Sequencing - Prioritising - Analysing	- Detecting bias - Evaluating - Metacognition (Thinking about thinking) - Making informed conclusions

ii. Creative Thinking Skills

A person who thinks creatively has a high level of imagination, able to generate original and innovative ideas, and able to modify ideas and products. Creative thinking skills include:	
- Generating ideas - Deconstructing and reconstructing - Relating - Creating - Making inferences - Predicting - Making generalisations - Visualizing	- Synthesising - Making hypothesis - Making analogies - Inventing - Transformation - Modelling - Simulating

2. Reasoning Skills - Reason is a skill used in making a logical, just, and rational judgement.

3. **Decision-Making Skills -** Decision-making involves selection of the best solution from various alternatives based on specific criteria and evidence to achieve a specific aim.
4. **Problem Solving Skills -** Problem solving skills involve finding solutions to challenges or unfamiliar situations or unanticipated difficulties in a systematic manner.

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 emphasize 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 • Analyze cause and effect relationships • Explore complex patterns, interactions and relationships • Differentiate between and among various options • The 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 • Improves personal financial management skills • Improves budgeting and investing skills • Creates a savvy relationship with money application skills • Creates 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 generalizations, 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	Organize	Theme webbing
Categorize	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

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.

Teaching and Learning Strategies

Food Technology teaching emphasizes 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 demand knowledge, skills, values, and attitudes that are required for preparation of students for career, higher education and citizenship in the 21st Century.

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.

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

Food Technology 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 the subject content are 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 for instance, food processing, in a Food Technology lesson.

Practical work is integral through studying Food Technology and this includes; cooking, demonstrations, creating and responding to design briefs, dietary analysis, food sampling and taste-testing, sensory analysis, product analysis and scientific experiments.

The Design Process is an important teaching and learning approach in Food Technology.

Teaching Strategies

These are some suggested teaching strategies recommended for lesson deliveries. However, teachers can blend these in with the existing or current teaching practices using technology.

- Use of multimedia for content research.
- Utilization 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 strands in TIA subject.

1. Use multiple types of instructional materials for learning.
2. Incorporate technology for reinforcement and motivation for learning.
3. Try new learning techniques.
4. Keep traditional methods.
5. Vary assessments.
6. Mix up group work styles.
7. Try a digital curriculum.

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 evaluation on daily basis,
- Make Technology a treat & not an expectation,
- Monitor closely usage of electronic devices,
- Set ground rules for all students,
- Share knowledge on how to get technical support,
- Communicate with parents,
- Familiarize yourself with the Technology, and
- Safe use of Technology.

These teaching and learning strategies will help teachers to;

- familiarize themselves with different methods of teaching in the classroom, and
- 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 utilize the suggested strategies as well as others.

Strands, Units and Topics

This section of the teacher guide contains the Food Technology content to be taught in grade 11. It consists of;

- a brief explanation of how the topics, learning objectives and lesson topics are derived,
- the unit of work containing information on how the content prescribed in the standards are unpacked and organized in a sequential manner, and
- an overview of the content distributed according to the four terms in an academic year. Refer to planning and programming section.

Food Technology is has two units. These units 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 to 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.

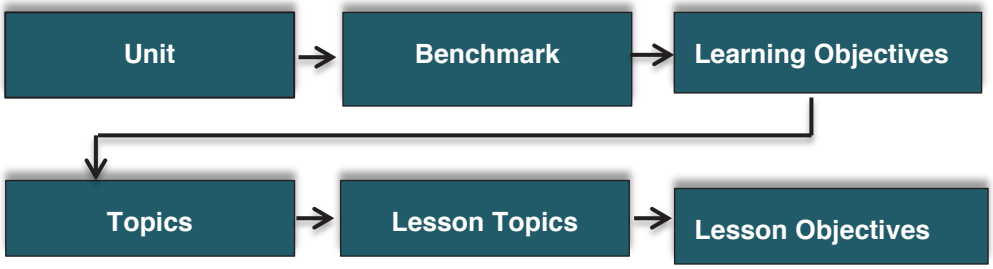


Table of Units, Benchmarks, Topics and suggested Lesson Titles

The table below outlines the contents of Grade 11 Food Technology benchmarks, units, topics and with suggested lesson titles for an academic year. Teachers are provided with what will be taught under in each of the unit in a year. This overview will guide the teachers on how to plan their teaching programs for a school year in each term. Further elaborations on the content for each of the topics and lessons are found in the Units of Work.

Content Standard: 2.1 Examine and analyze the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards.		
UNIT 1: Food and Nutrition		
Benchmark	**Topic**	**Lesson Titles**
11.2.1.1 Analyse the nature and properties of food	Properties of fruits, vegetables and legumes	**Lesson 1:** Classification and properties of fruits, vegetables and legumes
		Lesson 2: Ways of preparing and preserving fruits, vegetables and legumes
		Lesson 3: Principles behind cooking fruits, vegetables and legumes
11.2.1.2 Plan to develop a product using the food product development process and discuss the economic, social and technological influences	Influences on food product development	**Lesson 1:** Social influences on food production
		Lesson 2: Economic influences on food production
		Lesson 3: Technological influences
		Lesson 4: Environmental influences
11.2.1.3 Practise application in hygiene, safety, ethical values and etiquettes in meal preparation, food handling, product development and meal presentation	Food safety and hygienic practices in food product development	**Lesson 1:** Safe food handling practices
		Lesson 2: Safe food packaging
		Lesson 3: Safe food marketing
		Lesson 4: Food presentation
11.2.1.4 Solve nutritional problems using the design process and communicate ideas in written, oral and graphical forms	Solutions to nutritional problems	**Lesson 1:** Nutrition related illnesses
		Lesson 2: Meals for special needs
		Lesson 3: Guidelines to healthy eating
		Lesson 4: Plan and design a nutritious meal
11.2.1.5 Investigate the recommended dietary intake of energy, protein, vitamins and minerals for a particular individuals and groups using appropriate data such as RDI tables in print or electronic format	Investigate dietary issues	**Lesson 1:** RDI and Food composition tables
		Lesson 2: Targets for healthy living
		Lesson 3: Dietary guidelines for healthy living

Unit 2 Food Science		
Content Standard: 2.2 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. (e.g., health, occasions, lifestyle, business)		
Benchmark	**Topic**	**Lesson Titles**
11.2.2.1 Recognize the significance of food science as a relevant science including current and historical developments and advancements of global food production	Food product development advancement	**Lesson 1:** Introduction to food Biotechnology
		Lesson 2: Genetic food engineering
		Lesson 3: Gastronomy
11.2.2.2 Explain the role of science as it relates to research practices and practical scientific experiments	Food engineering	**Lesson 1:** Introduction to food engineering
		Lesson 2: Modified food products
		Lesson 3: Food security and Climate change
11.2.2.3 Distinguish between the different kinds of chemical reactions in food and understand the factors that affect then	Chemical reaction in food	**Lesson 1:** Chemical reactions in food
		Lesson 2: Chemical reactions in starch and proteins
		Lesson 3: Chemical reactions in oils, fats, vitamins and minerals
		Lesson 4: Food fermentation
11.2.2.4 Describe methods of food preservation and their relationship to food safety	Food preservation	**Lesson 1:** Methods of food preservation
		Lesson 2: Food packaging
11.2.2.5 Investigate microorganisms in terms of classification, their growth and their application of food science	Food microbiology	**Lesson 1:** Introduction to food microbiology
		Lesson 2: Classification of Micro-organism
		Lesson 3: Roles of micro-organisms in food production

Note: The above are suggested lesson titles for activities in relation to each of the benchmarks for the two units. Teachers are encouraged to develop additional lesson activities to suit their context and students learning needs.

The content background notes for each benchmarks in a unit of work help to reinforce the food technology content and concepts. Teachers can also use computers, internet sources or resource materials to gather more information on the topic.

Grade 11

Food Technology

Teaching Content

Grade 11

Food Technology

Teaching Content

Unit 1: Food and Nutrition

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		Lesson 3: Technological influences
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		Lesson 3: Guidelines to healthy eating
		Lesson 4: Plan and design a nutritious meal
11.2.1.5 Investigate the recommended dietary intake of energy, protein, vitamins and minerals for a particular individuals and groups using appropriate data such as RDI tables in print or electronic format	Investigate dietary issues	**Lesson 1:** RDI and Food composition tables
		Lesson 2: Targets for healthy living
		Lesson 3: Dietary guidelines for healthy living

Unit 1: Food and Nutrition

Content Standard: 2.1 Examine and analyze the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards.

Benchmark: 11.2.1.1 Analyze the nature and properties of food

Topic: Properties of Fruits, Vegetables and Legumes

Learning Objective(s): By the end of the topic, the students should be able to;

- Classify and analyze the properties of fruits, vegetables and legumes.
- Plan, design and apply the principles behind cooking fruits, vegetables and legumes.

Essential Questions:

- What are the physical and chemical properties of fruits, vegetables and legumes?
- What are the nutritional value of fruits, vegetables and legumes and their benefits to growth and development/health?
- How are fruits, vegetables and legumes prepared or processed?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Nature and property/characteristics of food • Vegetables • Pulses and nuts • Fruits • Food processing stages • Nutritional effects of processing
Skills	• Classify and explain the physical and chemical properties of fruits, vegetables and legumes • Evaluate the principles behind cooking fruits, vegetables and legumes • Design and evaluate the nutritional value of creating a product consisting fruits, vegetables and legumes
Values/Attitudes	• Make informed decisions on their selection of fruits, vegetables and legume and be responsible of their food choices. • Appreciate and recognize the nutritional value of fruits, vegetables and legumes for the benefit of their wellbeing

Teaching and Learning Strategies

The teacher is required to teach the prescribed knowledge on food effectively. Importantly, concepts must be introduced to help students understand the knowledge of the properties of fruits, vegetables and legumes. Students must be given the opportunity to apply their knowledge to discussing and explaining the benefits to health.

Learning Activities

Lesson 1: Classification and properties of fruits, vegetables and legumes

Activity 1: Differentiate and list down the physical and chemical properties of fruits, vegetables and legumes.

Activity 2: Identify and explain the different groups of fruits, vegetables and legumes and give examples.

Lesson 2: Ways of preparing and preserving fruits, vegetables and legumes

Activity 1: Choose a fruit, vegetable or legume and plan on how you will preserve it for later use for food preparation, cooking or consumption.

Activity 2: Students work in groups, plan and develop a recipe for preparing fruits, vegetables or legumes. The recipe should be based on what the students are able to find and use in their surroundings.

Lesson 3: Principles behind cooking fruits, vegetables and legumes

Activity 1: Explain the effect of cooking/heat on fruits, vegetables and legumes.

Activity 2: Discuss cooking methods that conserve the flavour, colour and the nutritional composition in fruits, vegetables and legumes.

Content Background

Fruits, vegetables and legumes provide an abundant and inexpensive source of energy, body building nutrients, vitamins and minerals. Their nutritional value is highest when they are fresh, but it is not always possible to consume them immediately. During the harvest season, fresh produce is available in abundance, but at other times it is scarce. Moreover, most fruits, vegetables and legumes are only edible for a very short time, unless they are promptly and properly preserved.

1. Fruits - Fruits are defined by botanically as matured ovaries of flowers. They offer a wide range of colours, textures, scents and flavours and are generally sweet in taste. Fruits consist of three sections: the skin, the pulp and the seeds.

Classification of fruits

Pome fruits	Apples, crab apples, Pears, Quinces
Berries	Blackberries and raspberries, Blueberries and cranberries Strawberries
Stone fruits	Apricots, Cherries, Nectarines, Peaches, Plums
Vine fruits	Grapes, Kiwifruit, Passion fruit
Citrus fruits	Grapefruit, Lemons, Limes, Mandarins, Oranges
Melons	Cantaloupes, Honey drews, Watermelons
Tropical fruits	Bananas, Mangoes, Pineapples
Dried fruits	Apples, Apricots, Currants, Dates, Pears, Prunes, Raisins, Sultanas

Characterisics and properties of fruits

Colour	The colour of the fruit is due to various pigments such as green is due to chlorophyll, orange and yellow to carotenoids and red and blue to anthocyanins.
Flavours	They are complex mixtures of naturally occurring chemicals, and can range from the subtle, slightly perfumed flavour of a mango to the strong citrus flavour of a lemon. The tangy flavour of fruits is due to acids they contain; **(a)** citric acid in oranges, grapefruit, lemons and limes **(b)** malic acid in apples, pears, peaches and apricots **(c)** oxalic acid in pineapple **(d)** tartaric acid in grapes.
Sweetness	The sweetness of fruit is due to the sugars they contain. Fruit sugar is called **fructose** and is classified as a simple sugar or a monosaccharide.
Texture	The texture is formed from a combination of different properties of the fruit including the plant cell shape and size, the amount of water in the fruit cells, and the amount of cellulose (fibre) and starch in cells.
Pectin	Is a complex polysaccharide found in the cell walls of many fruits. It forms a gel with sugar when in acid conditions and is responsible for the settings of jams.

Fresh fruits are generally made up of water and carbohydrates. The carbohydrate is found in the form of sugar in the ripe fruits such as sucrose, fructose and glucose. Fructose is a simple sugar or fruit sugar and is mainly found in fruits. Due to the highwater content in fruits, they are low in kilojoules and therefore energy value. Some carbohydrates is also present in the form of cellulose, a polysaccharide. The form is not easily digested and forms dietary fibre. Pectin is also a polysaccharide and gives fruit the ability to gel and form a jam. Fruits are important source of vitamins and the major source of Vitamin C. Vitamin A in the form of carotene, is present in yellow and orange fruits. Some fruits contain small amounts of minerals such as phosphorous, potassium and calcium.

Changes in the physical properties of fruit

Enzymatic browning - If the enzymatic action which occurs during ripening is allowed to continue, over ripening will occur and the fruit will spoil. Enzymatic browning can also occur during preparation of fruits when the cut or peeled fruit is exposed to oxygen in the air.
Bruising – can occur if the fruit is carelessly handled during picking and transporting. The cells usually on the surface are broken releasing some of the enzymes in the fruits. As a result, air is able to come into contact with the flesh causing a soft spot. The juice in the fruit also leaks out and discolorations or browning occurs and speeds up further destruction and rotting of the fruit.

2. Vegetables - Generally, vegetables are classified according to their colour, nutritional composition and most commonly they are classified according to the part of the plant that is used as food. This classification is based in the groupings of;

Flower vegetables - Broccoli, Cauliflower, Globe artichoke
Fruit vegetables - Eggplant, tomatoes, cucumber, marrow, capsicum
Fungi - Mushrooms, Truffles
Leaf vegetables - Brussels sprouts, cabbage, lettuce, Silverbeet, Spinach
Seeds and pods - Beans, Broad beans, Green peas, Snow peas, Sweet corn, Sugar peas
Stems and shoot vegetables - Asparagus, Celery
Tubers - Potatoes, Sweet potatoes
Shoots and sprouts - Bamboo shoots, Bean shoots, Sprouted seeds

Root vegetables

Beetroot can be bought in a number of varieties from the traditional large, deep red variety to the mini or baby beets. Beetroot is the native of the Mediterranean region. Only the root of the plant id generally eaten and is an excellent source of folate
Carrot when fresh have bright orange flesh, crispy texture and are topped with feathery green fonds. They are prized culinary ingredient as their sweet flavour can be used in both savoury and sweet dishes. Carrots are an excellent source of carotene and contain some Vitamin C and dietary fibre.
Parsnip have a sweet flavour which develops as the vegetable matures and the starch contained in the tap root is converted to sugar. When cooked, the flesh is soft and creamy. Parsnip are an excellent source of Vitamin C and dietary fibre.

Bulbs

Onions and other bulbs are members of the lily family. This group of vegetables is considered to be the most aromatic or pungent in both flavour and aroma, particularly when they are cut. They are used as the key ingredient in the preparation of many stocks, soups and other slowly cooked casserole-style dishes. All variety of onions are high in water and Vitamin C.
Garlic grows as a bulb with a number of cloves forming a head. Each individual clove of garlic is encased in a very thin skin which has a papery texture and appearance. The whole bulb or head of the garlic is covered with several layers of dry skin. When cooked garlic has a much sweeter and more mild flavour and aroma.
Leeks have long, thick, white stem and thick, dark green outside leaves which become paler the closer they are to the centre of the plant. The white stem and pale leaves are commonly used in cooking as the darker leaves are considered to be too bitter.
Red onions vary in shape and density of colour. They generally have a sweeter flavour than either white or brown onions and are often served raw.
Salad onions are a variety of spring onion which has been allowed to mature until the bulb is slightly larger, but still considered green. The flavour is less developed and they are suitable to eat raw.
Shallots are made up of a number of small bulbs joined together in one plant. Shallots are dry onion with a golden brown, papery skin.
Spring onions are green onions and are harvested before they are completely mature. The bulb of the spring onion should be the same width as the hallow leaves. The leaves of the spring onion as well as the white bulb are used either raw or cooked.
White onions are commonly available and have a stronger aroma and flavour than brown onions. They have a papery skin which is white in colour and are used in a variety of recipes.

Properties of vegetables

As vegetables come from different parts of plants, each type will vary in its nutrient content. They generally contain a lot of water, fibre and vitamins and minerals; they are also virtually fat free. Vegetables provide us with antioxidants—they have an anti-cancer action within the body. It is sensible to include in the diet a variety of vegetables because their high fibre and water content means they are bulky, thereby satisfying our appetite without contributing excess kilojoules. Vegetables also tend to have a low glycaemic index: they release their carbohydrates more gradually into the bloodstream. This is advantageous to people suffering from diabetes, weight problems and heart disease. The skin of vegetables provides fibre, underneath which are vitamins and minerals. It is therefore best to eat vegetables either unpeeled or peel the skin off very thinly.

3. Legumes

Legumes are pod-bearing plants. Peas, beans and lentils have pods containing edible seeds. If we eat the seeds of these plants when they are young, they are known as vegetables; if we eat the seeds when the pods dry up and split open, we call them legumes. Legumes are therefore dried peas, beans and lentils; they are also known as **Pulses**.

Classification of legumes

Beans	Soy, Red, Butter, Lima, Haricot, Black-eyed, Cannellini, Borlotti, Pinto, Mung, Lupin, Kidney
Peas	Split, Red, Chickpea, Green
Lentils	Brown, Red, Yellow

Properties of legumes

Legumes are a highly nutritious food. They are rich in vegetable protein, vitamins, and minerals. Legumes are on average twice as rich in protein as grains although they do not contain all the essential amino acids. They are also high in fibre, an excellent source of carbohydrates and are low in fat. Legumes are also meal extenders, for example, they can be added to a meat dish to provide all the essentials nutrients. They can be used whole, pureed or ground into flour and added into dishes such as stews, soups, crepes, noodles or sauces.

4. Nuts

Nuts are plant foods: they are the edible dried fruits or seeds of plants, have a hard shell and tend to grow on trees. One exception is peanuts because they are not a true nut: they are really legumes and grow underground. They are still grouped with nuts as they share many of their properties.

Properties of nuts

Nuts are quite nutritious. Many people in the past have avoided eating them because of their high fat content, but many health benefits can be gained from regularly eating a small amount. The fats present in nuts are regarded as 'good' because they are mainly monounsaturated and polyunsaturated. The only exception is coconut: the fats present in coconut tend to be saturated and may contribute to heart disease. Being plant foods, nuts contain no cholesterol. We often use the fats extracted from them in cooking. Nuts are also high in protein, B group vitamins and fibre; the protein is incomplete, which means that some of the essential amino acids are missing.

Principles behind cooking fruits, vegetables and legumes

Most fruits can be eaten raw, cooking fruits softens the cellulose, cooks the starch and caramelizes the natural sugars changing the texture and flavor of the fruit.

- During the cooking process the cell walls of the fruit becomes tender, as water passes through the cell membranes causing the cells to swell and burst. As a result, the fruit loses its shape and pulp becomes soft.
- The addition of sugar strengthens the structure of the fruit when cooking and helps to retain the shape.
- Heat application causes some pigment changes and some loss of color occurs.
- There are also changes in flavor as the naturally occurring sugars in fruit begin to caramelize.

Fruits are readily available and harvested at certain times of the year, they are said to be in seasons. Fruits are processed and preserved for use at other times when fresh supplies are scarce. The fruit preservation methods include; **Bottling, Canning, Crystallization, Drying, Freezing, Addition of sugar or vinegar.**

Vegetables are cooked to reduce their bulk and make them more digestible by cooking the starch they contain. Some vegetables example, potatoes increase in bulk when cooked as they absorb water. Vitamins and minerals, particular Vitamin C are destroyed by heat and so vegetables should be cooked carefully to keep such losses to minimum.

Vegetables, except for leafy types, can be chopped and sautéed in fat, then placed in a covered casserole with little liquid in the oven, and cooked until tender. The juices should be used for gravy. This conserves most of the flavors, color and shape of the vegetables. Microwave cooking of vegetables in a minimum of water also conserves nutrients. When we cook vegetables, a number of major changes take place in the texture of the vegetables, their flavor and color and to their nutritional composition.

Nuts play an important role in the diet of vegetarians, so they should be eaten with other sources of protein, such as legumes or vegetables, to ensure that all of the amino acids are present. Consuming a variety of fruits and vegetables, including dried beans and lentils, will supply a range of phytochemicals that can help to promote health and prevent disease.

Unit 1: Food and Nutrition

Content Standard: 2.1 Examine and analyze the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards.

Benchmark: 11.2.1.2 Plan to develop a product using the food product development process and discuss the economic, social and technological influences.

Topic: Influences on Food Product Development

Learning Objective(s): By the end of the topic, the students should be able to;

- Plan and design a food product using the food design process.
- Investigate on the social, economic and technological influences on food product development.
- Evaluate and communicate the result of their design solution and the impact on individual wellbeing.

Essential Questions:

- What are the principles behind planning and designing a food product?
- What are the social, economic and technological influences on food product development?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Food production development process • Influences on food product development on the following aspects; ***Social*** • Family life and social change • Migration • Health concerns ***Economic*** • Consumer demand • Consumer protection • Industry economics ***Technological*** • Developments in food processing • Pasteurization and freezing • Gas and electric stoves • Microwave cookery
Skills	• Create a food product or nutritional meal using the design process • Identify and explain the social, economic, technological and environmental influences on food product development • Evaluate their design process
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices. • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing • Be sensitive and responsible of the social, economic,

	technological and environment influences on food product development and make responsible decisions • Appreciate the significant role of food in the society

Teaching and Learning Strategies

The teacher is to be familiar with the content aspects to guide and direct students learning and using the design process. The students should observe, make decisions, think critically and practice the processes of making the product using the design process considering the influences on food product development.

Learning Activities

Lesson 1: Social Influences on food production

Activity 1: Brainstorm and discuss the factors in your family and society that affect the development of food products.

Activity 2: How does migration play a role in food product development?

Lesson 2: Economical Influences on food production

Activity 1: Construct a guide or tool to research on consumer demands of a food product and develop a plan in meeting their needs.

Activity 2: Plan a design brief of the product in demand, develop it, advertise, market and investigate other economic factors that influence food product development

Lesson 3: Technological Influences on food production

Activity 1: Research and discuss traditional and modern technologies used in producing food in PNG and explain how they are used.

Activity 2: Discuss the advantages and disadvantages of technological advances on food production.

Content Background

Many factors impact significantly on food availability and distribution, both locally and around the world. Each individual factor can disrupt supply and distribution chains; however, in situations where two or more factors affect food availability, the outcome can be devastating. In developing countries, scenarios lack of food due to climate changes and natural disasters, low education levels and poor socioeconomic status are not uncommon; for developed countries, newer struggles to do with changing climates and wider technological advancements affect food supply and distribution.

1. Social factors

Family lifestyle and social change

Family life has changed dramatically over the years. Much of this change has been the result of increasing number of women in the work force and the changing roles that has entailed. The increasing participation rate of women in the work force has had a significant impact on family life where both parents are working, less time is available to meet all the family responsibilities. In many families, couples have found that they can share the family responsibilities. However, in reality in most families, women still accept the main role for family task particularly the preparation of food, as much as they have done in the past.

Migration

The arrival of migrants has had a positive impact on the economy of a nation by increasing the demand for additional goods and services, and encoring the expansion of health education and welfare services. Migrants have also provided the community with many new skills, additional labour and income. The development of new business has also been another of the positive impacts of migration. Not only did migrants have many important skills, they also brought with them many of the cultural influences of their country of origin, including their traditional foods and methods of cooking.

Health concerns

Another of the key factors that has influenced the development of modified food products has been an increasing awareness on the links between food consumption, good health and the prevention of disease. Throughout most of the twentieth century nutrition scientist have been aware of the relationship between the food we consume and our short-term health. The fact that weight gain is linked to intake of an excessive number of kilojoules in proportion to our daily needs is clearly understand and has been well documented.

Educational levels

Education mirrors these conflicts with informal and non-formal types of education being aligned to traditional cultures, and formal education being part of our Western heritage. In developing countries, informal types of education are often linked with traditional forms of living, in which people learn the knowledge and skills required to support the family and cultivate the land to provide food. These people do not have access to educational knowledge both to advance their employment opportunities and to financially support a family, nor do they obtain equal access to a wide range of food choice and availability. People who receive poor education thus lack knowledge in the area of nutrition and its links to physical health and development for individuals at different stages of the life span. This means they are less able to provide themselves and their families with a nutritious and varied food intake.

Poor education may also lead to an inadequate knowledge about healthier methods of food preparation and cooking techniques. Many people living in developing countries face further educational requirements in terms of the sustainability of the world's food sources. People need to be innovative and come up with practical ideas to promote sustainable food practices and lifestyles, which will have a positive influence on the future availability of food. Such education may sustain equitable food production and consumption for longer periods during times of food shortage.

Religious and cultural beliefs

A community's religious and cultural beliefs often dictate many daily practices within the group. Our cultural and religious beliefs link us to certain ideals and traditions regarding the way we live our lives, the actions we perform and even the foods we eat. The religious and cultural beliefs of a group of people may dictate the types of foods available to them, and therefore may limit the amount and types of nutritious foods within the population. In developing countries, where a ruling cultural or religious group discriminates against another, the discrimination can extend to the types of foods provided to a community during a food crisis. Unfortunately, this can also be a way of the ruling group retaining their control over the group being discriminated against. This discrimination and power can have a profound impact on the group who has access to the food distribution, with those groups seen as the 'weaker' communities not given access to any food.

2. Economic factors

Socioeconomic status

Living in poverty and in areas of low socioeconomic status means people usually have limited access to employment, resources, health care and equitable food. Poor people are less able to have access to adequate and nutritious food, with malnutrition being a major issue for those in developing countries. The reality is that many people in developing countries are poor and face hardship in meeting their basic needs of food and clean drinking water. It is essential that the economic benefits of globalisation extend to developing countries to ensure adequate food supply. That is, developed countries need to level the globalisation 'playing field' by reducing the tariffs and subsidies to agriculture that deny developing countries an opportunity to participate fairly in global trade. Reduced global tariff s will allow developing countries to export and gain economic development and enable its citizens to purchase foods.

Consumer demand

Over time, consumer preferences change. This happens for a number of reasons, such as changing tastes, trends, health and dietary needs, lifestyle changes and environmental impact beliefs. Along with the change in the frequency and times of shopping, consumers are also becoming far more discerning in the types of products they seek to purchase. Many consumers are now demanding products that will make their meal preparation simpler while still allowing them to feel that they have prepared the meal themselves. Older consumers, no longer faced with the need to provide meals for a large family, are also changing the types of food products they purchase. Consumers are also demanding products to address some of the health concerns they face and to provide them with increased quality of life.

Over the past decade, food manufacturers and retailers have taken up this challenge and a myriad of products which are advertise as low fat, low salt, low sugar, increased fibre, or containing additional calcium or are vitamin enriched are now cramming the supermarket shelves.

Industry economics

Food manufacturing industry is one of the most important in terms if its impact on a country's economy. Much of the industry's success in the international markets has been linked to a variety of factors;

- Mild climate that enables the production of raw ingredients that are readily accessible and at generally competitive price
- Reputation in the international market for producing high quality products that are safe and free from contamination
- World-class manufacturing industry that is based on leading edge technology
- Society with a strong multicultural basis that has demanded a wide variety of foods
- Geographically close to the expanding food markets eg: Asia-Pacific region. Food manufacturers are becoming aware that to remain competitive, they need to compare in the international market.

3. Technological factors

Developments in food processing/technological advances

Technology has led to new products or packaging; new products have been developed to both accommodate and be used with modern domestic appliances within the home, such as microwaves, ovens, fridges and freezers, deep-fryers, bread makers, coffee makers and slow-cookers. Even though slow-cookers have been available for many years, slow cooking has started to come back into fashion as newer and safer models have been developed.

Packaging

Technology continues to contribute to improvements in packaging, with the development of new, stronger, lighter materials and innovative designs. Intelligent packaging has also emerged that indicates a change in temperature or concentration of specific gases. All of this means that our food is fresher and lasts longer and that there is a reduction in waste.

Unit 1: Food and Nutrition

Content Standard: 2.1 Examine and analyze the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards.

Benchmark: 11.2.1.3 Practice application in hygiene, safety, ethical values and etiquettes in meal preparation, food handling, product development and meal presentation.

Topic: Food safety and hygienic practices in food product development

Learning Objective(s): By the end of the topic, the students should be able to;

- Identify and analyze safe food handling practices and hygienic practices in food product development.
- Investigate and analyze safe food packaging and marketing in food product development.
- Design and evaluate safe food presentation in relation to food product development.

Essential Questions:

- What are safe food handling and hygienic practices in food product development?
- How is food safely packed and marketed?
- What are the different ways of safe food presentation?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Hygiene, safety, ethical values and etiquettes in; - Meal preparation - Food handling /Food quality - Product development - Ergonomics • Safe food packaging • Safe food marketing • Safe food presentation - Garnishing and decorations - Plating food
Skills	• Analyse food handling and hygienic practices in food preparation to consumption • Investigate the processes and procedures of safe food packaging and marketing • Design and evaluate safe ways of preparing and presenting food
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices. • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing • Value the knowledge and understanding of nutrition and food consumption
	• Being mindful of the consequences of food choices on health

Teaching and Learning Strategies

The emphasis is placed on food safety, hygienic handling and safe food packaging in food product development. The teacher will use a wide range of teaching and learning methods to teach knowledge, skills, attitudes and values in this topic. Apart from this, teachers should also research other texts and collate learning notes for students. Teaching and learning approaches must be aimed at encouraging interest and also developing an awareness of the processes and procedures involved in food packing and marketing. Students must also investigate and identify safe and hygienic practices in relation to food safety and food quality.

Learning Activities

Lesson 1 Safe food handling practices

Activity 1:

1a. Brainstorm and list reasons on safe food handling. What are some main areas to be aware of to maintain safe work practises when handling food.

1b. Explain the concept of food quality in relation to food safety.

Activity 2: Research and cut or draw posters and display rules on safe food handling practises in the kitchen. Apply these rules in preparation of food in the school or at home.

Lesson 2 Safe food packaging

Activity 1: Explain the importance of packaging food and its role in the marketing of food. Why is labelling also important as part of packaging food.

Activity 2: Identify and explain the different methods/ways in which food can be packaged safely for consumption and marketing.

Lesson 3 Safe food marketing

Activity 1: Why should people who sell, handle and cook food be particularly careful about their personal hygiene? What are the health regulations for selling of food for public consumption?

Activity 2: Describe the consequences of selling food that is not healthy or safe for consumption in the homes and public areas.

Content Background

Food safety and hygiene practices

All food poisoning cases are thought to result from the mishandling of food by the consumer. People become ill because of contaminated food. Working in a food technology center or your kitchen at home can be fun but it is important to be aware of safety and hygiene at all times. Handling food, storing and preparing food correctly reduce the risk of food spoilage. Food safety golden rules are;

- Keep it cold
- Keep it clean
- Keep it hot
- Check the label

Safe work practices

The four main areas to be aware of to maintain safe work practices include;

- Temperature control
- Cooking food thoroughly
- Preventing the cross–contamination of food
- Personal hygiene

Temperature control

Basically food should be kept at very high or very low temperatures to avoid food poisoning. On the other hand, heat or high temperatures may kill or inactive potentially harmful bacteria, refrigeration or freezing only slows down the growth of bacteria-they do not kill the bacteria however, it is recommended that you use the two hour-four hour guide as given in the following table.

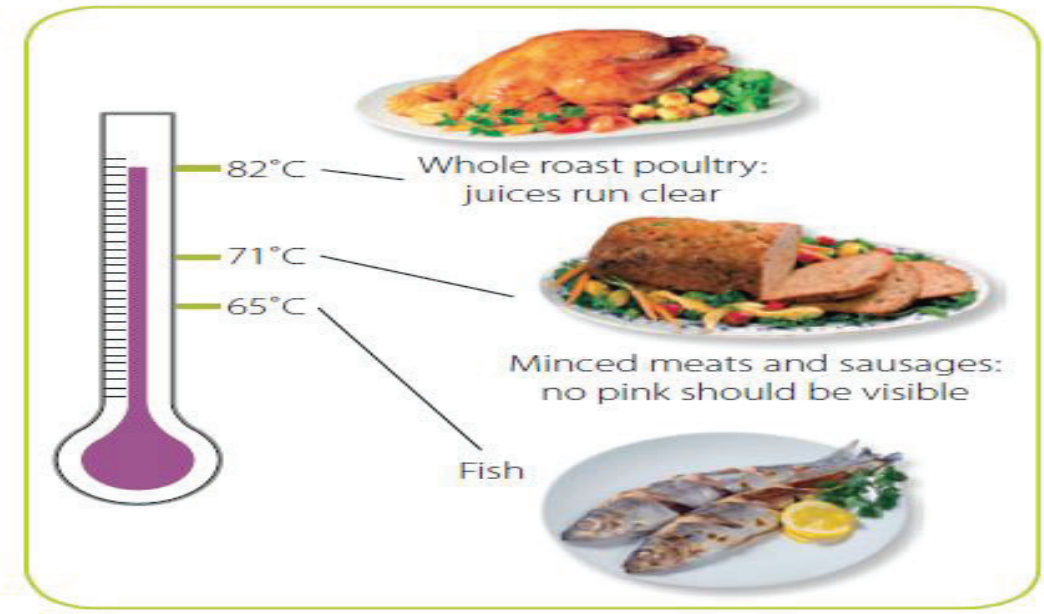
Food at room temperature	Recommended action
Less than two hours	Refrigerate or consume immediately
Between two and four hours	Consume immediately
Over four hours	Throw away

Cooking food thoroughly

Cooking food especially poultry correctly kills bacteria that may cause food poisoning. If the poultry or certain meats are not cooked thoroughly, it can be dangerous as they contain many harmful bacteria that can cause food poisoning. These bacteria such as salmonella and E.Coil, they are destroyed when meat is cooked thoroughly.

The illustration below shows the optimum temperatures for cooking particular meats.

- 82^0C – whole roast poultry juices run clear.
- 71^0C– minced meat and sausages: no pink should be visible.
- 65 ^{0}C – fish.



Preventing the cross-contamination of food

Cross- contamination is the transportation of harmful substances to food by;

a) Handling cooked foods or ready-to-eat foods without washing hands after touching raw foods such as meat, poultry and seafood.
b) Using the same knife and cutting board to cut the raw foods and ready to eat foods one after the other without being cleaned and sanitized in between.
c) Allowing the raw or contaminated foods to touch or drip fluids on cooked or ready-to-eat foods.

The safely cooked foods and the ready-to-eat foods may become hazardous by cross-contamination.

Food storage is important in order to prevent the cross –contamination of food or to help maintain food hygiene; Tips to store food correctly;

- Cover food with plastic wrap or put it in a container with an airtight lid before your place in the refrigerator.
- Ensure to place raw meat at the bottom of the refrigerator to prevent it from dropping onto another food, thereby causing potential bacterial infection.
- Make sure to cool cooked foods before putting them in the refrigerator or freezer.
- Store potatoes of other tubers in a cool, dark cardboard.
- Before placing foods in the freezer, label each with the date to ensure that you do not keep them for too long.

Food safety and hygiene is very vital in **food packaging, food marketing, food presentation**- Garnishing and decorations, plating food
Packaging plays a very important role in the production, preservation, distribution and marketing of manufactured foods. Packaging should contain the food, it should preserve and protect the contents from contamination. This is because consumers want food that is acceptable, safe and healthy for consumption. Good packaging of promotes safe and healthy food marketing.

Presentation of food in regard to visual appeal that includes garnishes used is a very important aspect of enticing people to eat. Food must be prepared and cooked following food safety and hygienic rules before serving or presenting it for consumption.

General food safety

- When shopping, pick up the refrigerated and frozen foods last.
- Choose frozen foods from the back of the freezer case; the items in the back usually remain the coldest.
- Never buy swollen chilled food packages, the foods in torn packages or imperfects seals.
- Do not buy frozen food packets containing ice crystals or clumps of ice
- Don't purchase the cans that are rusty, swollen and damaged.
- Never buy out-of-date food or food which shows the signs of spoilage or staleness.
- Do not purchase foods that do not have labels showing the information such as date of manufacture and expiry, ingredients, direction for preparation, storage temperature and address of manufacturer.
- Place perishables in the refrigerator or freezer as soon as you get home from the shop.
- Store meat, fish and poultry in plastic bags to avoid dripping on other foods
- Store can goods in a cool, clean and dry place.
- When power goes out, do not open the refrigerator and freezer doors as far as possible. A full freezer will stay at freezing temperature for two days if the door remain close.
- Never refreeze the thawed foods.
- Never eat raw or lightly cooked foods.
- Cook ground beef, red meats and poultry products until they are no longer red in the middle.
- Clean cans before opening them to avoid contamination of contents.

Food quality is a measure of excellence or state of being free from defects, deficiencies, and significant variations. A quality product is one that complies with the requirements specified by the client. This means quality is defined by client based on a number of subjective and objective measurements of the food product. This may include measures of purity, flavour, aroma, colour, maturity, safety, nutrition, or other attributes or characteristics of the product.

Food safety and food quality are among essential consumer requirements together with packaging and labeling.

Personal hygiene

Good personal hygiene help prevent bacteria from spreading to food and making everyone who eats the food ill. People and animals carry bacteria so it is important to keep pets out of the kitchen when preparing food. It is also important that you wash your hand thoroughly before handling food.

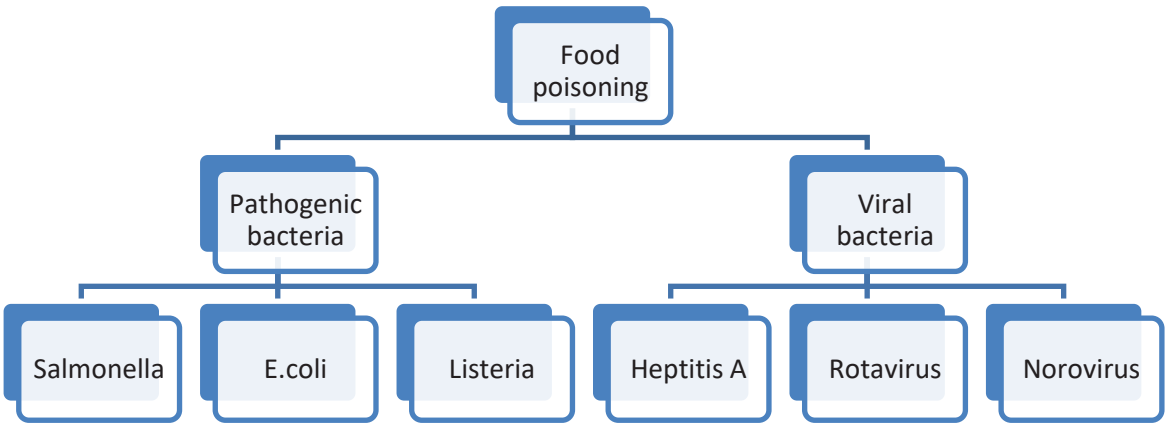
Washing hands

Seven (7) ways of washing hands;

1. Turn on the water at the hand washing sink. Warm water is recommended. Put your hands under the water to wet them and rise off any loose dirt.
2. Take one squirt of soap or use a bar of soap.
3. Rub the soap between your hands to make a lather. Wash your palms, the back of your hands between your fingers, under your fingernails and up to your wrists. You should do for 10-15 seconds.
4. Rinse off all the soap.
5. Dry your hands with a piece of paper towel or cloth.
6. Place the paper towel in the bin.
7. Make sure the sink is left neat and dry.

Food Hygiene

Food must be free from bacteria or viruses. Food poisoning is caused by pathogenic bacteria or viruses in food. The diagram below shows some examples of the different pathogenic bacteria and viruses.



Although symptoms will vary according to the type of bacterium or virus, general symptoms include diarrhoea, vomiting, nausea, abdominal pain and fever. Some common pathogens and their features are listed in the table below.

Pathogen	Symptoms	Associated foods
Bacillus cereus toxin	Sudden onset of severe nausea and vomiting	Incorrectly refrigerated cooked rice
Bacillus cereus toxin	Abdominal cramps, nausea and watery diarrhoea	Meats, stews, gravy
Campylobacter	Fever, nausea, abdominal cramps and diarrhea(sometimes bloody)	Raw and undercooked poultry, unpasteurised milk and contaminated water

Clostridium perfringens toxin	Abdominal cramps, watery diarrhea and nausea,	Meats, poultry, gravy, dried or precooked foods
Escherichia coil (STEC)	Diarrhea (often bloody), abdominal cramps	Incorrectly cooked beef, unpasteurized milk and juice, sprouts and contaminated water
Hepatitis A	Jaundice, fatigue, reduced appetite, nausea	Raw or poorly cooked seafood taken from contaminated waters, ready-to eat foods touched by an infected worker
Listeria monocytogenes	Meningitis, sepsis, fever	Soft cheese, unpasteurized milk, ready-to-eat daily meats

Ethical values and etiquettes in;

- Meal preparation
- Food handling
- Product development

Ergonomics

Greek word ‘ergon’ means work and ‘normos’ means law. The purpose of ergonomics is to design appliances, tools, equipment and tasks in such a way as to improve human safety, health, comfort and performance. Ergonomics reduces inconveniences and helps improve performance. For example, a well-designed and ergonomically sound kitchen tool, utensil or appliance is a valuable and necessary resource for the cook to carry out efficient and effective food preparation. Designers and manufacturers are very aware of consumers’ needs for convenient, time saving tools that help them carry out food preparation tasks quickly, effectively and safely. The sense of touch, sight and sound are also important considerations for kitchen equipment designers. All kitchen equipment, tools and gadgets much be safe and clean to handle for food preparation.

Unit 1: Food and Nutrition

Content Standard: 2.1 Examine and analyze the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards.

Topic: Solutions to Nutritional Problems

Benchmark: 11.2.1.4 Solve nutritional problems using the design process and communicate ideas in written, oral and graphical form.

Learning Objective(s): By the end of the topic, the students should be able to;

- Research and suggest possible nutritional solutions that are caused by nutritional related illnesses.
- Plan, design and evaluate a nutritious meal for a person or people with special needs.

Essential Questions:

- What are the causes of food borne illness in and how to prevent them?
- What are the different nutritional related illnesses?
- What are the various nutritional food needs for a person or people with special needs?
- How is a nutritious meal designed for a person or people with special needs?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Nutrition related illnesses and prevention of food borne illness - malnutrition - obesity - diabetes - coronary heart disease - hypotension - anorexia - anaemia - osteoporosis - bowel cancer - bulimia • Food intolerance - enzyme deficiency - mal-absorption - food allergies • Guidelines to healthy eating - Nutrition labelling awareness - Healthy eating pyramid • Nutritious meal planning and preparation
Skills	• Investigate on the causes of acquiring food borne illnesses and how to prevent them • Analyse the different nutritional needs of a person or people with special needs • Evaluate a nutritional meal planned, prepared and

	presented
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices. • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing

Teaching and Learning Strategies

The teacher is encouraged to introduce the topic and divide the lessons into theory and practical lessons. The emphasis is on illnesses caused by poor nutrition as well as the correct dietary intakes with people with special needs. Students are required to participate in all organised learning activities. Students must be given the opportunity to research and investigate the causes of nutrition related diseases and to also apply problem solving approaches. The lesson activities will require the teacher's close supervision to guide students. The learning strategy is enquiry and project based.

Learning Activities

Lesson 1: Nutrition related illnesses

Activity 1: Explain the difference between food borne illness and nutrition related illness. What is cross-contamination. Discuss the ways in which food borne illnesses can be prevented and how a nutrition related illness such as diabetes be treated.

Activity 2: Work in pairs, select any food related illness, research and present in class.

Lesson 2: Meals for special needs

Activity 1: What is a balanced diet? Consult the food guide pyramid and dietary guidelines to help you plan individual selection of healthy diets.

Activity 2: Identify the different groups of people and their nutritional requirements. Which group of people need more attention in your surrounding? Plan and prepare meals for those with special need.

Lesson 3: Guidelines for healthy eating

Activity 1: Research and present in class the healthy eating guidelines that should be practised in PNG to avoid or prevent different nutrition related illnesses affecting people in PNG.

Activity 2: Carry out nutrition labelling awareness and educate others on the importance of reading and understanding the nutrition content of food before buying.

Lesson 4: Plan and design a nutritious meal

Activity 1: Do a research in your surrounding on people living with or suffering from some nutrition related illnesses. Construct a design brief including the specification of your design brief.

Activity 2: Work in groups:

Plan and prepare a meal by identifying a recipe suitable for helping a selected person from your research (Activity 1) who is affected by a nutrition related illness.

Content Background

Food borne illness is a disease transmitted to humans through food and water. Most food borne illness are caused by bacteria. Bacteria are present in air, water, ground and raw products such as meat, poultry, seafood and eggs. The safety cooked foods and ready-made-foods may become hazardous by cross-contamination. The food borne illness can be prevented by four ways;

- Keep hands and surfaces clean
- Keep raw foods from the cooked or ready-to-eat foods
- Cook foods at right temperature- safe cooking temperature for raw foods
- Refrigerate promptly – recommended times for refrigerator and freezer food storage

Nutrition related illness

1. Malnutrition

Malnutrition refers to an imbalance of nutrients. It can result from either consuming too many nutrients (over nutrition) or not consuming enough nutrients (under nutrition). In both cases, the balance of nutrients is not correct. Not enough or too many nutrients can result in diet-related diseases.

2. Obesity

Obesity is defined as being 20 per cent or more overweight. Men are more likely to be overweight and obese than women at every age. Obesity increases the risk of many chronic (or ongoing) and potentially fatal diseases, many of which are preventable through healthy eating and regular physical activity. The more fat a person carries, the greater the risk to their health. These diseases and conditions include:

• insulin resistance
• high blood pressure
• stroke
• cardiovascular disease
• sleep apnoea
• type 2 diabetes
• gall bladder disease
• some cancers, such as breast, colon and endometrial
• stress incontinence
• gout

3. Type 2 diabetes

Diabetes occurs when the body cannot make proper use of the glucose in the blood. The most common type of diabetes is type 2 diabetes: it accounts for 90 per cent of all diabetes cases and is diet related. Insulin is manufactured by the body to move glucose into the cells. When the body resists the action of the insulin, the glucose cannot enter the body's cells.

This resistance occurs because of the increasing levels of fat in and around the cells, most often seen in overweight or obese people. When the insulin cannot get the glucose into the cells, the body responds by producing more insulin. If this continues over a long period of time, type 2 diabetes may develop. In many cases, being overweight or obese results in high insulin levels and insulin resistance.

Many people wrongly believe that consuming excess amounts of sugar causes diabetes.

This is because diabetes itself results in a high level of blood sugar. In this way, people with diabetes used to be told to avoid all sugars as sugar was thought to cause blood sugar levels to increase more than other factors in food. We now know that this is not always the case. Sugar does not cause blood glucose levels to rise very high at a rapid rate. The effect of food on blood glucose levels depends on many factors, such as the composition of the food and how it is processed. Foods with a low glycaemic index (GI) tend to cause a lower, steadier rise in blood glucose levels and so are more beneficial to those people with diabetes. For example, low GI foods consumed as part of a meal can decrease the overall GI of the meal, slowing the increase of glucose in the bloodstream after the meal. Consuming a diet high in fibre, low in fat and based mainly on plant foods is recommended for those with diabetes. It is also recommended that a healthy weight is maintained and regular physical activity is undertaken.

4. Coronary heart disease

Is a disease in the major blood vessels of the heart where build-up of plaque cause arteries to narrow limiting blood flow to the heart. To reduce the risk of developing heart disease, we should undertake regular physical activity most days of the week. Coronary heart disease is also associated with a diet high in saturated fats, trans fats and cholesterol. We should replace much of the saturated and trans fats in our diet with polyunsaturated and monounsaturated fats to reduce blood cholesterol levels. We should also note that all fats provide the same number of kilojoules. Cholesterol is an important part of cell membranes and some hormones. It is also an essential substance for good health. We do not need to consume it as our body can make its own supplies. Problems arise therefore with cholesterol when people consume too much saturated fat. Clogged arteries hinder blood flow and enable blood clots to settle. To decrease blood cholesterol, one must decrease saturated fats in the diet. Oats, legumes and some fruits and vegetables, all high in soluble fibre, tend to increase the amount of cholesterol that is excreted in the faeces. Cholesterol in the blood is attached to a protein molecule called a lipoprotein. High-density lipoproteins (HDL) are beneficial to health as they remove cholesterol from the artery wall and return it to the liver. In this way, HDL can protect against heart disease. In contrast, low-density lipoproteins (LDL) are not considered to be beneficial to health as they deposit cholesterol in the cell, resulting in a build-up of cholesterol. Saturated fats increase the levels of LDL in the blood.

5. Hypertension

Hypertension is the term used to describe high blood pressure. It can be the result of a high-salt diet. Other factors that contribute to this diet-related disease include:

- being overweight
- a sedentary (or inactive) lifestyle
- high fat intake.

Hypertension results when the heart is forced to pump blood around the body under too much pressure. A high-salt diet can lead to the build-up of sodium in the smooth muscle cells of the small blood vessels. The blood vessels then start pumping more vigorously, which causes an increase in blood pressure. The circulatory system is put under a great deal of strain when blood pressure is increased, and the inner lining of the arteries become damaged. Fatty tissues can build up in the damaged area, leading to heart disease and stroke. A stroke causes damage to the brain because the blood supply is interrupted. It can result if a blood vessel breaks and blood leaks into the surrounding brain tissue. Hypertension can cause the blood vessels to become damaged and lead to them rupturing; this can also be caused by a build-up of fatty deposits.

6. Anorexia and bulimia nervosa

Disordered (or restrained) eating is a term that refers to a group of illnesses for which people have a distorted view of their body shape and weight and have disturbances in their eating behaviour. They have a strong desire for weight loss and to be unhealthily thin because they consider themselves fat. Anorexia nervosa is a type of disordered eating that is characterised by excessive concerns about weight, low self-esteem, extreme fear of gaining weight or becoming 'fat'and intentional maintenance of a very low body weight.

Effects of disordered eating on health

People who have eating disorders tend to have low self-esteem. Disordered eating occurs in both males and females, but it is more prevalent in females. The causes of disordered eating are often unclear, but there tend to be psychological, social and genetic determinants. The physical effects of eating disorders include:

- dehydration, diarrhoea and constipation
- irregular or no periods (for females)
- muscles spasm or cramps
- chronic indigestion
- kidney damage
- damage to the colon
- infections of the urinary tract.

Another type of disordered eating is bulimia nervosa. This illness is typified by periods of bingeing, usually on high-kilojoule foods, and then followed by an avoidance of the weight gain by:

- vomiting (or purging)
- using laxatives
- excessive exercising
- strict dieting.

A person with bulimia nervosa is often not recognised as having the condition because they are typically average or slightly above average weight for their height.

7. Anaemia

Prolonged iron deficiency can lead to anaemia, which means that there are decreased levels of haemoglobin in the blood and therefore less oxygen is reaching the body tissues. Symptoms of anaemia include irritability, faintness and fatigue. This means that the body is not able to operate normally. The lack of iron is a common nutrient deficiency in many developed countries. Symptoms of iron deficiency include:

- weakness
- tiredness
- decreased ability to maintain a constant body temperature
- decreased ability to perform physical activity.

Adolescent girls and women are more prone to anaemia owing to blood losses from menstruation and the demands of pregnancy and lactation. Iron-rich foods such as red meat are therefore essential. However, many females select chicken over red meat because they incorrectly assume that red meat contains more fat. Other groups at risk of anaemia are athletes and vegetarians.

8. Osteoporosis

Osteoporosis is a condition in which the loss of bone density mass results in brittle bones. This means that the bones become thinner, more porous and therefore more liable to break. Osteoporosis is linked to a lack of calcium. It is therefore important to build up bone density by consuming calcium-rich foods majority of calcium consumed is used for the development of bones and teeth.

9. Bowel cancer

The bowel in the body includes the small bowel, colon and rectum, and consists of the long tube that absorbs water and nutrients from food and processes waste products into faeces. Bowel (or colorectal) cancer usually begins in the lining of the colon or rectum. If left untreated, the cancer will spread into the wall of the bowel, then into the lymph nodes and possibly the liver and lungs. Factors that are considered risk factors for bowel cancer include:

- high intake of saturated fat
- high intake of salt
- low intake of fibre
- lack of physical activity.

These factors can be prevented with changes to eating and physical activity behaviours.

Unit 1: Food and Nutrition

Content Standard: 2.1 Examine and analyze the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards.

Benchmark: 11.2.1.5 Investigate the recommended dietary intake of energy, protein, vitamins and minerals for particular individuals and groups using appropriate data such as RDI tables in print or electronic format.

Topic: Dietary Issues

Learning Objective(s): By the end of the topic, the students should be able to;

- Investigate and analyze dietary guidelines recommended for different age groups and needs.
- Discuss and examine the importance of using Recommended Dietary Intake (RDI) tables and their consequences of not following them.

Essential Questions:

- Why are RDI guidelines and other nutritional food information guidelines important to different age groups?
- What are the causes of refraining from following the RDI and nutritional guidelines?
- How are RDI guidelines useful to different age groups?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• RDI (Recommended Dietary Intake) tables/Food composition table • Food pyramid • Targets for healthy eating • Collecting, analysing and interpreting data for dietary intake • Dietary guidelines for special needs; - Infants and children - School age - adolescence - Adults - Pregnant mothers - Invalids (old, sick) - Sportspersons - Pregnant women - Vegetarians (strike diets)
Skills	• Explain and analyse the importance of following the RDI guidelines other nutritional food information guidelines • Evaluate the consequences of refraining from following the RDI and nutritional guidelines
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices. • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing

Teaching and Learning Strategies

Teachers are required to introduce to students to better understand the ideas and concepts that are taught for this topic. Students will investigate and analyse dietary issues such as RDI guidelines and other nutritional food information guidelines that is important to different age groups. Hence, students will further learn the key concepts of RDI, food composition tables and dietary guidelines for healthy living. Students must be given opportunities to apply their knowledge to analyse, investigate, discuss and examine the importance of using RDI dietary guidelines and issues.

Learning Activities

Lesson: RDI and food composition tables

Activity 1: Refer to the recommended dietary intake table and answer these questions.

1a. How does the RDI of protein for boys aged 14-18 compare with that of girls aged 14-18?
1b. Identify one nutrient in which the RDI for boys and girls aged 14-18 is the same.
1c. Identify one nutrient in which the RDI for boys and girls aged 14-18 is different.
1d. Explain NRV and how it relates with RDI and its importance.

Activity 2: Refer to the Pacific Islands food composition table and answer these questions

2a. Study the Pacific island food composition table on starchy food and list down five foods that provide the highest amount of energy and Calcium.

Lesson 2 Targets for healthy living

Activity 1: In groups, discuss and present in class some ways that can help individuals to practise healthy living and reasons why everyone should target for healthy living in the school.

Lesson 3 Dietary guidelines for healthy living

Activity 1: Study the example of the dietary guidelines for Australia and use our foods available in PNG to draw up a dietary guideline to follow.

Activity 2: What types of foods are recommended to be eaten in small amounts?

Content Background

Eating well is easy in theory. All you have to do is choose a selection of the estimated essential nutrients, fibres and energy without excess intake of fat, sugar and salt and be sure to get exercise to balance the food you eat. A few people do these things automatically but most do not. Many people are overweight, or undernourished, or suffer from nutrient excess or deficiencies that impair their health. To master the task of meeting your nutrient needs, you may find it useful to learn the answers to several questions.

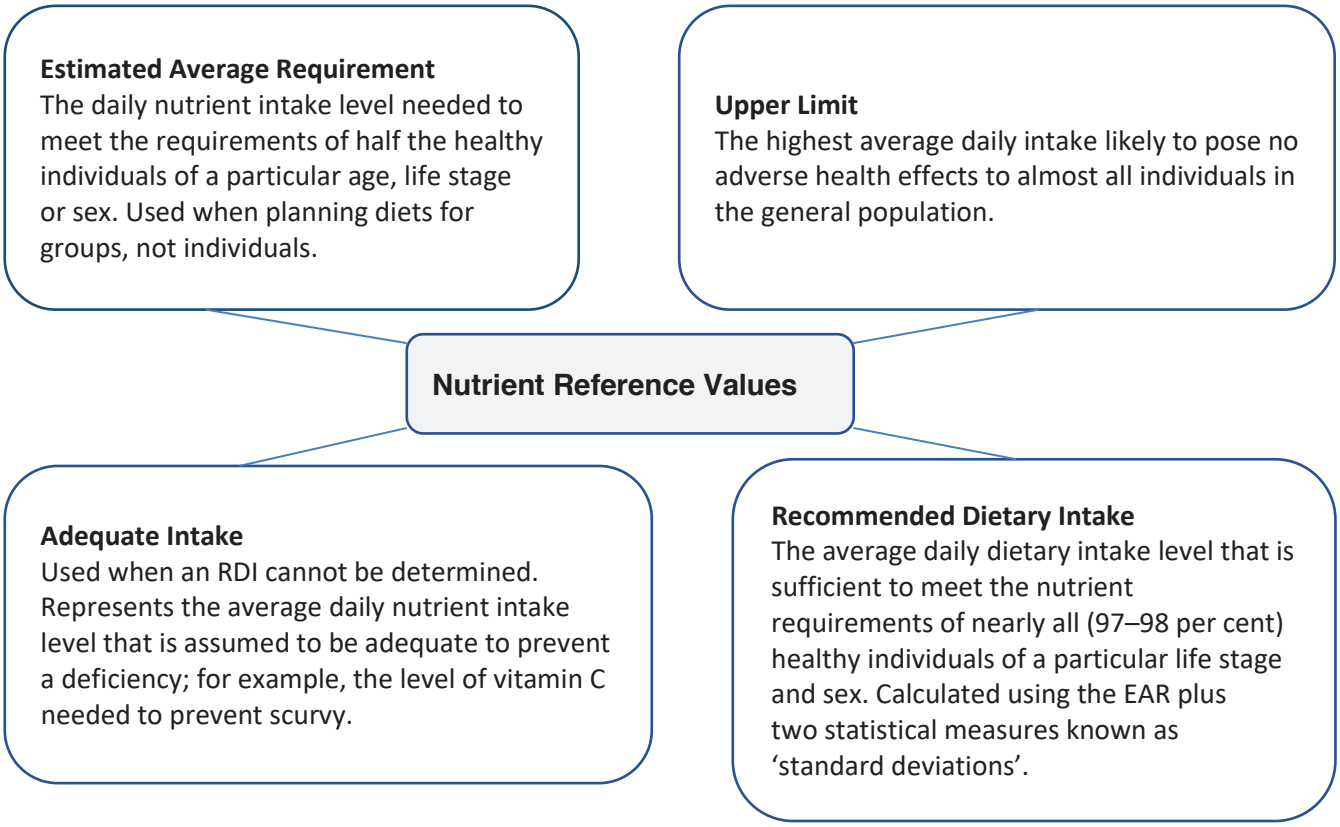
1) How much energy and how much of each nutrient do you need?
2) How much physical activity do you need to balance the energy you take in from food?
3) Which types of food supply which nutrient?
4) How much of each type of food do you have to eat to get enough?
5) How can you eat all this foods without gaining weight and without getting too much sugar and fat?

Nutrient recommendations- are sets of yardsticks used as standards for measuring people's energy and nutrient intakes. Nutrition experts use them to make nutrient recommendations, to assess nutrient intakes, and to perform other nutrients related tasks.

Recommended dietary Intake (RDI)
Researchers have found that certain amounts of some of the nutrients are needed each day from the diet to keep people healthy. **These amounts are called the Recommended Dietary Intakes (RDI)**. The Recommended Dietary Intake (RDI) is the average daily dietary intake that is sufficient to meet the nutrient requirements of nearly all healthy individuals in a particular life span stage and sex group. The RDIs were just one single value and have been designed for use with populations groups; however, they were often incorrectly used in assessing the dietary adequacy of individuals. NRVs were developed to help overcome this incorrect use.

Nutrient reference values (NRV) are a set of reference values for each nutrient. NRVs were released to replace the Recommended Dietary Intake (RDI). The concept of the RDI is retained in this set of reference values. NRVs provide recommended intakes for the 33 nutrients based on age, sex and life stages (compared with 19 covered by the old RDIs). These changes in values show evidence of current research in nutrition to assist dieticians with providing accurate information.

The NRVs contain four different values: the Adequate Intake (AI), the Estimated Average Requirement (EAR), the Upper Limit (UL) and the Recommended Dietary Intake (RDI).



There is also a new set of Suggested Dietary Targets (SDTs) that recommend increase intakes of particular nutrients that may prevent chronic diseases such as high blood pressure, heart disease and some cancers. For example, the RDI for Vitamin C is 45 milligrams, but the SDT is 190 milligrams for women and 220 milligrams for men.

The guideline to Healthy Eating

Many countries including PNG have guidelines to Healthy Eating. The guidelines for some countries reflect the cultural nature of food consumption patterns. The guideline is a food selection model that can help individuals plan a variety of foods to be consumed daily. It has five food groups and encourages individuals to consume a variety of foods from each of these five groups. The model also includes foods to eat in small amounts that are high in fat, sugar and salt. In addition, it promotes the consumption of water.

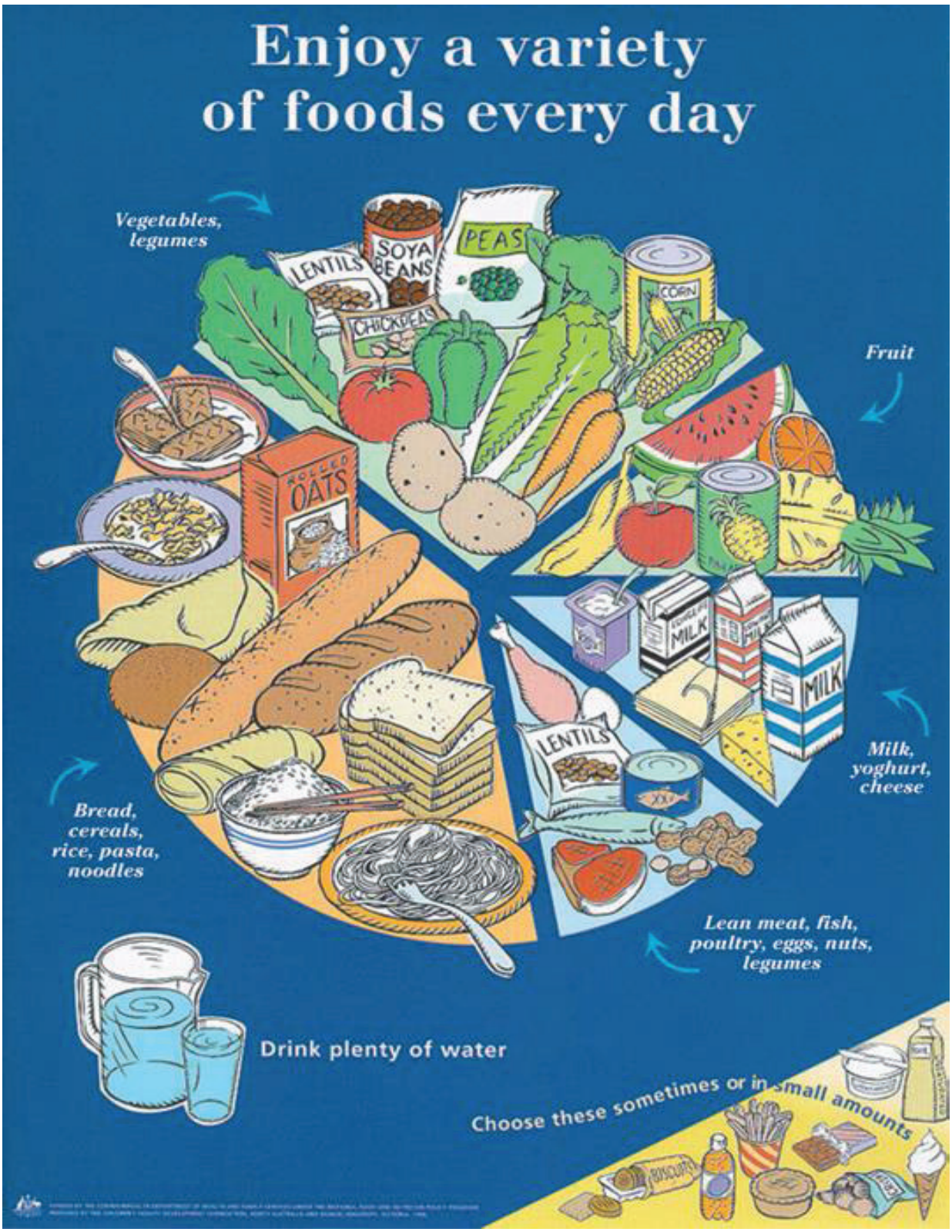
Let us learn about the Australian Guide to Healthy Eating

Individuals who consume a diet consistent with the *Australian Guide to Healthy Eating* are eating a variety of foods across and within the five food groups. Such individuals would be consuming:

- bread, cereals, rice, pasta, noodles,
- vegetables and legumes,
- fruit,
- milk, yoghurt and cheese
- meat, fish, poultry, eggs, nuts and legumes.

These foods are grouped according to their similarities in nutrients. These individuals are also avoiding foods that should be eaten in small amounts because of their high fat, salt and sugar content, such as cakes, biscuits and chips. This helps to promote healthy eating and reduce the risk of many health problems now and later in life, such as hypertension, obesity and coronary heart disease.

A guide to healthy eating e.g.: Australian Guide to Healthy Eating



Nutritional requirements across the life cycle

We all need the same types of nutrients through life, but the amounts of nutrients required vary at each stage of the life cycle. Let's explore the stages of the life span and the important nutrients necessary for each stage.

Stages of life	Characteristics	Important Nutrient
Prenatal	Requires increase in nutrients, not kilojoules, for growth of foetal and maternal tissues	Protein, carbohydrates, B group vitamins, iron, folate
Infancy	Time of rapid growth	Protein, carbohydrates, calcium, phosphorus, B group vitamins, water
Childhood	Slow, steady growth and high activity	Fats, carbohydrates, Protein, B group vitamins, calcium, phosphorus, vitamin D, zinc, iron, water
Adolescence	Rapid growth and development and high activity	Carbohydrates, B group vitamins, protein, iron, calcium, water
Adulthood – early and middle	Growth slows down greatly, so most nutrients are required for maintenance and repair	Calcium, phosphorus, vitamin D, fats, carbohydrates, protein, B group vitamins, water
Late adulthood	Growth has slowed down, metabolic rate decreases and menopause occurs in women	Fiber, water protein, calcium, phosphorus, vitamin D and B group vitamins.

Recommended dietary Intake (RDI) for adolescence, children and adults

Nutrient	RDI for adolescents aged 14–18	Compared with RDI for children and adolescents aged 9–13	Compared with RDI for adults aged 19–30
Protein	Boys: 65 (0.99 g/kg) Girls: 45 (0.77 g/kg)	Increase	• Decrease for males • Increase in amount of protein but decrease g/kg for females
Vitamin A as retinol equivalents	Boys: 900 µg Girls: 700 µg	Increase	Same
Thiamine	Boys: 1.2 mg Girls: 1.1 mg	Increase	Same
Riboflavin	Boys: 1.3 mg Girls: 1.1 mg	Increase	Same
Niacin equivalents	Boys: 16 mg Girls: 14 mg	Increase	Same
Vitamin B6	Boys: 1.3 mg Girls: 1.2 mg	Increase	• Same for males • Increase for females
Vitamin B12	Boys: 2.4 µg Girls: 2.4 µg	Increase	Same
Folate	Boys: 400 µg Girls: 400 µg	Increase	Same
Vitamin C	Boys: 40 mg Girls: 40 mg	Same	Increase
Calcium	Boys: 1300 mg Girls: 1300 mg	• Increase for boys and girls aged 9–11 • Same for boys and girls aged 12–13	Increase
Iodine	Boys: 150 µg Girls: 150 µg	Increase	Same
Iron	Boys: 11 mg Girls: 15 mg	Increase	• Decrease for males • Increase for females
Magnesium	Boys: 410 mg Girls: 360 mg	Increase	Decrease
Molybdenum	Boys: 43 µg Girls: 43 µg	Increase	Increase
Phosphorus	Boys: 1250 mg Girls: 1250 mg	Increase	Decrease
Selenium	Boys: 70 µg Girls: 60 µg	Increase	Same
Zinc	Boys: 13 mg Girls: 7 mg	Increase	Increase

THE PACIFIC ISLANDS FOOD COMPOSITION TABLES

Key	Food name		Measure	Water	Energy	Energy	Protein	Total fat	CHO available	TDF	Na	Mg	K	Ca	Fe
			g	g	kcal	kJ	g	g	g	g	mg	mg	mg	mg	mg
A	**STARCHY STAPLES**														
A001	Arrowroot, Polynesian, flour		100	12	336	1 404	0.1	0.2	84.5	0.1	2	4	12	35	0.5
		1 tablespoon	9	1	30	126	T	T	7.6	T	T	T	1	3	T
A004	Banana, cooking, boiled, unsalted		100	69	111	465	0.8	0.2	26.3	1.2	4	33	400	5	0.5
A005	Banana, cooking, ripe, fried		100	35	265	1 109	1.5	9.2	43.9	2.3	3	54	610	6	0.8
A006	Banana, cooking, raw		100	68	124	519	0.9	0.2	29.8	0.7	4	36	489	18	0.6
		1 whole	140	95	174	727	1.3	0.3	41.7	1.0	6	50	685	25	0.8
A089	Banana, cooking, ami, baked		100	71	109	456	1.4	0.1	25.1	1.8	4	31	505	2	1.0
A095	Banana, cooking, opine, baked		100	53	180	753	2.4	0.2	42.4	0.7	4	50	505	3	1.7
A002	Breadfruit, boiled		100	81	75	313	1.3	0.9	14.4	2.5	1	23	350	13	0.2
A003	Breadfruit, baked		100	74	103	429	1.3	0.6	22.1	2.5	1	23	436	18	0.3
		1 serve	166	123	170	712	2.2	1.0	36.7	4.2	2	38	724	30	0.5
A008	Breadfruit, pulp, raw, mature		100	72	107	450	1.5	0.4	23.6	2.5	1	24	480	25	1.0
A011	Cassava, boiled		100	68	117	490	0.6	0.4	27.5	1.4	22	22	217	10	0.2
		1 serve	164	111	192	804	1.0	0.7	45.1	2.3	36	36	356	16	0.3
A012	Cassava, raw		100	60	147	614	1.1	0.5	34.2	1.5	26	27	331	11	0.2
		1 serve	142	86	208	871	1.6	0.7	48.6	2.1	37	38	470	16	0.3
A042	Cassava, tuber, baked		100	54	177	740	2.0	0.3	41.5	1.3	7	35	365	35	2.2
		1 cup	227	123	402	1 680	4.5	0.7	94.2	3.0	16	79	829	79	5.0
A041	Cassava, tuber, baked, earth-oven		100	59	151	632	0.8	0.5	35.0	2.8	21	29	326	11	0.2
		1 cup	227	134	343	1 435	1.8	1.1	79.5	6.4	48	66	740	25	0.5
A010	Cassava, flour		100	9	349	1 461	1.1	0.5	84.5	3.7	4	74	739	84	1.0
		1 cup	227	20	793	3 317	2.5	1.1	191.8	8.4	9	168	1 678	191	2.3
A091	Jakfruit, raw, *A. heterophyllus*, raw		100	83	55	232	1.6	0.2	7.4	9.4	48	10	292	37	1.7
A092	Jakfruit, *A. integer*, raw		100	67	126	529	2.5	0.4	25.8	5.7	25	46	246	40	1.1
A090	Jakfruit, *Artocarpus* sp., raw		100	75	83	348	2.2	0.3	16.7	3.0	3	14	350	18	0.8
A088	Pandanus, flour		100	13	319	1 334	2.9	1.3	75.0					797	1.7
A016	Potato, tuber, baked, salt & fat added		100	65	180	754	2.3	10.1	19.3	2.8	148	26	774	11	0.8
		1 whole	60	39	108	452	1.4	6.1	11.6	1.7	89	16	464	7	0.5
A017	Potato, dried, home prepared, mashed		100	77	97	404	2.7	2.3	14.8	3.6	245	11	136	41	0.5
		1 cup	260	199	251	1 050	7.0	6.0	38.5	9.4	637	29	354	107	1.3

THE PACIFIC ISLANDS FOOD COMPOSITION TABLES

Key	Food name		Measure	Zn	Retinol	β-carotene equiv.	Tot. Vit A equiv.	Thiamin	Riboflavin	Niacin	Vitamin B12	Vitamin C	Vitamin E	Cholesterol
			g	mg	µg	µg	µg	mg	mg	mg	µg	mg	mg	mg
A	**STARCHY STAPLES**													
A001	Arrowroot, Polynesian, flour		100	0.6	0	0	0	0.10	0.02	0.5	0.00	0.0	T	0
		1 tablespoon	9	0.1	0	0	0	0.01	T	T	0.00	0.0	T	0
A004	Banana, cooking, boiled, unsalted		100	0.2	0	116	10	0.03	0.04	0.5	0.00	9.0	0.3	0
A005	Banana, cooking, ripe, fried		100	0.4	0	149	12	0.11	0.02	0.6	0.00	12.0	2.2	0
A006	Banana, cooking, raw		100	0.1	0	180	15	0.15	0.06	0.7	0.00	11.0	0.3	0
		1 whole	140	0.1	0	252	21	0.21	0.08	1.0	0.00	15.4	0.4	0
A089	Banana, cooking, ami, baked		100	0.1	0	206	17	0.05	0.08	0.6	0.00	15.0	0.3	0
A095	Banana, cooking, opine, baked		100	0.2	0	206	17	0.08	0.13	1.0	0.00	25.0	0.5	0
A002	Breadfruit, boiled		100	0.1	0	30	3	0.08	0.05	0.7	0.00	22.0	0.7	0
A003	Breadfruit, baked		100	0.1	0	23	2	0.08	0.04	0.6	0.00	22.0	1.0	0
		1 serve	166	0.1	0	38	3	0.13	0.07	1.0	0.00	36.5	1.6	0
A008	Breadfruit, pulp, raw, mature		100	0.1	0	24	2	0.10	0.06	1.2	0.00	20.0	1.0	0
A011	Cassava, boiled		100	0.3	0	T	T	0.02	T	0.3	0.00	15.0	0.2	0
		1 serve	164	0.5	0	T	T	0.03	T	0.5	0.00	24.6	0.3	0
A012	Cassava, raw		100	0.4	0	T	T	0.04	0.02	0.4	0.00	36.0	0.2	0
		1 serve	142	0.6	0	T	T	0.06	0.03	0.6	0.00	51.1	0.3	0
A042	Cassava, tuber, baked		100	0.4	0	2	T	0.11	0.05	0.7	0.00	53.0	0.2	0
		1 cup	227	0.9	0	5	T	0.25	0.11	1.6	0.00	120.3	0.5	0
A041	Cassava, tuber, baked, earth-oven		100	0.4	0	T	T	T	T	0.4	0.00	31.0	0.2	0
		1 cup	227	0.9	0	T	T	T	T	0.9	0.00	70.4	0.5	0
A010	Cassava, flour		100	1.2	0	T	T	0.02	0.03	0.6	0.00	0.0	T	0
		1 cup	227	2.7	0	T	T	0.05	0.07	1.4	0.00	0.0	T	0
A091	Jakfruit, raw, *A. heterophyllus*, raw		100	0.5	0	110	9	0.06	0.06	0.4	0.00	7.9	0.1	0
A092	Jakfruit, *A. integer*, raw		100	0.5	0	80	7	0.16	0.15	0.5	0.00	17.7	0.2	0
A090	Jakfruit, *Artocarpus* sp., raw		100	0.8	0	1 130	94	0.04	0.12	0.6	0.00	6.0	0.1	0
A088	Pandanus, flour		100		0	1 200	100	0.06	0.16	2.3	0.00	0.0		0
A016	Potato, tuber, baked, salt & fat added		100	0.4	0	10	1	0.10	0.05	1.3	0.00	13.0	0.1	0
		1 whole	60	0.2	0	6	1	0.06	0.03	0.8	0.00	7.8	T	0
A017	Potato, dried, home prepared, mashed		100	0.2	1	30	4	0.01	0.08	0.6	0.00	1.0	T	1
		1 cup	260	0.5	3	78	9	0.03	0.21	1.6	0.00	2.6	T	3

THE PACIFIC ISLANDS FOOD COMPOSITION TABLES

Key	Food name		Measure	Water	Energy	Energy	Protein	Total fat	CHO available	TDF	Na	Mg	K	Ca	Fe
			g	g	kcal	kJ	g	g	g	g	mg	mg	mg	mg	mg
A	**STARCHY STAPLES**														
A013	Potato, fries, commercial, deep fried		100	50	250	1 044	4.0	13.9	26.2	3.7	158	29	520	9	1.1
		1 cup	95	47	237	992	3.8	13.2	24.9	3.5	150	28	494	9	1.0
A014	Potato, hash brown, McDonald's		100	44	312	1 305	2.4	21.7	27.3	1.4	520	21	360	23	2.6
		1 cup	95	42	296	1 240	2.3	20.6	25.9	1.3	494	20	342	22	2.5
A019	Potato, pale skin, peeled, baked		100	71	108	450	3.0	2.8	17.2	1.5	8	20	500	4	0.7
		1cup	260	184	280	1 171	7.8	7.3	44.7	3.9	21	52	1 300	10	1.8
A018	Potato, pale skin, peeled, boiled		100	79	66	275	2.6	0.2	13.0	1.1	7	17	415	2	0.5
		1cup	260	206	171	715	6.8	0.5	33.8	2.9	18	44	1 079	5	1.3
A015	Potato salad, canned		100	75	121	507	1.5	6.9	13.2	1.0	340	8	156	4	1.0
		1 cup	180	136	218	912	2.7	12.4	23.8	1.8	612	14	281	7	1.8
A023	Sago, flour		100	13	332	1 391	0.4	0.1	83.4	0.5	3	3	5	9	0.7
		1 cup	227	29	754	3 157	0.9	0.2	1 89.3	1.1	7	7	11	20	1.6
A022	Sago, flour, meal		100	13	347	1 451	1.4	0.2	85.9	0.3	8	3	36	15	1.4
		1 cup	227	30	787	3 294	3.2	0.5	1 95.0	0.7	18	7	82	34	3.2
A028	Sweet potato, konime, baked, earth-oven		100	67	128	534	1.9	0.1	29.6	1.2	31	22	414	33	2.1
		1 serve	213	142	272	1137	4.0	0.2	63.0	2.6	66	47	882	70	4.5
A029	Sweet potato, konime, baked, salted		100	67	128	535	1.3	0.1	30.3	1.2	108	22	533	33	2.1
		1 serve	213	142	273	1 140	2.8	0.2	64.5	2.6	230	47	1 135	70	4.5
A027	Sweet potato, konime, boiled		100	71	106	442	0.8	0.2	25.0	1.0	13	19	262	29	1.8
		1 serve	213	152	225	940	1.7	0.4	53.3	2.1	28	40	558	62	3.8
A030	Sweet potato, orange, peeled, boiled		100	79	69	287	1.9	0.1	14.1	2.3	10	13	225	26	0.5
		1 serve	213	168	146	611	4.0	0.2	30.0	4.9	21	28	479	55	1.1
A031	Sweet potato, pale, raw		100	72	110	461	1.0	0.3	25.6	1.3	52	26	260	21	0.9
A037	Sweet potato, seyspen, baked, earth-oven		100	70	114	478	2.0	0.1	25.8	1.8	31	22	414	30	2.0
		1 serve	213	148	243	1 018	4.3	0.2	55.0	3.8	66	47	882	64	4.3
A039	Sweet potato, white, peeled, boiled		100	77	79	329	1.4	0.1	17.3	2.0	12	8	182	13	0.5
		1 serve	213	163	167	701	3.0	0.2	36.8	4.3	26	17	388	28	1.1
A040	Sweet potato, yellow, raw		100	71	117	489	1.2	0.3	27.1	1.3	45	20	412	36	0.9
A036	Sweet potato, composite, baked		100	66	129	540	1.4	0.2	30.1	1.7	51	26	356	28	0.5
		1 serve	213	140	275	1 151	3.0	0.4	64.1	3.5	109	55	758	60	1.0

THE PACIFIC ISLANDS FOOD COMPOSITION TABLES

Key	Food name		Measure	Zn	Retinol	β-carotene equiv.	Tot. Vit A equiv.	Thiamin	Riboflavin	Niacin	Vitamin B12	Vitamin C	Vitamin E	Cholesterol
			g	mg	µg	µg	µg	mg	mg	mg	µg	mg	mg	mg
A	**STARCHY STAPLES**													
A013	Potato, fries, commercial, deep fried		100	0.5	1	0	1	0.10	0.04	1.5	0.00	10.0	0.3	12
		1 cup	95	0.5	1	0	1	0.10	0.04	1.4	0.00	9.5	0.3	11
A014	Potato, hash brown, McDonald's		100	0.4	1	0	1	0.01	0.03	1.2	0.00	6.0	0.5	38
		1 cup	95	0.4	1	0	1	0.01	0.03	1.1	0.00	5.7	0.4	36
A019	Potato, pale skin, peeled, baked		100	0.3	0	0	0	0.08	0.02	1.2	0.00	18.0	0.1	0
		1cup	260	0.8	0	0	0	0.21	0.05	3.1	0.00	46.8	0.2	0
A018	Potato, pale skin, peeled, boiled		100	0.3	0	0	0	0.07	0.02	1.0	0.00	21.0	0.1	0
		1cup	260	0.8	0	0	0	0.18	0.05	2.6	0.00	54.6	0.2	0
A015	Potato salad, canned		100	0.2	0	50	4	0.02	0.02	0.6	0.20	2.0	0.6	5
		1 cup	180	0.4	0	90	8	0.04	0.04	1.1	0.36	3.6	1.1	9
A023	Sago, flour		100	1.3	0	0	0	0.01	T	T	0.00	0.0	T	0
		1 cup	227	3.0	0	0	0	0.02	T	T	0.00	0.0	T	0
A022	Sago, flour, meal		100	1.3	0	0	0	0.01	0.00	0.2	0.00	0.0	T	0
		1 cup	227	3.0	0	0	0	0.02	0.00	0.5	0.00	0.0	T	0
A028	Sweet potato, konime, baked, earth-oven		100	0.4	0	63	5	0.10	0.04	0.6	0.00	48.0	5.4	0
		1 serve	213	0.8	0	134	11	0.21	0.09	1.3	0.00	1 02.2	11.5	0
A029	Sweet potato, konime, baked, salted		100	0.4	0	63	5	0.10	0.04	0.6	0.00	48.0	5.4	0
		1 serve	213	0.8	0	134	11	0.21	0.09	1.3	0.00	1 02.2	11.5	0
A027	Sweet potato, konime, boiled		100	0.3	0	57	5	0.08	0.04	0.6	0.00	42.0	4.0	0
		1 serve	213	0.6	0	121	10	0.17	0.09	1.3	0.00	89.5	8.5	0
A030	Sweet potato, orange, peeled, boiled		100	0.5	0	5 760	480	0.02	0.05	1.0	0.00	23.0	3.5	0
		1 serve	213	1.1	0	12 269	1 022	0.04	0.11	2.1	0.00	49.0	7.5	0
A031	Sweet potato, pale, raw		100	0.3	0	66	6	0.14	0.05	0.7	0.00	21.0	4.8	0
A037	Sweet potato, seyspen, baked, earth-oven		100	0.3	0	63	5	0.09	0.04	0.6	0.00	44.0	5.4	0
		1 serve	213	0.6	0	134	11	0.19	0.09	1.3	0.00	93.7	11.5	0
A039	Sweet potato, white, peeled, boiled		100	0.4	0	17	1	0.04	0.03	1.1	0.00	19.0	3.8	0
		1 serve	213	0.9	0	36	3	0.09	0.06	2.3	0.00	40.5	8.1	0
A040	Sweet potato, yellow, raw		100	0.3	0	4 380	365	0.12	0.05	0.6	0.00	30.0	4.8	0
A036	Sweet potato, composite, baked		100	0.4	0	63	5	0.09	0.04	0.7	0.00	25.0	5.6	0
		1 serve	213	0.9	0	134	11	0.20	0.08	1.6	0.00	53.3	11.9	0

Unit 2: Food Science

Content Standard 2.2: 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. (e.g., health, occasions, lifestyle, business)		
Benchmark	**Topic**	**Lesson Titles**
11.2.2.1 Recognize the significance of food science as a relevant science including current and historical developments and advancements of global food production	Food product development advancement	**Lesson 1:** Introduction to food Biotechnology
		Lesson 2: Genetic food engineering
		Lesson 3: Gastronomy
11.2.2.2 Explain the role of science as it relates to research practices and practical scientific experiments	Food engineering	**Lesson 1:** Introduction to food engineering
		Lesson 2: Modified food products
		Lesson 3: Food security and Climate change
11.2.2.3 Distinguish between the different kinds of chemical reactions in food and understand the factors that affect then	Chemical reaction in food	**Lesson 1:** Chemical reactions in food
		Lesson 2: Chemical reactions in starch and proteins
		Lesson 3: Chemical reactions in oils, fats, vitamins and minerals
		Lesson 4: Food fermentation
11.2.2.4 Describe methods of food preservation and their relationship to food safety	Food preservation	**Lesson 1:** Methods of food preservation
		Lesson 2: Food packaging
11.2.2.5 Investigate microorganisms in terms of classification, their growth and their application of food science	Food microbiology	**Lesson 1:** Introduction to food microbiology
		Lesson 2: Classification of Micro-organism
		Lesson 3: Roles of micro-organisms in food production

Unit 2: Food Science

Content Standard: 2.2 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. (e.g., health, occasions, lifestyle, business)

Benchmark: 11.2.2.1 Recognize the significance of food science as a relevant science including current and historical developments and advancements of global food production.

Topic: Food product development advancement

Learning Objective(s): By the end of the topic, the students should be able to;

- Identify and describe the significance of science in food product development.
- Examine the current and historical developments of food production.
- Investigate the advancements of science and technology in the global food production.

Essential Questions:

- What are the impacts on the current and historical developments of food production?
- How is science and technology advancement important in the global food production?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Biotechnology of food • Genetic engineering and irradiation - genetic modification - cells, DNA and genes • Modified food products - organic foods and antioxidants - functional foods • Gastronomy of food • Food security and effects of climate change on food • Emerging technology in food production
Skills	• Explain the impact of food genetic engineering and irradiation • Analyse the historical and current modified food products • Explore and identify emerging science and technology in food production • Design a food prototype using science and technology
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices. • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing

Teaching and Learning Strategies

Teachers are encouraged to use a variety of teaching and learning strategies to motivate students to think critically and enjoy learning at the same time.

Students are required to participate in all organised learning activities. Students must be given the opportunity to research and investigate the on the historical and advancements of global food production and food science. The lesson activities will require the teacher's close supervision to guide students.

Learning Activities

Lesson 1. Introduction to food Biotechnology

Activity 1: Explain the process of biotechnology and its purpose in food. What are some uses of biotechnology?

Activity 2: Explain examples of modern development in biotechnology

Lesson 2. Genetic food engineering

Activity 1: How is genetic engineering of food different to traditional methods of plants and animal breeding? Identify some of the difficulties for farmers in developing countries if GM seeds are available to sow their crops?

Activity 2: What are some of the dangers of genetically engineering of food? Would vegetarians be able to eat vegetables with animal gene inserted in them?

Lesson 3. Gastronomy

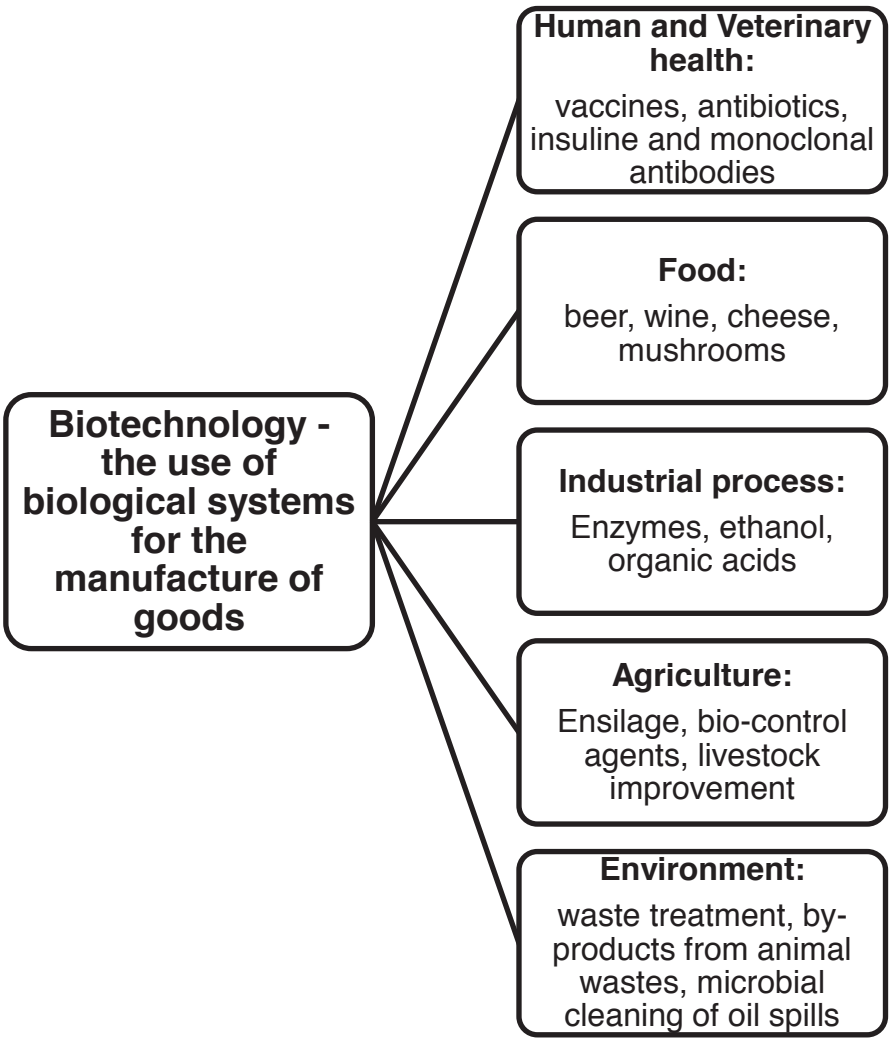
Activity 1: Explain what gastronomy is. How does biotechnology contribute to the preparation and consumption of food products?

Content Background

Biotechnology

For thousands of years, humans have used selective breeding to improve production of crops and livestock. Throughout history, farmers have advertently altered the genetics of crops through introducing them to new environment and breeding them with other plants. Farmers were able to choose the best needed crops having the good yields to produce enough food for everyone. The discovery that fruit juices fermented into wine or that milk could be converted into cheese or yoghurt, or that beer could be made by fermenting solutions of malt and hops began the study of biotechnology.

Biotechnology is a technique used to change life forms. Selected components of plant and animal cells, and microbes are integrated to develop new or modified organisms that are useful to human beings. It includes choosing and reproducing the best traits in plants and animals to improve breeds or crops. It also includes changing inherited characteristics by altering the genetic makeup of a living thing. Biotechnology has been happening in the production of food for thousands of years. Beer, wine and bread utilise micro-organisms in their production processes. Turning milk into yoghurt and cheese, and preserving food by pickling in vinegar are all products of biotechnology. Being able to eat a fresh tomato or a bunch of grapes in winter are examples of modern development in biotechnology and is common-place in our lives. Without it we would not be able to produce enough food for the world.



Genetic Engineering

Although biotechnology has been around for centuries, the development of some modern techniques in the moleculer biology has revolutionized the ancient processes and given us potential to do more. **Genetic engineering** is a relatively new technique in biotechnology is being used in the agricultural and food processing industries. The properties of living cells are determined by their genetic make-up by the instructions contained in the **genes.** These genes are made up of **Deoxyribonucleic acid (DNA).** All the information about a plant and animal, including its colour, size, shape, and growth is carried in its genes. This information is passed on to the next generation of plants and animals when it reproduces. Using genetic engineering, scientists can alter genes and change certain features of a plant or animal. Scientists do not always know where the introduced gene will land on the host DNA and can only guess at the broader long-term impacts of such changes to a complex living system.

Genetically modified foods

Genetically modified foods are not extension of traditional selective breeding practices that developed new wheat varieties and cattle breeds. Traditional breeding could not produce organisms beyond the limits of natural reproduction. Cross-pollination, hybridisation and matting cannot cross species boundaries that are plants cannot cross breed with animals. In contrast, genetic engineering can take genes from any species and transfer them to another.

Transgenic foods

Transgenic foods are foods that have some DNA from another species inserted into it to alter one or more of its characteristics. Plants can become resistant to disease and pest that often spoil them, or their nutritional value may change to be higher in protein or to resist the absorption of fat when cooking. Some examples of genetically engineered food products include;

1. Tomatoes that do not go soft during transport and can be left on the plant longer to develop.
2. Potatoes that have resistance to potato leaf roll virus.
3. Yeast that raises bread more quickly.

Genetically Modified Crops

Crops can be given extra genes for new and useful characteristics. They are genetically modified (GM)

What characteristics might be useful in crops?

- Pest resistance
- Frost resistance
- Disease resistance
- Herbicide resistance
- Drought resistance
- Longer shelf life

Plants with extra vitamins
Rice can be genetically modified to make beta-carotene, a substance that is converted into vitamin A in the body.

The colour of the rice is an indication of how much more beta-carotene it contains.

The GM rice is called **'Golden Rice'** and is being developed to help fight vitamin A deficiency and blindness in developing countries.

Advancements in Genetic engineering
Researchers involved in genetic modification are aiming to develop foods that offer many consumers benefits such as;

- Increased in vitamin and protein content.
- Removal of allergy-causing properties.
- Inclusion of properties that prevent chronic diseases, cancers and heart disease.
- Use of fewer chemicals in agricultural production.

Some people are concerned about the use of this new technique, so genetically engineered foods are carefully controlled and regulated. The concerns include;

1. Genetically engineered plants and animals could affect the natural ecology of wildlife.
2. The genes from animals that some religions forbid people to eat may be used in foods.
3. The welfare of animals could be at risk.
4. Legislation is needed to require such foods to be clearly labeled.

When scientist transfer generic material from one organism to another, the genetic transfer is neither random nor natural boundaries between species, and even between the biological kingdoms; plants, animals and micro-organisms. Some generic scientists argue that our ecosystem has always been able to respond to and control newly evolved species. But natural evolution occurs slowly over time and usually in small isolated environments. Genetic modifications have the potential to introduce large numbers of organisms into an ecosystem in a very short time. A good thing about it is that the direct genetic manipulation of crops can be precisely tailored, rather than by relying on the old and haphazard processes of hybridization and selective breeding.

Unit 2: Food Science

Content Standard: 2.2 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 (e.g., health, occasions, lifestyle, business).

Benchmark: 11.2.2.2 Explain the role of science in food science as it relates to research practices and practical scientific experiments.

Topic: Food Engineering

Learning Objective(s): By the end of the topic, the students should be able to;

- Describe the scientific processes involved in the development and advancement of food products.
- Examine various scientific research practices leading to improved food production processes.

Essential Questions:

- How are modified food products processed?
- What are the scientific researches and practices involved in food product development?
- Is food engineering research practices environmentally friendly?
- How sustainable are the practices of food engineering in food production?
- Are genetically modified foods biologically safe for human consumption?
- How will food engineering concept improve the quality of life of the world's people?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Food engineering • Genetic engineering and irradiation - genetic modification (cells, DNA and genes) - biotechnology • Modified food products • Food security and effects of climate change on food
Skills	• Identify and explain the various scientific research and practices involved in food product development • Investigate the impact of science and technology in food production process • Design a food prototype product using scientific processes
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices. • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing

Teaching and Learning Strategies

Food engineering is an important and cross-cutting concept in the 21st century hence in-depth knowledge is required by the teacher for effective lesson planning and delivery of theory activities and practical applications.

Encourage students to participate in all planned activities, read widely to broaden their content background, utilize current knowledge on genetically engineered foods and be observant in the food products that are available in the consumer market to be able to guide in making informed individual choices. Use various information sources to read and understand issues on food security in relation to food engineering and climate change.

Engage students in problem – solving issues to deepen their understanding to effectively solve issues in their communities.

Learning Activities

Lesson 1: Introduction to Food Engineering

Activity 1: Use various references to extract information for the following activities;

1a. What was the traditional focus of food engineering?
1b. What is food engineering, its role and uses? Why study food engineering?
1c. When is food engineering important?
1d. What is the difference between food processing and food engineering?
1**e.** What are the pillars of food engineering?

Activity 2

The following are application and practices used in food engineering to produce safe, healthy, tasty and sustainable food. Research each one and write up a summary.

2a. Refrigeration and Freezing

2b. Evaporation

2c. Packaging

2d. Energy

2e. Heat Transfer

2f. Food Safety management

2. Investigate the functions of the food engineering technology. Explain the benefits of utilizing these technologies.

2a. The three Dimensional Printing of Food

2b. Biosensors

2c. Milk Pasteurization Technology

Lesson 2: Genetically Engineered Foods

Activity 1

1a. What are genetically modified food, give examples and what is the purpose of bioengineering foods?

1b. Summarize the advantages and disadvantages of introducing **GMO** foods into human diets?

1c. Explain using illustrations hoe food plants and animals undergo the genetic modification process.

1d. Investigate the risks and controversies surrounding the use of genetically modified Organisms. (GMOs)

1e. Make a list of GMO foods.

Activity 2

2a. Use various sources to compile a power – point presentation on GMO crops in the United States and do a logical layout for presentation.

2b. Investigate the results of animals that eat GMO foods made from GMO crops. Place emphasis on the results.

2c. What is the role of US Food and Drug Administration in relation to GMO plants and animals?

Lesson 3: Food security and climate change

Activity 1: Food engineering has negative impacts on the environment. Deliberate on these issues and summarize the key issues. Relate your discussion to climate change.

Activity 2: To achieve food security, food engineers are required to address issues of land and water versus population. Discuss possible intervention or sustainable ways to overcome to help find solutions to the world's growing population and their food needs.

Content Background

Food engineering is a scientific, academic, and professional field that interprets and applies principles of engineering, science, and mathematics to food manufacturing and operations, including the processing, production, handling, storage, conservation, control, packaging and distribution of food products. Given its reliance on food science and broader engineering disciplines such as electrical, mechanical, civil, chemical, industrial and agricultural**,** engineering, food engineering is considered a multidisciplinary and narrow field.

Food science is the study of the physical, biological, and chemical makeup of food; and the concepts underlying food processing. Food science examines everything that can happen to food between harvest and consumption.

Due to the complex nature of food materials, food engineering also combines the study of more specific chemical and physical concepts such as biochemistry, microbiology, food chemistry, thermodynamics, transport phenomena, rheology, and heat transfer. Food engineers apply this knowledge to the cost-effective design, production, and commercialization of sustainable, safe, nutritious, healthy, appealing, affordable and high quality ingredients and foods, as well as to the development of food systems, machinery, and instrumentation.

Food engineering is a relatively recent and evolving field of study, it is based on long-established concepts and activities. The traditional focus of food engineering was preservation, which involved stabilizing and sterilizing foods, preventing spoilage, and preserving nutrients in food for prolonged periods of time. More specific traditional activities include food dehydration and concentration, protective packaging, canning and freeze-drying . The development of food technologies were greatly influenced and urged by wars and long voyages, including space missions, where long-lasting and nutritious foods were essential for survival. Other ancient activities include milling, storage, and fermentation processes. Although several traditional activities remain of concern and form the basis of today's technologies and innovations, the focus of food engineering has recently shifted to food quality, safety, taste, health and sustainability.

The following are some of the applications and practices used in food engineering to produce safe, healthy, tasty, and sustainable food.

Refrigeration and freezing

The main objective of food refrigeration and/or freezing is to preserve the quality and safety of food materials. Refrigeration and freezing contribute to the preservation of perishable foods, and to the conservation some food quality factors such as visual appearance, texture, taste, flavor and nutritional contents. In addition, freezing food slows down the growth of bacteria that could potentially harm consumers.

Evaporation

Evaporation is used to pre-concentrate, increase the solid content, change the color, and reduce the water content of food and liquid products. This process is mostly seen when processing milk, starch derivatives, coffee, fruit juices, vegetable pastes and concentrates, seasonings, sauces, sugar, and edible oil. In addition, evaporation is used in food dehydration processes.

The purpose of dehydration is to prevent the growth of molds in food, which only build when moisture is present. This process can be applied to vegetables, fruits, meats, and fish.

Packaging
Food packaging technologies are used to extend the shelf-life of products, to stabilize food (preserve taste, appearance, and quality), and to maintain the food clean, protected, and appealing to the consumer. This can be achieved, for example, by packaging food in cans and jars. Because food production creates large amounts of waste, many companies are transitioning to eco-friendly packaging to preserve the environment and attract the attention of environmentally conscious consumers. Some types of environmentally friendly packaging include plastics made from corn or potato, bio-compostable plastic and paper products which disintegrate, and recycled content. Even though transitioning to eco-friendly packaging has positive effects on the environment, many companies are finding other benefits such as reducing excess packaging material, helping to attract and retain customers, and showing that companies care about the environment.

Energy for food processing
To increase sustainability of food processing there is a need for energy efficiency and waste heat recovery. The replacement of conventional energy-intensive food processes with new technologies like thermodynamic cycles and non-thermal heating processes provide another potential to reduce energy consumption, reduce production costs, and improve the sustainability in food production.

Heat transfer in food processing
Heat transfer is important in the processing of almost every commercialized food product and is important to preserve the hygienic, nutritional and sensory qualities of food. Heat transfer methods include induction, convection, and radiation. These methods are used to create variations in the physical properties of food when freezing, baking, or deep frying products, and also when applying ohmic heating or infrared radiation to food. These tools allow food engineers to innovate in the creation and transformation of food products.

The following technologies, which continue to evolve, have contributed to the innovation and advancement of food engineering practices:

- **Three-dimensional printing of food**
- **Biosensors**
- **Milk pasteurization by microwave**

Challenges
Sustainability
Food engineering has negative impacts on the environment such as the emission of large quantities of waste and the pollution of water and air, which must be addressed by food engineers in the future development of food production and processing operations. Scientists and engineers are experimenting in different ways to create improved processes that reduce pollution, but these must continue to be improved in order to achieve a sustainable food supply chain.

Food security

To achieve food security, food engineers are required to address land and water scarcity to provide enough growth and food for undernourished people. In addition, food production depends on land and water supply, which are under stress as the population size increases. There is a growing pressure on land resources driven by expanding populations, leading to expansions of croplands; this usually involves the destruction of forests and exploitation of arable land.

Genetically Modification technology

Benefits of GM technology

- Genetic modification could help increase the nutritional value, visual appeal, shelf life and processing potential of foods, for example, carrots with antioxidants or tomatoes that taste better.
- Crops could be modified to resist attack by pests and disease. There would be less wastage, greater yields, more economical production and in turn lower cost food.

Disadvantages

- Some scientists are concerned about the effect of GM foods on human health.
- The production of GM crops also raises environmental concerns.
- The organic food industry is concerned that genetic modification of some crops to permanent produce the natural biopesticide.

The table below lists reasons why some foods or food sources could be genetically modified.

Food sources	Reasons for genetic modifications
Soybeans	• Increased resistance to herbicides so that farmers can spray weeds without damaging the crops
Legumes such as chickpeas	• Increased nutritional value • Improved yields by enhancing plants natural protection against fungal and bacteria disease.
Oil seeds such as canola and sunflower	• Increased mono-unsaturated (omega-3) fatty acids in margarines and oils which will contribute to improved cardiovascular health
Sugar	• Increased amount of sugar produced in each plant • Enhanced resistance to disease
Wine grapes	• Increased color, flavor and sweetness • Increased productivity by enhancing resistance to pets and disease, and by making the plant more effective at absorbing nutrients from the soil
Barley	• Increased productivity by enhancing resistance to pets and disease • Improved brewing efficiency
Wheat	• Improved health of consumers by increasing the amount of fiber • Enhance exportability by designing varieties of wheat to suit different market demands
Apples and pears	• Decreased used of pesticides by improving natural to insect pests
Grapes and citrus fruits	• Production of seedless varieties to meet consumer demands
Potatoes	• Production of non-browning varieties to meet consumer demand

	• Decreased use of pesticides by increasing the natural resistance to insect pests
Poultry	• Improved poultry health by enabling infectious bursal disease to be detected
Pigs	• Improved pig health by increasing the pig's natural immunity to infection and decreasing the use of antibiotics
Salmon	• Enhanced growth rate and size
Dairy cattle	• Removal of lactose in milk so that lactose – intolerant people can consume dairy products
Fish	• Increase growth and natural disease resistance
Livestock	• Increased disease immunity and phasing out of antibiotic therapy
Cheese	• Improved exportability by the adaption of cheese flavours to suit overseas markets
Yeast	• Hastened fermentation and enhanced flavor
Preserved foods	• The use of natural antibacterial agents as food preservatives

Unit 2: Food Science

Content Standard:2.2 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. (e.g., health, occasions, lifestyle, business)

Benchmark: 11.2.2.3 Distinguish between the different kinds of chemical reactions in food and understand the factors that affect them.

Topic: Chemical Reaction in Food

Learning Objective(s): By the end of the topic, the students should be able to;

- Explain the various types of chemical reactions that occur in food and how they affect them.
- Investigate on the factors that influence the physical and chemical changes that occur in food from preparation or processing to consumption.

Essential Questions:

- What are the different types of chemical reactions that affect food?
- How are food chemically affected in the process of preparation to consumption?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Chemical reactions in food • Cooking methods • Food fermentation • Chemical reactions on starch • Chemical reactions on protein • Chemical reactions in fats and oils • Chemical reaction on vitamins and minerals
Skills	• Examine the different chemical reactions that occur in food and how they affect them • Explain the factors that contribute in the physical and chemical changes of food from preparation to consumption • Design a meal or food product and observe the chemical reactions involved in processing the food
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices. • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing

Teaching and Learning strategies

In this unit of work, the focus is on chemical reactions that occur in food. The prescribe content is to be taught however, it is advisable for more in-depth reading to be done for both the teacher and students. Probing questions and practical activities are to be given to expand on content and to also facilitate further enquiry learning in students on chemical reaction in food.

Prescribed activities are for knowledge and enrichment and offer the opportunity for students to communicate information using means.

Learning Activities

Lesson 1: Chemical Reactions in Food

Activity 1

1a. Differentiate between lipid oxidation and non-enzymatic browning.

1b. Explain the impact of these (above) changes during food processing and storage.

1c. Specify the chemical reactions in the;

- making of cheese
- brewing of beer
- making of wire

1d. List examples of simple Acid-Based reactions in a kitchen.

Activity 2

2a. Explain how the following types of chemical reactions occur in one way or other in food.

a. Exothermic Reaction

b. Endothermic Reaction

c. Mailard Reaction

d. Caramelization Reaction

e. Catabolic Reaction

f. Cellular Reaction

g. Enzymatic Reaction

h. Hydrolosis

i. Oxidation

j. Polymerization

k. Denaturation

l. Emulsification

m. Pyrolysis

2b. Below is a chemical reaction equation. Translate it appropriately.

$6CHO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

What is the general formula for protein?

Lesson 2: Chemical Reactions on Starch and Protein

Activity 1

1a. What is the chemical formula for starch?

1b. What is the chemical reaction between starch and water?

1c. What is the chemical equation of starch breakdown?

1d. What is the chemical reaction of glucose to starch?

1e. What type of reaction happens when glucose is formed from starch?

1f. What are the two chemical components of starch?

1g. What type of reaction is starch and iodine?

Activity 2

2a. Explain the denaturation process of protein.

2b. Write the chemical equation of Amino Acids.

2c. What are the reactions of protein on food?

2d. What are elements of protein and its reactions?

2e. What are the colour reactions of protein?

2f. What is an example of a protein that catalyses' reactions?

2g. What is the type of reaction by which proteins are synthesized?

Lesson 3: Chemical Reactions in Oil, Fats, Vitamins and Minerals

Activity 1

Define the following concepts;

1a. Hydrogenisation

1b. Hydrolosis

1c. Oxidation

1d. Saponification

Activity 2

2a. What is the chemical reaction of fatty acids?

2b. What is the chemical decomposition of fats and oils?

2c. What is the hydrolysis reaction of fats and oils?

2d. What chemical reaction occurs in oil during frying?

2e. How do chemicals work in chemical reactions?

2f. Do vitamins regulate many chemical reactions in the body?

Lesson 4: Food Fermentation

Activity 1

1a. What is the purpose of fermenting food? Explain the process and show picture illustrations.

1b. What are the benefits of fermenting foods?

1c. What are the basic principles of food fermentation?

1d. List a range of fermentation methods used in food processing.

1e. Analyze and list some disadvantages of fermenting foods.

1f. What ingredients are needed to start the fermentation process?

Activity 2

Project

Select a fermentation project idea below. Work in groups to research, document, compile and submit a folio, outlining clear steps and stages of the fermentation process from start to end product. Attach pictures and illustrations to add volume and content to your work. (This work can be assessed.)

Project Ideas

- Making wine
- Ginger beer
- Chutney
- Pickled onion
- Saurkraut
- Honey Garlic
- Sourdough Bread

Content Background

Enzymatic changes

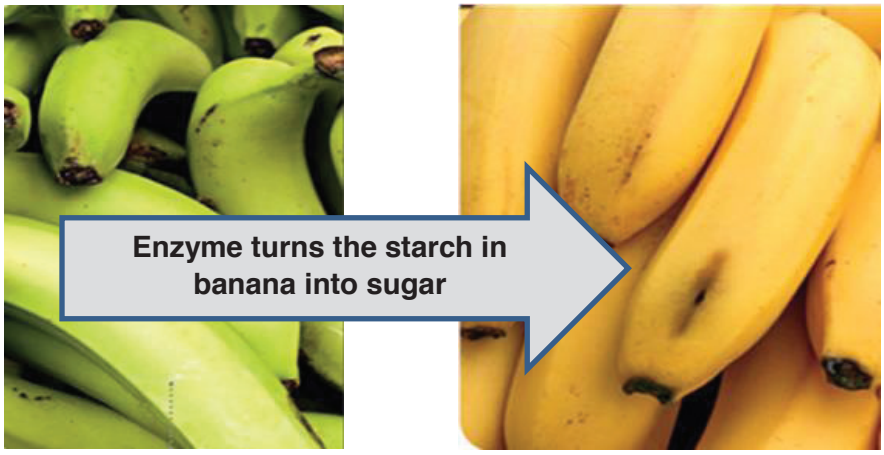
Enzymes are chemicals that consist of proteins naturally found in the cells of food. They are also found naturally in the cells of micro-organisms that break down animal and plant foods. Enzymes accelerate the chemical changes in food and so are responsible for the ripening or ageing of food. This eventually leads to food spoilage. Therefore, enzymes are also responsible for causing food to lose flavour, colour and texture. Some people enjoy the flavours of very ripe fruit and aged cheeses and beef. When you think about it, cheese is really just sour milk.
Enzymes are very sensitive to heat because they consist of protein. The optimum temperature for enzyme activity is at room temperature on a warm day. **The breakdown of food will continue to occur until the enzymes are inactivated or stopped by:**

• **Freezing**: Enzymes can be inactivated by very low temperatures, such as those temperatures found in the freezer. They are not destroyed by low temperatures, so it is important to realise that food in the freezer will not last forever. The action of enzymes are slowed down in the freezer but not stopped.

• **Blanching**: This involves plunging food in boiling water for a brief time and then placing it in cold water to stop the cooking process.

• **Cooking**: The activity of enzymes is stopped when they are heated above 60°C.
Enzymes play a role in:
• **making fats and milk become rancid** (or go 'off ')
• **browning in meats and vegetables**
• **the putrefaction of meats**

Some enzymes are inactive until the food is harvested or slaughtered. Once activated, they accelerate the process of deterioration by breaking down the tissues and components of the food in various ways, such as:
• **oxidation** - when food comes into contact with oxygen, the enzymes cause the destruction of particular nutrients, such as vitamin C and thiamin.
• **browning** - when food is exposed to air, enzymes cause browning on the food's surface, such as cut apple and potatoes.
• **ripening** - enzymes are responsible for the ripening of food, such as turning the starch in banana into sugar.



Enzymes are involved in the ripening process of particular food such as fruits and vegetables. The activity of enzymes in food therefore makes it easier for the micro-organisms responsible for food spoilage to enter the food.

Physical and chemical reactions

Foods have different physical and chemical, including nutritional components. Some foods have a natural physical protective barrier to some types of contaminations, such as the skin of fruits and vegetables and the shells of nuts. The bruising or puncturing of vegetables, fruits or vacuum-packaged food by rough handling can lead to food spoilage.

Chemical properties and food spoilage

The chemical properties of a food product influence the types of micro-organisms that can grow. This affects the changes in appearance, flavour, odour and other qualities of food. Carbohydrate-rich foods, such as breads and potatoes, are spoiled by micro-organisms such as yeast and moulds. In contrast, foods high in fats, such as cheese, are digested by relatively few micro-organisms, such as moulds and some bacteria. Foods are classified as acidic or alkaline (non-acidic). Most fruits are acidic foods, while nearly all vegetables, fish, meats and milk products are alkaline. Acidic foods have a sufficiently low pH that helps prevent the growth of most bacteria; they are usually spoiled by yeast and moulds. Alkaline foods tend to be exposed to spoilage from bacteria, but they can also be spoiled by moulds under certain conditions.

The moisture content of food can also affect food spoilage. The growth of micro-organisms requires at least 13% water in foods. **Moulds and bacteria** grow in food with high water content. Foods with high sugar and salt concentration, such as jam, do not support the growth of most micro-organisms; however, they are most likely to be spoiled by moulds:

- Bacteria are generally inhibited by 5% to 11% salt.
- Many moulds and some yeasts can endure salt concentrations greater than 15%.
- 65% to 70% sugar is required to inhibit moulds.
- 50% sugar content inhibits bacteria and most yeast.

Chemical and physical changes in starch

Dextrinisation of starch – When starch is subjected to dry heat, such as from toasting or baking, dextrin is formed. This is the process that occurs when a slice of bread is toasted and turns brown and when a brown crust forms on baked bread. The polysaccharide starch is broken down to form the disaccharide dextrin.

Gelatinisation of starch – At temperature below 60^0 C starch granules absorb moisture, and some cold swelling occurs and increase the size of the starch grain by 10%. This process is reversible. If the starch grain is dried out, the starch granule will regain its original shape. Acids and sugar also affect the process of gelatinisation. Sugar decreases the temperature at which a starch gel will thicken and the addition of acid causes thinning of the gel.

Retrogradation or syneresis – After a gelatinised mixture is allowed to cool and stand, it will go through a process of retrogradation or syneresis. As the starch cools the molecules pull closer together, tithening the 'gel' structure and squeezing out liquid.

Caramelisation

When heated to a high temperature, sugar will melt and become a brown liquid. This chemical process is known as caramelisation. It occurs when making toffee, caramel sauce and fruit cakes. Caramelisation does not require oxygen. The browning of vegetables with high sugar content, such as carrots and sweet potatoes, is likely to becaused by caramelisation. Caramelisation occurs in dryheat cooking methods, such as baking and grilling.

Crystallisation

Crystallisation is when dry sugar (or a sugar-and-water solution) is heated, and the resulting solution becomes concentrated and produces a syrup to form sweets, such as toffees.

Chemical and physical changes in Protein

Denaturation – Denaturation is a change in the physical, chemical and biological properties of protein. This process can be brought about by heat, acid, an enzyme, salt or mechanical means. As a result, the protein becomes less elastic and less soluble. The hardening or setting of proteins due to heat or changes in pH is called coagulation.

Coagulation

Applying heat for a longer period of time will cause the coagulation of the protein as the protein structure creates a network and entraps the liquid, forming a gel. For example, when an egg is cooked, both the liquid yolk and white will become firm and change colour. Other ways to cause protein to coagulate include the addition of acids, alkalis or enzymes. Cooking protein foods for too long will result in the protein becoming overcoagulated. The product becomes dry and tough because the protein shrinks and forces the moisture out. This is evident when meat or poultry is overcooked.

Aeration

Another way to denature protein by a mechanical method is aeration. This is the process of incorporating air into food products. Aeration can also be done chemically and biologically. Whisking and beating are examples of mechanical methods of aeration.

Agitating the protein will cause it to become denatured-the protein structure unwinds, and air is entrapped in the network. Trapping air in the protein network creates foam, such as when egg whites are beaten for soufflés or meringues.

Hydrolysis
Is the chemical breakdown of complex molecules to smaller, simpler ones. The collagen in meat is hydrolysed to form gelatine. Collagen is the fibrous protein found in the connective tissue of meat and this is softened or made tender. Hydration occurs when proteins chemically combine with water. When heated in water, the collagen is converted to gelatine and the tenderness is greatly increased.

Chemical and physical changes in fats and oils

Fats and oils have the chemical elements as carbohydrates (carbon, hydrogen and oxygen), but in a structure that is made up of fatty acids and glycerol.

Hydrolysis - The breakdown of fats into fatty acids and glycerol can occur when it is boiled with water or with acids and alkalis. This process is used most in the production of ghee and in clarifying butter where the milk solids and salts are separated out from the liquid.

Rancidity - Fats and oils become rancid or develop off flavours and taste when they absorb oxygen in the presence of heat and light over an extended period of time. This process is called oxidation. Antioxidants are added to commercially produced foods to prevent rancidity occurring.

Emulsification - Emulsification is the ability of a fat or oil to be equally dispersed or suspended throughout a liquid. Milk is a fat in water emulsion and butter is a water in fat emulsion. Emulsifiers allow fats and oils to mix with water to form a low fat spreads and salad dressings. They give food smooth creamy texture and help to improve shelf life of baked products.

Hydrogenation – Unsaturated oils can be made solid by a process known as hydrogenation. Unsaturated fats do not contain the full complement of hydrogen atoms. When they undergo the hydrogenation, hydrogen is bubbled through the liquid oil it attaches itself to the carbon chain where there is a double bond. The hardening or saturating of the oil makes it a soft spreadable product.

Food Fermentation
Fermentation is the process by which yeast cells convert sugar into carbon dioxide an alcohol. During the process, energy is released for use by the yeast. This process is a form of respiration called anaerobic respiration meaning in the absence of oxygen. A common example is the action of yeast on sugar solution to produce alcohol. The sugar is not completely oxidizes to carbon dioxide and water but converted to carbon dioxide and alcohol.

Unit 2: Food Science

Content Standard: 2.2 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. (e.g., health, occasions, lifestyle, business)

Benchmark: 11.2.2.4 Describe methods of food preservation and their relationship to food safety.

Topic: Food Preservation

Learning Objective(s): By the end of the topic, the students should be able to;

- Investigate the impact on the methods of food preservation and food safety.
- Explain the importance of food packaging in relation to food preservation.

Essential Questions:

- What are the various methods of food preservation?
- Why is food safety important in food packaging?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Methods of food preservations • Food packaging - Functions of packaging - Functional properties of packaging materials - Packaging materials and types
Skills	• Describe the impact on the methods of food preservation in relation to food safety • Examine the importance of food packaging • Design safe food packaging for food preservation
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing

Teaching and Strategies

The teacher is encouraged to motivate students' quest for learning the topic by providing theory and practical learning experiences. The emphasis is on food preservation methods and how they can apply the knowledge, skills and techniques learned to sustain themselves throughout their lives.

Learning Activities

Lesson 1: Methods of food preservation

Activity 1: Why are foods preserved? Identify the methods of food preservation. How can enzymes be destroyed without changing the food.

Activity 2: What are the advantages and disadvantages of each of the preservative methods. How does using sugar when drying and preserving stop fruit from decaying. Explain why freezing cannot successfully preserve vegetables such as cucumber and lettuce.

Activity 3: Select any method of preserving food, plan, prepare and apply safe and hygienic practices in preserving and packaging of your product.

Lesson 2: Food packaging

Activity 1: Why are food packaged? What functions does packaging perform? Is packaging wasteful of materials and energy? How does packaging increase the choices of food for shoppers?

Activity 2: Select two food products that you can feel could be redesign to be packaged in a more environmentally friendly way. Suggest the materials you would use and provide sketches of the package product.

Content Background

Ancient cultures preserved food for the very same reasons that we do today. Food is processed so that the eating qualities of fresh produce are maintained for long periods. The two major causes of food spoilage are;

1. Enzymes - The proteins in all animals and plant tissue
Enzymes are the organic, non-living substances in all cells. They cause foods to ripen or age by acting as catalysts for chemical reactions in cells. They are slowed down by cold and killed by heat. Enzymes are responsible for natural reactions such as when a peeled apple turns brown and fruit ripens.

2. Micro-organisms - the moulds, yeast and bacteria that live in air, water, and soil and are in fresh food. Micro-organisms are responsible for changes in food. Yeast and moulds are usually non-poisonous, but cause flavours and odours making food unacceptable to eat. Bacteria break down food, and in the process some produce poisonous by products. Micro-organism growth is affected by;

- Temperature,
- Time,
- Availability of oxygen and moisture, and
- Physical and chemical properties of food.

There are five groups of micro-organisms are; Bacteria, virus, protozoa, moulds and yeast. The main micro-organisms responsible for the contamination of food are; **Bacteria, Moulds and Yeast.**

Method of food preservation
1. Drying - is one of the oldest methods of food preservation. Bacteria need moisture to grow. Drying reduces the water in the food enough to prevent or delay the growth of bacteria. Most meats can be dried-beef jerky is one example. Other foods suitable for drying are:
• many fruits, such as apricots, apples, mangoes and papaya, grapes and plums
• cereal grains, such as wheat, oats, barley, rice and rye.

Examples of drying methods include:
• sun-drying is a traditional technique in many parts of the world,
• oven-drying, including microwave-drying, and
• freeze-drying- an expensive process of dehydration requiring two processes: the food is frozen and then warmed in a vacuum so that the ice vapour does not thaw into a water stage.

2. Addition of chemicals
Salt, vinegar and sugar are three common chemicals used to preserve food.

3. Pickling using salt and vinegar
Brine is an edible liquid that is high in salt. Pickling using brine is a method of preserving food. Pickling occurs when the food is placed in brine, which slows down or kills the micro-organisms or bacteria. The resulting food is called a pickle. The food will have a salty taste. Salt has a pH of less than 4.6 that causes the bacteria in the food being pickled to be destroyed. Foods that are commonly pickled include cucumbers, herring, eggs and corned beef. Many pickling processes involve heating, or boiling, the food as well. The food becomes saturated with the vinegar (or brine).
The jar and lid are boiled to sterilise them and then the raw food, such as vegetables, and vinegar (or brine) are placed in the jar.

The jar is sealed with the lid and placed in a pot of boiling water for several minutes. Examples of food preserved using vinegar are pickled cucumbers and onions. Chutney is an example of a food being preserved using acid (along with sugar and salt). The foods will usually have a sour.

4. Freezing

One of the most common methods of preserving food by decreasing the temperature is freezing. The very low temperatures slow down the actions of enzymes and stop the growth of micro-organisms; some micro-organisms are even destroyed at such low temperatures. The very low temperatures also produce ice that causes the water to be drawn out of the food. This form of dehydration prevents the growth of micro-organisms. Many foods are preserved by freezing, such as meats, fish, poultry, vegetables and fruits.

5. Sugar

Using sugar as a food preservation method is similar to pickling: it creates an environment that is not favourable to micro-organisms and enzymes that is, moisture levels are restricted and so helps prevent food spoilage. Examples of the types of sugar include table or raw sugar, honey and golden syrup; jams and jellies are examples of foods preserved using sugar. When sugar concentration is high, micro-organisms and enzymes are not able to grow. Food preservation methods using sugar include:

• Combining sugar and water creates a syrup. Fruits, such as peaches, apricots and plums, can be preserved by being immersed in the syrup.

• Sugar can be used in a crystallised form. The food to be preserved is cooked in sugar to the point of crystallisation, and the product is then stored dry.

• Glacé fruit is where the fruit is preserved in sugar but then extracted from the syrup so that the preservation is maintained by the sugar content of the fruit and the coating of the syrup.

6. Refrigeration

The refrigerator is used to chill foods. Chilling is another common technique of lowering the temperature to preserve food. Foods that are preserved this way include dairy foods (such as yoghurt and milk), meat and fish. Chilling slows down the growth of micro-organisms and decreases the activity of enzymes; however, it does not destroy micro-organisms. For example, milk will last five to ten days when refrigerated, though it will eventually spoil. Foods are often chilled at temperatures between 0°C and 5°C. The lower the temperature, the slower the growth of micro-organisms.

7. Canning and bottling

Canning and bottling are other methods of preserving food using temperature. In this case, the temperature is being increased. Food is cooked and then sealed in sterile cans or jars and the micro-organisms are destroyed. Some foods may require a final step of being cooked in a pressure cooker to destroy any remaining microorganisms. High-acidic fruits, like strawberries, require no preservatives prior to canning and a short boiling cycle; however, low-acidic foods, such as vegetables and meat, require a longer cooking process in a pressure cooker and additional acidic ingredients to ensure that all microorganisms are destroyed. Canning and bottling therefore use two methods of preserving food:

• heating to kill micro-organisms and enzymes.

• sealing food before the heating process to stop further contamination. Once canned or bottled food is opened, food is at risk of spoilage owing to the presence of micro-organisms in the air.

8. Pasteurisation

Pasteurisation is a heat process that kills most pathogenic bacteria and enzymes that cause food spoilage. It aims to decrease the number of pathogenic micro-organisms so that they are unlikely to cause disease-assuming that the pasteurised food is refrigerated and consumed before its use-by date. Pasteurisation typically uses temperatures below boiling to prevent the loss of the flavour and nutritional value of food. The food is then cooled rapidly. Foods that are typically pasteurised include milk and fruit juices. Pasteurised food is perishable and requires refrigeration; however, it has a longer shelf-life than unpasteurised food.

9.Ultra-heat treatment

Milk and fruit juices are examples of foods that can be preserved using ultra-heat treatment (UHT); they can be stored without refrigeration for up to about six months. UHT refers to the partial sterilisation of the food by heating it for a short time, around one to two seconds, at a temperature exceeding 135°C. This high temperature kills micro-organisms in the food; however, it also destroys some of the nutrients. Once the food is opened, the micro-organisms in the air will enter the food and so the food will spoil within its usual time.

Food packaging

In today's society, packaging plays a vital role in the production, preservation, distribution and marketing of manufactured foods.

Functions of packaging

Packaging should contain the food product. Defective packaging, or under packaging, can result in spillages and therefore major losses and serious damage. Various packaging systems engage in independently sterilizing both the food and the packaging and then carrying out the filling and sealing operations in a hygienic environment. This permits preservative-free foods; retains flavour, nutrition and colour; and allows long-life storage without refrigeration.

Packaging should preserve and protect the contents. This is because the consumer wants a food product that is acceptable for consumption and has not been damaged because of inadequate packaging. The product should be protected:

- During transport and distribution.
- From climatic effects, such as heat and cold, moisture vapour and drying atmospheres.
- From dangerous substances and contaminants.
- From infestation.

Packaging should also act as a communication tool, providing information about the food product, such as price, ingredients and nutritional values, cooking instructions and recommended use-by date.

Trends in marketing are placing greater emphasis on the appearance, sales appeal and quality of the packaging because it can increase sales through product differentiation and presentation, greater brand awareness and convenience.
As consumers' demands evolve, consumers will require better quality graphics and promotional links between graphics and advertising to support brand identities.
Packaging is also a significant part of our contemporary lifestyle:

- In the move to convenience and pre-packaged foods, packaging allows for single or small serves to cater for families of varying sizes and lifestyles. Individually wrapped butter provides the consumer with a specific amount of the product, reducing wastage. Other containers can be resealed if all the contents are not consumed.

• Packaging allows for quick preparation of foods. Examples include; microwaveable soups and pasta dishes, and the simple use of products by way of spouts, squeeze bottles and aerosols.
• Packaging results in fewer visits to the supermarket.
• Secure packaging for jars of jam, for instance, provides evidence if the food has been tampered with.

Forms and materials for packaging

Packaging is changing as new materials become accessible and innovative processing techniques are developed. Today, packaging is produced more quickly and efficiently than ever before. It has progressed from a fairly limited range of heavy, inflexible containers made of wood, glass and steel to an extensive collection of rigid, semi rigid and flexible packaging options constructed from lightweight materials. Compared with earlier forms of packaging, today's packaging is lighter in weight, uses less material and is easier to open, dispense from, reseal, store and dispose of.

Unit 2: Food Science

Content Standard: 2.2 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. (e.g., health, occasions, lifestyle, business)

Benchmark: 11.2.2.5 Investigate microorganisms in terms of classification, their growth and their application to food science.

Topic: Food Microbiology

Learning Objective(s): By the end of the topic, the students should be able to;

- Identify and classify the various types of micro-organisms.
- Investigate the growth and usefulness of micro-organisms and how they affect food development to consumption.

Essential Questions:

- Why are micro-organisms useful in food preparation to consumption?
- What are the different classification of micro-organisms and how they affect food?
- How are micro-organisms related to food science?

Essential Knowledge, Skills and Values/Attitudes:

Knowledge	• Food microbiology • Microorganism in food • Classification of micro-organisms
Skills	• Explain the classification of micro-organisms and why are they useful in food science • Analyse the growth and application of micro-organisms in food science • Design a food product and observe the usefulness of micro-organisms in food production process
Values/Attitudes	• Make informed decisions on designing a food product and be responsible of their food choices • Appreciate and recognize the nutritional value of food for the benefit of their wellbeing

Teaching and Learning Strategies

The teacher is encouraged to motivate students' quest for learning the topic by providing theory and practical learning experiences. The emphasis is on the usefulness of micro-organisms in food production. Teachers are required to support research, plan and apply safe and hygienic practices in food product development.

Learning Activities

Lesson 1 Introduction to food microbiology

Activity 1: What is food microbiology? Describe the importance of microbes in food production.

Activity 2: What are the main reasons for the deterioration of food? What conditions control microbial action?

Lesson 2 Classification of micro-organisms

Activity 1: Identify which micro-organisms cause:

a) food spoilage b) food poisoning

Activity 2: What are pathogens? Identify five (5) pathogens that cause illnesses associated with food.

Lesson 3 Micro-organisms in food production

Activity 1: Explain some uses of micro-organism in food production.

Activity 2: Work in groups. Find or write a recipe that uses yeast. Plan, prepare and apply safe and hygienic practices in making your product.

Content Background

Microbiology refers to the study of life and organisms that are too small to be seen with the naked eye and they are called **microbes or micro-organisms.** Microorganisms are the smallest and simplest living things and can be found everywhere on earth. Microbes are both useful and harmful.

Groups or types of microbes

There are five main groups of microbes.

1. Viruses

- The smallest of all microbes. They only grow and reproduce inside other living cells.
- Parasites (pathogenic) causes diseases to host organisms.
- Viruses must enter living cells before they become active and reproduce to make more viruses.

2. Bacteria

- Are unicellular organisms and are found everywhere, where there is life.
- Bacteria found in the soil are mostly decomposers.
- Many are parasites in which some are pathogens (cause diseases) while others are harmless.

3. Algae

- Simple green plants that contain chlorophyll.
- Live everywhere, where water is found.
- Cause problem such as eutrophication to aquatic environment.

4. Fungi

- Can be single celled (eg.yeast) or many celled. (eg. Moulds and mushrooms)
- Plant without chlorophyll and cannot make their own food. They obtain food by secreting chemicals to food.
- Those that live in host are called parasites and those that live on dead organisms are saprophytes.
- Fungi used in the food production. (e.g. yeast for baking or fermentation)

5. Protozoa

- Single celled organism and is the largest of all organisms of microbes.
- They live in water or damp places while others which are parasites live in the bodies of the host causing diseases. (e.g. malaria)

Food microbiology

Food microbiology is the study of microorganisms causing food spoilage and foodborne illness. This includes microorganisms in food and used for the production of foods, for example, to produce yoghurt, cheese, beer and wine.

Causes of food spoilage

Micro-organism	Foods typically affected	Food spoilage versus food poisoning	Description
Bacteria	Meats, poultry and dairy products, including milk	Cause food spoilage and likely food poisoning	• Simple, single-celled micro-organism • Ideal conditions for bacterial growth include warmth, moisture, oxygen and neutral pH level (around 7) • Some bacteria are harmless and used in food preparation, such as yoghurt and cheeses • Other bacteria are pathogenic and cause food spoilage • Food contaminated by pathogenic bacteria becomes slimy, soft and eventually putrid-smelling • Bacteria release poisons into food and these poisons enter the body when the food is consumed , causing illness
Yeasts	Foods with high moisture content, such as fruits and fruit juices	Cause food spoilage, but do not commonly cause food poisoning	• Small single-celled micro-organisms • Invisible to the naked eye • Yeasts require warmth, moisture, oxygen and time to reproduce • Destroyed at temperatures above 60^0C • Some types are used in food production such as breads and beer • Some are quite dangerous if consumed
Moulds	Corn, nuts, breads, meats, cheese, fruits and vegetables	Cause food spoilage but do not commonly cause food poisoning	• Visible to the naked eyes as blue, green, grey or black 'clumps' • Food has a musty smell and an mushy texture • Do not cut away moulds in food –they can be natural part of the food such as cheese like Brie, Camembert or blue vein; however, in other cheese it is best to discard the cheese as moulds forms a network of microscopic strands that extends into the food and cause allergic reactions

Pathogen	Symptoms	Associated foods
Norovirus	Fever, nausea, vomiting, abdominal cramps, diarrhoea and headache	Poorly cooked shellfish, ready-to-eat foods touched by an infected worker
Salmonella	Headache, fever, abdominal cramps, diarrhoea, vomiting and nausea	Undercooked poultry, raw egg desserts and mayonnaise, sprouts, tahini
Staphylococus aureus toxin	Sudden onset of vomiting, abdominal cramps	Cream desserts and pastries, potato salad
Vibrio parahaemolyticus	Nausea, vomiting, abdominal cramps and	Undercooked or raw seafood

	watery diarrhoea	
Bacillus cereus toxin	Sudden onset of severe nausea and vomiting	Incorrectly refrigerated cooked rice
Bacillus cereus toxin	Abdominal cramps, nausea and watery diarrhoea	Meats, stews, gravy
Campylobacter	Fever, nausea, abdominal cramps and diarrhea (sometimes bloody)	Raw and uncooked poultry, unpasteurized milk and contaminated water
Clostridium pertringens toxin	Abdominal cramps, watery diarrhea and nausea	Meats, poultry, gravy, dried or precooked foods
Escherichia coil (STEC)	Diarrhoea (often bloody), abdominal cramps	Incorrectly cooked beef, unpasteurized milk and juice, sprouts and contaminated water
Hepatitis A	Jaundice, fatigue, reduced appetite, nausea	Raw or poorly cooked seafood taken from contaminated waters, ready-to-eat foods touched by an infected worker
Listeria moncytogenes	Meningitis, sepsis, fever	Soft cheeses, unpasteurized milk, ready –to-eat deli meats

Useful Microbes

Many of the microbes are of industrial importance as they find use in production of new foods and food chemicals by fermentation and also in the preservation of food products. Microorganisms which are of importance in food microbiology include bacteria, yeast and mould**.**

Whilst there are undoubtedly some who fear all microbes due to the association of some microbes with various human illnesses, many microbes are also responsible for numerous beneficial processes such as:

- industrial fermentation (e.g. the production of alcohol, vinegar and dairy products),
- antibiotic production, and
- as vehicles for cloning in higher organisms such as plants.

Scientists have also exploited their knowledge of microbes to produce biotechnologically important enzymes such as Taq polymerase, reporter genes for use in other genetic systems and novel molecular biology techniques such as the yeast two-hybrid system.

Roles of micro-organisms in food production

- Microorganisms involved in producing many foods and beverages.
- Fermentation produces characteristic flavors, aromas, and consistencies of various foods.
- Microbial metabolism has other functions;
    - Acts as a preservative.
    - Destroys many pathogenic microbes and toxins.
    - Can add nutritional value in form of vitamins or other nutrients.
- Microbes are used in food production.
- Microbes can control activity that would result in food spoilage.
- Many common products result from fermentation of vegetables, meats, and dairy products.

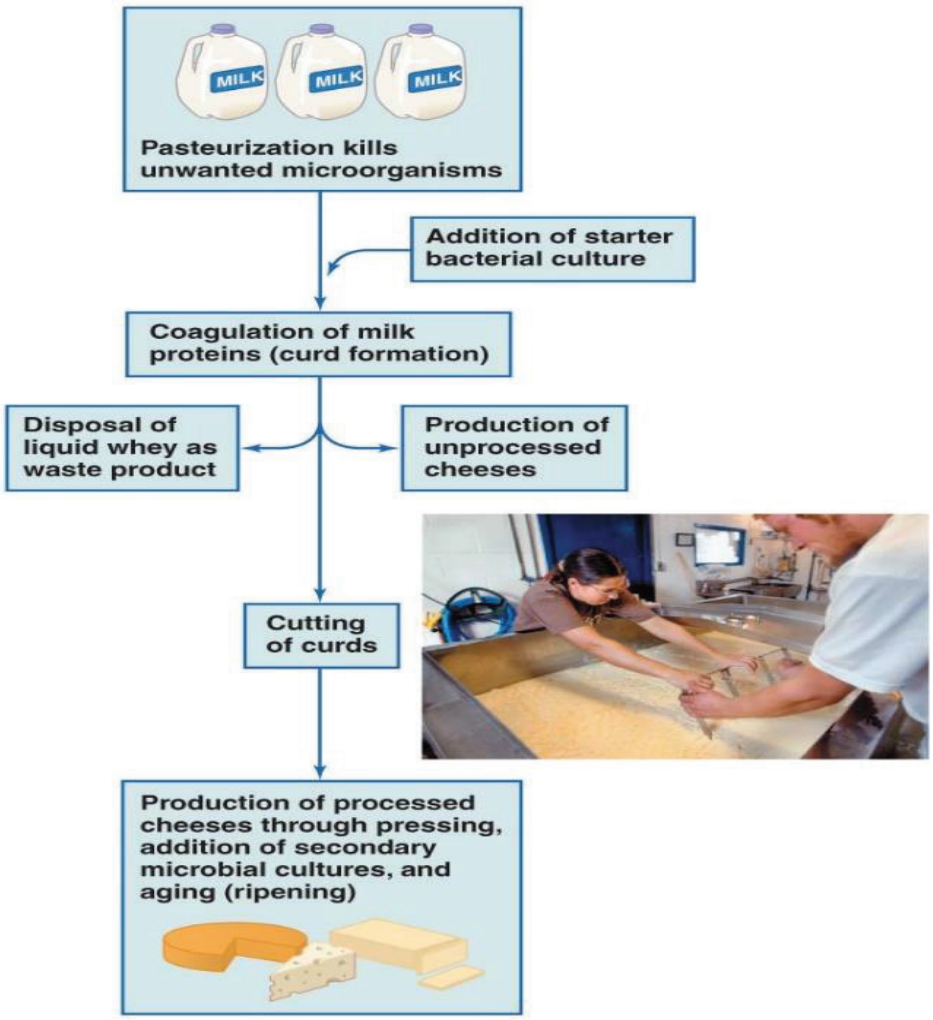
Yeast

Yeast comes under group of microbes called Fungi. There are many species of yeast. The most common yeast known as **saccharomyces cerevisiae** is used in the baking and brewing industry. Yeast also plays an important role in the production of wine kefir and other products. Yeast needs sugar to grow. They produce alcohol and carbon dioxide from sugar. This reaction makes yeast so important for the food industry. Yeast also produces pleasant aroma components. These aroma components play a very important role for the flavor of the end product. In beer yeast is needed to produce alcohol and carbon dioxide for the brim. In bread industry, both alcohol and carbon dioxide are formed. The alcohol evaporates during baking.

Examples of microbes used in producing food.

1. **Cheese making**

Milk from cows, sheeps and goats are used to prepare cheese. Cheese and yoghurt are products resulted from fermentation of milk by **bacteria**.
Common species used are **streptococcus or Lactobacillus.**



2. Beer-brewing

Beer is made from barley. The fermentation is brought about by **yeast** and the most species are **saccharomyces cerevisiae and S.carlsbergensis**. Commercial techniques have refined the traditional methods so the process is controlled from start to finish.

The beer brewing process

1. Barley is moistened and germinated, producing enzymes that convert starch into sugars, Barley is then dried to halt germination, and crushed to produce malt.
2. Mashing malt adjuncts with warm water allows enzymatic activity to generate more sugars. Solids are removed to produce wort.
    - Addition of hops for flavoring
3. Cooking of wort halts enzymatic activity, extracts flavor from hops, and kills the microorganisms present.
    - Removes hops
    - Addition of yeast culture
4. Wort ferments into beer.
5. Aging, filtering or pasteurization and bottling finish the process.

Planning and Programming

The 8 steps in Planning and Programming Process

The Planning and Programming Process used by the Food Technology Subject 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 Units, Content Standards and Benchmarks for each of the units in the TIA Syllabus.
Step 2: Identify the total number of Content Standards, Benchmarks and Number of Topics in the 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, Units, Content Standards, and Benchmarks in the TIA Syllabus (Grade 11&12 TIA Syllabus Page 29)

It is important to first identify the strand and unit names for familiarization and also the number of strands and units in the Grade 11 Technology and Industrial Arts subject.

Technology and Industrial Arts has 5 strands and 13 Units.

Grade 11 Food Technology has 2 units, 2 content standards and 10 benchmarks. Unit 1: Food and Nutrition contains 5 benchmarks and Unit 2. Food Science contains 5 benchmarks.

	Units	Content Standards	Benchmarks
	1: Food and Nutrition	1	5
	2: Food Science	1	5
Total:	**2**	**2**	**10**

Grade 11 Food Technology in TIA Subject

In grade 11 and 12 Food Technology is a standalone subject but the subject content information is found under the TIA Subject Syllabus.

The information below helps teachers to understand the organization of the Technology and Industrial Arts Subject Strands and 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 12, linking from junior 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 11 &12 TIA Syllabus Page 29)

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 11 Food Technology Content Matrix

The Grade 11 Food technology Content Matrix shows the total number of units, content standards, Benchmarks and topics to be covered in Grade 11. Note that the topics are broad enough to derive lesson titles.

Total Number Of Units	Total Number of Content Standards	Total Number Of Benchmarks	Total Number Of Topics
2	2	10	10

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 pose a challenge to the planning and programming process.

Facts and Considerations about the Grade 11 Technology and Industrial Arts

1. As per the Matrix, there are a total of 10 Benchmarks and 10 Topics which must be programmed and taught in a school year.
2. Food Technology is a compulsory subject which requires all students to take up the subject.
3. In the instance that there is no trained or specialist teacher to teach Food Technology, Subject specialist teachers teaching science, chemistry or agriculture are encouraged to teach Food Technology.
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. Time Allocation for Grade 11 Food Technology is 200 minutes per week which means it has 5 periods/5 lessons a week: 1 block of 80 minutes (2 periods) periods and 1 x 120 minutes (3 periods blocked).
6. There is a total of 40 teaching weeks in a school year. (4 Terms x 10 Weeks each)
7. In a term, there are about 8 weeks of actual teaching weeks which gives us 48 periods/48 lessons of actual teaching in a term. (6 periods a week x 8 actual teaching weeks in a term)
8. Using these facts and considerations, we can Plan and Program the Food Technology according.

Step 4: Distribute the Content evenly across the 4 school terms in a Matrix (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. The table below shows the proposed distribution of Food Technology content.
Note that the Unit of Work (UOW) contains the descriptions of teaching and learning content based on the benchmark and topic. Teachers are encouraged to go by the Unit of Work (UOW) to plan and program your lessons. If need be, additional topics can be derived to teach the essentials concepts and skills for the subject.

Table 1: Grade 11 proposed set of benchmarks distributed in each term with topics

Terms	Units, Benchmarks & Topics	
1	**Unit 1: Food and Nutrition**	
	Benchmark 11.2.1.1	**Topic 1:** Properties of fruits, vegetables and legumes
	Benchmark 11.2.1.2	**Topic 2:** Influences on food product development
Term 1 Assessment		
2	**Unit 1: Food and Nutrition**	
	Benchmark 11.2.1.3	**Topic 3:** Ethical practices and food product development
	Benchmark 11.2.1.4	**Topic 4:** Solutions to nutritional problems
	Benchmark 11.2.1.5	**Topic 5:** Investigate dietary issues
Term 2 Assessment		
3	**Unit 2: Food Science**	
	Benchmark 11.2.2.1	**Topic 1:** Food product development advancement
	Benchmark 11.2.2.2	**Topic 2:** Food engineering
	Benchmark 11.2.2.3	**Topic 3:** Chemical reaction in food
Term 3 Assessment		
4	**Unit 2: Food Science**	
	Benchmark 11.2.2.4	**Topic 4:** Food preservation
	Benchmark 11.2.2.5	**Topic 5:** Food microbiology
Term 4 Assessment		

5: Expand and plot the distributed content into the complete Yearly Content Overview for the subject for the grade. (Proposed Template)

Grade 11 Food Technology Topics and Lesson Titles as per Strands and Units

The Units and Benchmarks are further unpacked into Topics and Lesson Titles in the Teacher Guides. These are outlined in the table below:

Content Standard: 2.1 Examine and analyze the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards.		
Unit 1: Food and Nutrition		
Benchmark	**Topic**	**Lesson Titles**
11.2.1.1 Analyse the nature and properties of food	Properties of fruits, vegetables and legumes	**Lesson 1:** Classification and properties of fruits, vegetables and legumes
		Lesson 2: Ways of preparing and preserving fruits, vegetables and legumes
		Lesson 3: Principles behind cooking fruits, vegetables and legumes
11.2.1.2 Plan to develop a product using the food product development process and discuss the economic, social and technological influences	Influences on food product development	**Lesson 1:** Social influences on food production
		Lesson 2: Economic influences on food production
		Lesson 3: Technological influences
		Lesson 4: Environmental influences
11.2.1.3 Practise application in hygiene, safety, ethical values and etiquettes in meal preparation, food handling, product development and meal presentation	Ethical practices and food product development	**Lesson 1:** Safe food handling practices
		Lesson 2: Safe food packaging
		Lesson 3: Safe food marketing
		Lessons 4: Food presentation
11.2.1.4 Solve nutritional problems using the design process and communicate ideas in written, oral and graphical forms	Solutions to nutritional problems	**Lesson 1:** Nutrition related illnesses
		Lesson 2: Meals for special needs
		Lesson 3: Guidelines to healthy eating
		Lesson 4: Plan and design a nutritious meal
11.2.1.5 Investigate the recommended dietary intake of energy, protein, vitamins and minerals for	Investigate dietary issues	**Lesson 1:** RDI and Food composition tables
		Lesson 2: Targets for healthy living

a particular individuals and groups using appropriate data such as RDI tables in print or electronic format		**Lesson 3:** Dietary guidelines for healthy living

Unit 2 Food Science

Content Standard:2.2 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. (e.g., health, occasions, lifestyle, business)

Benchmark	Topic	Lesson Titles
11.2.2.1 Recognize the significance of food science as a relevant science including current and historical developments and advancements of global food production	Food product development advancement	**Lesson 1:** Introduction to food Biotechnology
		Lesson 2: Genetic food engineering
		Lesson 3: Gastronomy
11.2.2.2 Explain the role of science as it relates to research practices and practical scientific experiments	Food engineering	**Lesson 1:** Introduction to food engineering
		Lesson 2: Modified food products
		Lesson 3: Food security and Climate change
11.2.2.3 Distinguish between the different kinds of chemical reactions in food and understand the factors that affect then	Chemical reaction in food	**Lesson 1:** Chemical reactions in food
		Lesson 2: Chemical reactions in starch and proteins
		Lesson 3: Chemical reactions in oils, fats, vitamins and minerals
		Lesson 4: Food fermentation
11.2.2.4 Describe methods of food preservation and their relationship to food safety	Food preservation	**Lesson 1:** Methods of food preservation
		Lesson 2: Food packaging
11.2.2.5 Investigate microorganisms in terms of classification, their growth and their application of food science	Food microbiology	**Lesson 1:** Introduction to food microbiology
		Lesson 2: Classification of Micro-organism
		Lesson 3: Roles of micro-organisms in food production

Step 6: Develop the Termly Programs

Extract the terms content from the Yearly Overview to expand the content into the termly teaching program. Below is a proposed Template to develop a Teaching Program for a Term.

Subject: _____Grade _____Term:____ Year: _____

Week	CS	BM	Unit	Topic	LO	K	S	A/V	PS
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, students 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	LO	K	S	A/V	Sugg.L.Act	PS
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	LO	K	S	A/V	PS	Lsn.nno: & Title	Lsn.Obj.	Sug.L.Act.
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	

Step 8: Review, Evaluate and Re-plan the yearly, termly, weekly Programs.

This process must be done collaboratively by all who teach the subject.

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 Maths /Science/Computing Teacher.
These three teachers will be timetabled to teach TIA during the term. Then the planning and programming will be organized 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 Teacher	
Class 3 and 4	Communication and Computer Technology	Computing ICT Teacher	These classes can be rotated so they all cover all the strands of TIA
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 Teacher	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	

This process must be done collaboratively by all who teach the subject.

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 panning 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. Teacher must engage and prepare motivating instructional activities that will provide the students with opportunities to demonstrate the benchmarks. For instance, teacher 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 organized set of lesson plans. Good planning allows for more effective teaching and learning. The lesson plan is a guide and map for organizing 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, analyze 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, and
- 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 is 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.

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 2: Food Technology

Unit 1: Food and Nutrition

Content Standard 11.2.1 Students will be able to examine and analyze 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.

Benchmark 11.2.1.1 Analyze the nature and properties of food.

Topic 1: Properties of fruits, vegetables and legumes

Lesson Title: Classification and properties of fruits, vegetables and legumes

Instructional Objective (s): By the end of the lesson, students will be able to;

- Classify and analyze the properties of fruits, vegetables and legumes.
- Plan, design and apply the principles behind cooing fruits, vegetables and legumes.

Essential Questions:

- What are the physical and chemical properties of fruits, vegetables and legumes?
- What are the nutritional values of fruits, vegetables and legumes and their benefits to humans?
- How are fruits, vegetables and legumes processed or prepared for consumption?

Knowledge:

- Nature and properties/characteristics of food. (gelatine, vegetables, pulses and nuts, fruits)
- Food processing stages/ food preparation.
- Principles behind preparing and cooking fruits, vegetables and legumes.

Skill(s):

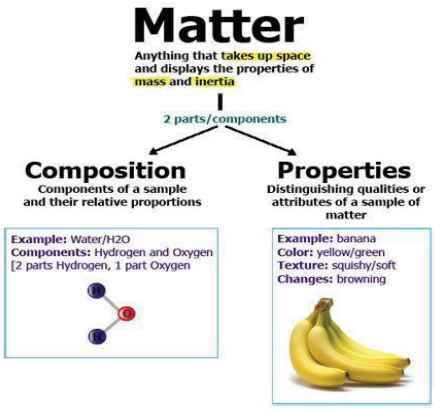
- Classify and analyse the physical and chemical properties of fruits, vegetables and legumes.
- Examine the food processing stages.
- Evaluate the principles behind cooking fruits, vegetables and legumes.
- Use the design brief to create a product containing fruits, vegetables and legumes.

Values/Attitudes:

- Appreciate and recognize the nutritional value of fruits, vegetables and legumes.
- Be responsible and of their food choices.
- Make informed decisions of designing a food product.

Teaching and Learning Strategies

Teacher will …	Student will …
Introduction (time in minutes)	
• Introduce the lesson topic and engage students in groups to brainstorm the different groups or classifications of fruits, vegetables and legumes. • Inform students about the lesson topic and the demonstration of the lesson. • Allow students to present their group findings.	Participate in groups and discuss and brainstorm the different groups or classifications of the following foods. Group 1 – Fruits Group 2 – Vegetables Group 3 – Legumes
Body (time in minutes)	
Modeling	
• Get the students together and demonstrate the food structure by cutting/slicing open a fruit or vegetable or legume. • Distribute handouts and ask them to read and discuss the contents of the handouts. • Ask students to present their findings.	• Students in their groups do the following; • Read and discuss the content in the handouts. • Identify different food groups and classify them accordingly.
Guided Practice	
• Display the foods and ask the students to carefully observe the foods that have been cut or sliced or cooked to identify their physical and chemical properties. • Ask students read handout and examine the changes happening to the food.	• Students discuss and identify their physical and chemical properties.

	
Independent Practice	
• Ask students in groups to investigate on the nutritional value of these food groups. (fruits, vegetables and legumes) • Provide guided questions for their group research based on the topic. • Make corrections where necessary to their reports.	• Students in groups research, discuss and evaluate nutritional values and uses of fruits, vegetables and legumes. • Compile a report on their research topic. • Present their findings/report to the rest of the class.
Conclusion (time in minutes)	
• Summarize important points by asking students questions related to their reports – What did the students learn in this lesson? • Self-evaluation – Points to consider such as content, teaching and learning strategies for lesson improvement.	• Students reflect on their given tasks and identify areas of improvement.

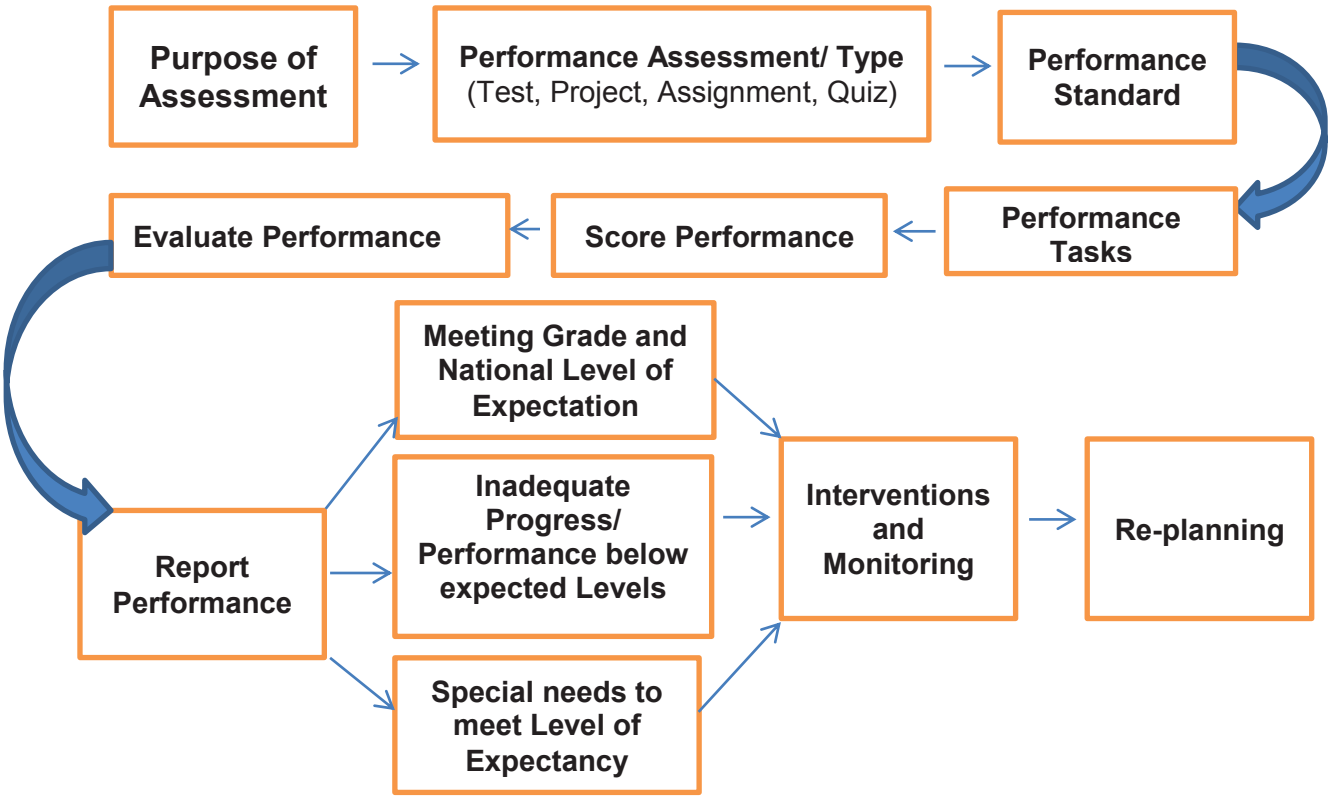
Assessment, Monitoring and Reporting

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 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, and
- compare students' performances and the performances of other students.

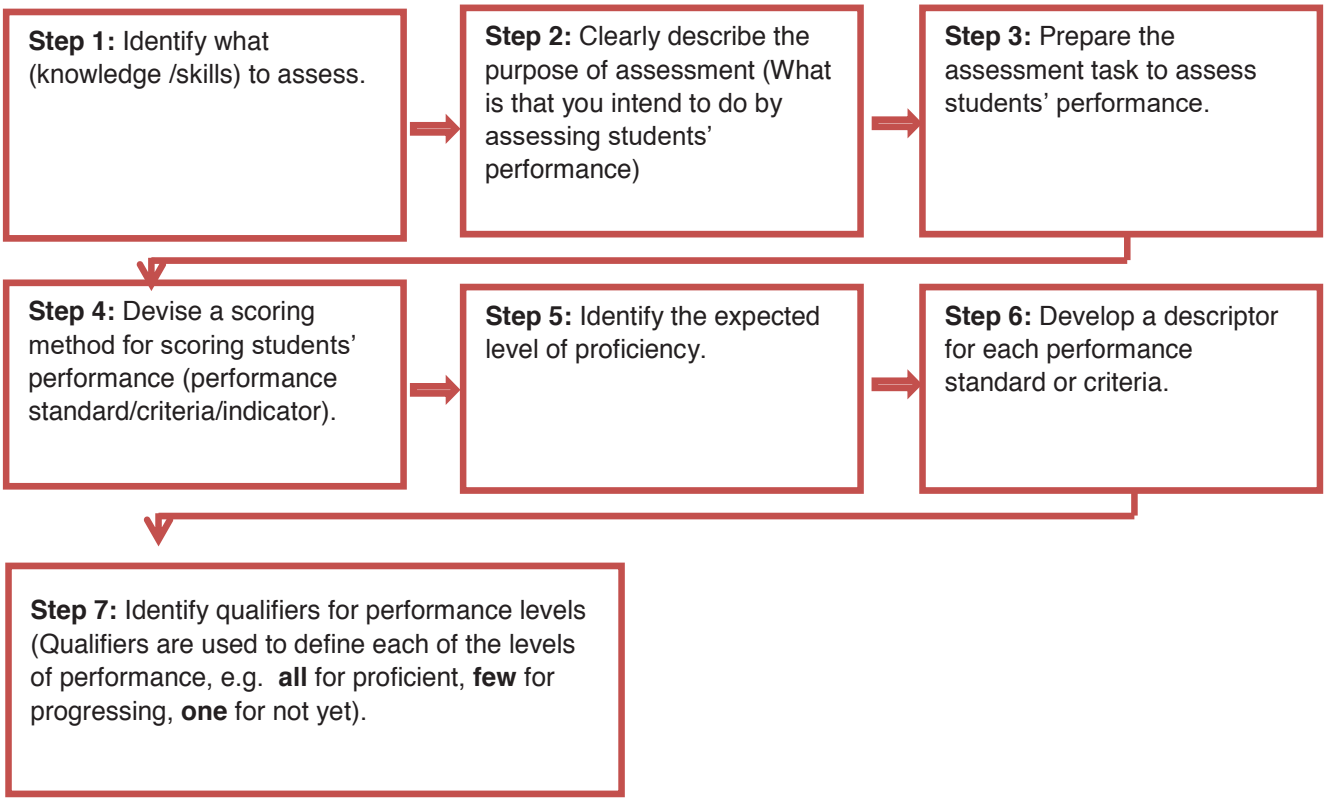
Principles of Standards-Based Assessment

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, and
- 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 and 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…," and
- 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.

The table shows a range of action verbs that are used in the different levels of learning and where applicable for the type of assessment 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, memorize, name, order, recognize, relate, recall, reproduce, list, tell, describe, identify, show, label, collect, examine, tabulate, quote	• Prior knowledge inventory, misconception/preconcepti on 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, recognize, 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, dramatize, 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	Analyze, appraise, calculate, categorize, compare, contrast, criticize, 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,	• Reflection component of a portfolio or experience • Journaling • Peer evaluation

	conclude, compare, summarize	
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

The table shows different strategies that are applicable in the standards-based assessment types.

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 complete.
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, Examinations	A quiz, test, or examination requires students to respond to prompts in order 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.
Case study	This strategy is used to extend students' understanding of real life issues The teacher provide students with case studies related to the topic of the lesson and allow them to analyse and evaluate. Students 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	This strategy is used to increase students' interest, involvement and participation. Teacher provides 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. Students 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.

Games and simulations	This strategy encourages motivation and creates a spirit of competition and challenge to enhance learning. The teacher being creative, select appropriate games for the topic of the lesson. Give clear instructions and guidelines. The game selected must be fun and build a competitive spirit to score more than their peers to win small prices. Students go into groups and organise. Follow the instructions and play to win.
Peer Teaching and 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 skills of inquiry. Teacher distributes topics to groups to research and teach others in the classroom. Go through the basics of how to present their peer teaching. Students 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.
Project (individual/group)	Projects help students complete tasks individually or collectively. Teacher outline the steps and procedures of how to do the project 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 and technology	Teacher is encouraged to use media & technology to teach and generate engagement depending on the age of the students. Show a full movie, an animated one, a few episodes form documentaries, you tube movies and others depending on the lesson. Provide questions for students to answer before viewing. Viewing can provoke questions, debates, critical thinking, emotion and reaction. Students after viewing, students engage in critical thinking and debate.

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, and
(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.
- Lists the criteria, or characteristics, that student work should exhibit and describes specific quality levels for those criteria.
- Is a great way to improve communication, learning, and grading fairness.
- Is descriptive and not evaluative.
- Can be used to evaluate, but the operating principle is to match the performance to the description rather than "judge" it.
- Is as good or bad as the criteria selected and the descriptions of the levels of performance under each.

Knowing how to create and use rubrics gives the teacher a better understanding of assessment and another option for assessing student performance. 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.

Below is a sample showing parts of a 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 reasons for developing caring relationships	Explain only one reason for developing caring relationships

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	

2. 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.

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

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 nor the overall quality, proficiency, or understanding of a specific content or skills.
- You are assessing large numbers. (e.g. 150 portfolios)

2. **When to use Analytic Rubric**

- Several subjects are assessing the student work.
- Description promotes 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.

General Rubric Matrix

This is a sample of a general rubric matrix that can be used for projects or other assessment. The table presents information that you can use or choose from to develop your own rubrics. You can adjust to suit the subject.

Criteria	Performance Standards (Descriptors)
Beyond	**Beyond Standard (s) - *Advanced in Performance and Understanding***
	Consistently demonstrates advanced conceptual problem-solving understandings Consistently generates tasks that make connections between and among problem-solving ideas Consistently applies strategies to unique situations Consistently demonstrated confidence to approach tasks beyond the proficiency level for grade Consistently initiates problem-solving investigations
Consistent	**Meet Standard (s) - *Proficient in Performance and Understanding***
	Consistently demonstrates understanding of problem-solving 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 problem solving arguments of thinking and reasoning Uses problem-solving language correctly and appropriately
Inconsistent	**Progressing - *Not Yet Proficient in Performance and Understanding***
	Inconsistently uses tools appropriately and strategically Demonstrates inconsistent understanding of key problem-solving ideas at grade level Demonstrates inconsistent conceptual understanding of key problem solving 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 problem-solving ideas inconsistently
Seldom	**Not Yet - *Limited Performance and Understanding***
	Exhibits minimal understanding of key problem -solving 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 problem-solving ideas

Steps to use the general matrix to develop rubrics

Here is a description of the process on how to use the above table and develop the rubric for an assessment.

1. Organise the criteria and qualifier in a four (4) pointer scale as shown below.

Criteria	Beyond	Consistent	Inconsistent	Seldom

Note: *The qualifiers Beyond, Consistent, Inconsistent and Seldom are taken from the general matrix*.

2. Refer to the general matrix and select an appropriate descriptor under each of the qualifiers to suit your assessment and place it in the table as shown below.

Criteria	Beyond	Consistent	Inconsistent	Seldom
1	Consistently demonstrates advanced conceptual problem-solving understandings	Consistently demonstrates understanding of problem-solving standards and cluster at the grade level	Inconsistently uses tools appropriately and strategically	Exhibits minimal understanding of key problem-solving ideas at grade level

Note: *The descriptors are taken from the general matrix. The descriptors do not have to be in the order as they appear in the general matrix.*

3. If the assessment tasks consist more than one criteria (performance tasks) the appropriate descriptors from the general matrix can be used in the rubrics.

Criteria	Beyond	Consistent	Inconsistent	Seldom
1	Consistently demonstrates advanced conceptual problem-solving understandings	Consistently demonstrates understanding of problem-solving standards and cluster at the grade level	Inconsistently uses tools appropriately and strategically	Exhibits minimal understanding of key problem-solving ideas at grade level
2	Consistently generates tasks that make connections between and among problem-solving ideas	Consistently demonstrated conceptual understanding	Demonstrates inconsistent conceptual understanding of key problem-solving ideas at grade level	Rarely demonstrates conceptual understanding
3	Constructs logical problem-solving arguments of thinking and reasoning	Constructs logical problem-solving arguments of thinking and reasoning	Depends upon assistance of teacher and/or peers to understand and complete tasks	Consistently requires assistance and alternative instruction

Note*: Ensure that the descriptors must not be repeated.*

4. The general matrix can be used for three (3) pointer scale as shown below:

Criteria	Consistent	Inconsistent	Seldom
1	Consistently demonstrates understanding of problem-solving standards and cluster at the grade level	Inconsistently uses tools appropriately and strategically	Exhibits minimal understanding of key problem-solving ideas at grade level

Note: *The steps two and three can be used also for the three (3) pointer scale.*

Scoring of Performance for Formative Assessment

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

There are three (3) commonly used types, these are as follow:

A. Frequency Rating Scales

B. Grade Rating Scales

C. Number Rating Scales

A. Frequency Rating Scales

A frequency rating scale scores how often a task is done to meet criteria.

Here is an example of a frequency rating scale used to assess the skill “Collaboration”. This frequency rating scale can be used for assessing students during group activity. The collaboration focuses on students’ ability to be part of a group and work together displaying qualities such as leadership, patience, tolerance, consideration and guidance.

Criteria	**Frequency**			
	Always = 4	**Sometimes = 3**	**Rarely = 2**	**Never - 1**
1. Embraces 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 an activity	Always ensures everyone is tasked to an activity	Sometimes ensures everyone is tasked to an activity	Rarely ensures everyone is tasked to an activity	Never ensures everyone is tasked to an activity
3. Encourages everyone to achieve together	Always encourages everyone to achieve together	Sometimes encourages everyone to achieve together	Rarely encourages everyone to achieve together	Never encourages everyone to achieve together

B. Grade Rating Scales

A grade rating scales can be use letters to grade and indicate the students' level of performance or achievement for example A, B, C, D, etc.

Here is an example of a rubric showing Grade Rating Scale. It is a summative assessment, that has been accumulated and the scoring is given in percentage and grade.

Performance Standards/ Criteria	**A 90 - 100**	**B 70 - 89**	**C 50 - 69**	**D 0 - 49**
Identify reasons for developing collaborative skills	Identify and explain the reasons for developing collaborative skills	Identify all the reasons for developing collaborative skills	Identify only a few of the reasons for developing collaborative skills	Identify only one reason for developing collaborative skills
Explain the reasons for developing collaborative skills	Explain all the reasons for developing collaborative skills and provide an in-depth justification for some of the reasons	Explain all the reasons for developing collaborative skills	Explain only a few of the reasons for developing collaborative skills	Explain only one reason for developing collaborative skills
Identify reasons for fostering collaborative skills	Identify and explain all the reasons for fostering collaborative skills	Identify all the reasons for fostering collaborative skills	Identify only a few of the reasons for fostering collaborative skills	Identify only one reason for fostering collaborative skills
Explain the reasons for fostering collaborative skills	Explain all the reasons for fostering collaborative skills and provide and in-depth justification for some of the reasons	Explain all the reasons for fostering collaborative skills	Explain only a few of the reasons for fostering collaborative skills	Explain only one reason for fostering collaborative skills

Grade rating scale

Score Range/Percentage Rating (%)	**Grade**
80 – 100%	A
70 – 79%	B
60 – 69%	C
50 – 59%	D
0 – 49%	E

C. Number/Numerical Rating Scale

A number rating scale measures students' preferences, feelings, perceptions and interest on a provided numerical scale.
Here is an example of a number rating scale used to assess the skill "Collaboration".

Number scales	1	2	3	4	5
Rating	Not all true	Some truth	Unsure	true	Very true

Sample 1
Here is an example of a rubric showing Number Rating Scale, has a rate of 1 indicating *Not all true* to a rate of 5 *Very true*.

Criteria	***Number Rating Scale***				
1. Collaboration is a 21st century skill that is required in achieving a team's goals and aims	***1***	***2***	***3***	***4***	***5***
2. Collaboration involves skills such as leadership, patience, tolerance, consideration and guidance.	***1***	***2***	***3***	***4***	***5***

Descriptive Terms to use for Rating Scale

The following tables show descriptive words to use when planning and constructing rubrics to assess students' performances or achievements.

The table shows terms 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

The table shows terms 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

The table shows terms 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

The table shows terms 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

The table shows terms 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	disorganised

The table shows terms 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

The table shows terms 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

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 an 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	

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 an 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 Technology and Industrial Arts Subject 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, the subject can plan to score assessment of students per term according to this components:

- 1 x Project = maximum of 50 marks
- 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' 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 TIA 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 subject is based on the Grade 9 & 10 and Grade 11 & 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 mandatory total)	Theory and also applications in theory	Normative
Marks	**100 %**	**A combination of design folios, practical applications, moderations and tests.**	

Sample Assessment Outline

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 different parts of assessment. The teacher can decide to have any number from 4-6. Assessment is weighted accordingly as shown in the table below.

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	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 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. Note down the KSAVs of the Unit of Work for the STEAM activity.
4. Write a Description of the Authentic Situation for the STEAM activity based on the identified Authentic Situation.
5. Write down the Task Descriptions for the STEAM Activity in order to approach the Authentic Situation.
6. Develop the Rubric to assess the STEAM Activity. Find below the steps 1-13.

Steps in developing the Rubrics;

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.
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 For the STEAM Assessment.
13. Consider the Applications of the Steam Rubric.

Grade 9 Sample STEAM Activity for Assessment
The teacher can use this sample as a guide to develop STEAM assessment.
Refer to the Appendix Section for the STEAM Activity Assessment Template.

Subject: Food Technology

Unit 1: Food and Nutrition

Content Standard 2.1 Students will be able to 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.

Benchmarks: 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.

Related Concept Links to Food Technology Benchmark with other Subject Areas

Subjects	Reference Benchmark Codes	Essential KSAV (Knowledge, Skills, Attitudes and Values)
1. Science	9.3.3.1	**K:** Physical and chemical properties of Food, pH Value of Food **S:** Investigate **A/V:** Being responsible
2. Character Social Development (CSD)	9.2.2.3 , 9.2.2.4, 9.1.5.2	**K:** Nutrition, Eating Disorders, Quality of Life **S:** Decision Making skills, **A/V:** Show respect and appreciation, goal setting, team work
3. English	9.2.3.1, 9.2.4.1, 9.2.8.1, 9.5.4.1	**K:** Descriptive writing, Ideas of writing, Clear and coherent ideas of writing, Information sources **S:** Research skills Interrogation skills, Comprehension skills, Presentation skills Report writing skills **A/V:** Being critical and considerate
4. Social Science (Geography)	9.1.3.4	**K:** Impact of migrations on places, resources, services, environments and cultures **S:** Analyze situations **A/V:** Being tolerant
5. Technology Industrial Arts (Communication Technology)	9.4.1.5	**K:** Range of communication and media products or services **S:** Problem solving **A/V:** Appreciate the development and benefits of communication products
6. Business Studies	9.1.1.3, 9.1.2,4, 9.2.2.8, 9.3.1.3, 9.5.2.5,	**K:** Types of journals used in accounting process, Customer service strategies, Importance of marketing mix, Marketing on social media, 5 P's of Marketing Mix **S:** Financial skills, ICT Skills,

		A/V: Transparent and accountable, making business decisions,
7. Agriculture	9.1.5.4, 9.1.3.1, 9.2.2.1	**K:** Food Crops, Animal Food products, Consumption needs of people, Food Demand and Supply, Food Security **S:** Research and Analyze data **A/V:** Making informed decisions, show respect and consideration
8. Maths	9.1.1.4	**K:** Calculation methods, Money is measured using numbers **S:** Estimate a reasonable solution to a problem using rounding and estimation, mathematical Thinking Skills, Problem Solving **A/V:** Being trustworthy
9. Arts	9.3.3.2, 9.3.3.5	**K:** Food presentation **S:** Creativity, artistic thinking **A/V:** Care and consideration,

The anchor subject in this sample STEAM assessment is Technology Food Technology

Topic: The Technology Design: Design, produce, market and evaluate

Learning Objectives: By the end of the topic, students will be able apply the design process to create food solutions to address nutritional issues affecting individual health and wellbeing.

Purpose of Assessing the Topic

The main purpose of this assessment task is to give students the opportunity to develop knowledge and skills to confront a problem like situation. They will use problem solving skills, design process and enquiry approach to gather information, plan, create market and evaluate a food product. Hence, they will use practical strategies or approaches as a platform to solve real life problems.

How the Performance Task will be done: Group Project Presentation

Performance Standard

By the end of the project, students will be able to;

- use enquiry approach to investigate and gather and analyze information to establish practical solutions to problems,
- use the design process to develop food product considering nutritional quality of food,
- advertise and market their food products, and, account daily earnings,
- conduct nutrition campaigns in their school community,
- make recommendations and compile a folio of the project.

Authentic Situation

Teachers in the school have noticed a general decline in students' participation and performance. Many students are from the local electorate, and they are experiencing social, political, physical and economical changes as a result of land grabbing, migration and infrastructure development. Many students have been seen at school with unhealthy lunches. The school canteen is not well stocked to provide for students lunch needs.

The Business and Technology department has identified the situation and will take a practical approach to find solutions. To achieve this, the grade 9 food technology students, as an assessment task will conduct a survey to gather information, analyze and communicate the results. Students will engage in cooking activities. They will design food menus, develop and sell food products to students and teachers. Proceeds will be entered on cash books for the department hence, the students will organize in groups and conduct outdoor health awareness campaigns to promote and stress the concept of healthy eating.

Task Description

- Develop questionnaires to conduct a survey to investigate the nutritional status of students.
- The questions must aim to investigate and establish the type of foods students eat at school lunches and at home.
- Decide on the logistics of the survey and conduct the survey as wildly as possible.
- Analyze the results of the survey and list recommendations.
- The results of the survey should set the stage/scene for further practical tasks.
- Plan and design food menus and formulate recipes to cook, simple but nutritious lunches.
- Create a food application or use smart phones either watsapp or Facebook to upload and advertise food menus and take food orders.
- Calculate food costing and present budget
- Prepare, process and package food products.
- Organize in groups to do outdoor nutrition campaigns and sell food products.
- Prepare and record proceeds from food sales for the Home Economic Department.
- Identify strengths and weakness, discuss, document and submit as project evaluation report.
- Compile a folio with attachments of survey instruments, tabulated findings and recommendations, food menus and recipes, food costings and budget samples, cash book entry, photographs and illustrations and submit for assessment.

Materials

- Survey questions
- Recipes sheets
- Cooking ingredients
- Cooking tools and equipment
- Food packaging materials
- Smart phone/laptop
- Charts/posters/pamphlets/fliers
- Markers and charts
- Audio-visual equipment
- Cash Entry Book

1. Categorizing Tasks for the Rubrics (Holistic Rubric)

Research

- The questions must aim to investigate and establish the types of foods eaten at school lunches and at home. ***(Content/information)***
- Analyse the results of the survey and list recommendations to set the stage/pace for further practical tasks. ***(Survey results and recommendations)***

Project Planning

- Plan and design food menus, formulate recipes. ***(Planning and designing of food product development)***
- Create a food application. Use smartphones to upload lunch menus, advertise and take food orders. ***(Technology application)***
- Calculate food costing and present a budget. ***(Budget + costing)***

Production – Product Development & Marketing

- Prepare, process and package food products. ***(Food product development)***
- Organize in groups to conduct outdoor nutrition campaigns and to sell food products. ***(Outdoor awareness and advocacy)***
- Prepare cash book entry and record proceeds from food sales for Home-eco Department. ***(Cash Book Entry)***

Project Evaluation and Folio Submission

- Identify strengths and weakness, discuss, document and submit as project evaluation report. ***(Project Evaluation)***
- Compile a folio with attachments of survey instruments, tabulated findings and recommendations, food menus and recipes, food costing and budget samples, cash book entry, photographs and illustrations and submit for assessment. ***(Folio product compilation and submission)***

2. List the Criteria against the Tasks Descriptions in the Table

Category/Criteria	Task Description
Content information	Participants to adhere to survey guidelines. Provide accurate information on the questionnaire sheets
Survey Results and Recommendation	Compile a survey report, list recommendations and finalize for further action
Planning on Food Product Development	Plan and design nutritious food menus. Formulate recipes
Technology Application	Create a food application or use watsapp or Facebook (social media) to advertise food menus and take food orders
Costing and Budget	Calculate food costs, draft a Budget and food purchase
Food Product development	Prepare, process and package foods as per order
Outdoor Presentations	Group presentations of nutrition awareness and food sales
Cash Book Entry	Record proceeds from food sales for HE Department
Project Evaluation	Identify strengths and weaknesses. Discuss, document and submit the project evaluation report
Product: Folio completion and submission	Compile all aspects of the survey, planning and development of food production, nutrition awareness campaign, records of food sale and project evaluation report

3. Unpack the Task Descriptions and Identify the essential KSAV that can be assessed

Category/Criteria	Task Description	Essential		
		Knowledge	Skills	Attitudes/ Values
Gathering Information	Participants to adhere to survey guidelines. Provide accurate information on the questionnaire sheets	• Ethical issues • Nutritional value of food • Dietary needs for different groups	• Public relation, • Questionin g techniques, • Entering information Organize content logically	• Appreciation • Being responsible • Respect views of others
Survey Results and Recommendation	Compile a survey report, list recommendations and finalize for further action	• Food Nutritional values • Health issues	• Analyze survey information • Compiling findings	• Making informed decisions
Food Product Development Planning	Plan and design nutritious food menus and recipes	• Food properties • Nutritious value of food • Dietary guidelines • Cooking methods • Food safety and handling	• Design process – Investigating , analyzing, • Problem solving, • Classifying, • Communicat ing ideas	• Taking responsible actions, • Making informed decisions, • Being creative and innovative
Technology Application	Create a food application, utilize Watsapp or Facebook platforms (social media) to advertise and market food products	• Use of technology, • Online platforms for sales and marketing, • e-commerce	• Operate technology devices, • Create market venues on electronic devices, • Create food app	• Making informed decisions, • Online citizenship
Costing and Budget	Planning Budget and food costing	• Budget, • Food costing	• Accuracy, • Mathematic al calculations, • Accounting skills	• Consumer knowledge of food and purchasing food
Food Product development	Prepare, process and package foods as per order	• Cooking methods • Food ingredients • Packaging	• Safety and care • Design process	• Making informed decisions • Problem solving

Outdoor Presentations	Outdoor awareness presentation and food sale	• Food and nutrition • Health and wellbeing	• Communication, • Advocacy and awareness, • Sales and marketing skills	• Commitment & perseverance
Cash Book Entry	Record revenue and expenditure	• Money transactions • Profit • Revenue • Expenses	• Keep records of money • Math calculations (addition& subtraction)	• Wise consumer • Transparency and accountability
Project Evaluation	Identify: Evaluate successes and failures of the project. Make recommendations	• Report Writing	• Judgmental skills	• Making informed recommendations, • Mental, physical and social preparedness
Product: Folio completion and submission	Compile a folio attach project details, submit for assessment	• Report Writing	• Folio & write up • Research skills	• Transparency and accountability

4. Completed Rubric Sample: School Lunch Assessment Rubric

Criteria	Advance	Achieved	Progressing	Novice	Marks
Gathering information	Participants were well versed of the information and provided **accurate** results on time	Participants were knowledgeable and provided **satisfactory** results on time	Participants completed **some** tasks with care. Others were incomplete and needed help	Participants attempted to complete **few** tasks, and not all were attempted. Lack of motivation	/4
Survey Results and Recommendations	Questionnaires provided **precise** answers, **well-structured** information compiled, analyzed and logically presented	Questionnaires provided answers and information **satisfactorily** compiled, analyzed and presented	Questionnaires provided **partial** answers and some were irrelevant to topic and purpose	Questionnaires provided very **few** answers, information **incomplete,** not presented in a logical manner	/4
Food Product Development Planning	Menus and recipes are **well-structured** and contain precise instructions with nutritional considerations	Menus and recipes are of the **correct layout** with nutritional considerations	Menus and recipes are correctly structured, but **some had information gaps**	Menus and recipes are poorly structured but noted for **incomplete information**	/4
Technology Application	Successful uploading of information on social media accommodating **smart marketing strategies** and attracted many customers. Display good team work	Successful uploading of information on social media. Able to employ **some marketing strategies** to convince customers to buy food product or place food orders	Successful attempts to connect on social media. **Lack marketing skills** but attracted customers	Struggled with social media. Encountered problems getting started but convinced **only a few** customers and shows less team work	/4
Costing and Budget	Have an **in-depth** understanding on calculating food costs and develop realistic and reliable budget	Have **basic** understanding on calculating food costs and skills of budgeting	Have **partial** understanding on calculating food costs per portion, completed a budget plan with figures that seem exaggerated and unreal	Encountered **difficulty** in calculating food costs per portion and struggled to plan a budget	/4
Food Product Development	Food product/lunch **well** prepared, processed and package as per order with consideration of	Food product/lunch prepared, processed and package as per order with **little** consideration of	Food product/lunch was **not well** prepared, processed and package as per order with little	Food product/lunch **lacked** the process of development, poor order done and no	/4

	food safety	food safety	consideration of food safety	consideration of food safety	
Outdoor Presentation – Nutrition Awareness and Lunch sale	Awareness was **well organized** and logically presented with tasks delegated well. Awareness messages were delivered with in-depth knowledge, creativity and confidence. **Exceptional** selling skills/techniques displayed, food sold and sales techniques maturely evident	Awareness was **satisfactorily** organized and presented with tasks delegated. Awareness messages were delivered with sound knowledge and confidence. Good selling skills/techniques displayed, food sold and sales techniques evident	Awareness was **partially** presented, some tasks not fairly delegated. Food was sold, errors occurred during money handling. Needed supervision and guidance at some stages. Organization was evident but team work was lacking	Awareness was **difficult to organize.** Students' roles were not specified correctly. Disorganization was evident, Food sales was slow and showed lacked of coordination and team work	/4
Cash Book Entry	Figures entered **correctly**, checked and all balanced well. No outstanding/ uncollected money	Figures entered **correctly with minor errors** identified, checked and all balanced. No outstanding/ uncollected money	Figures were entered however, **food was sold on credit** resulting in the delay of recouping all money for the records to be entered, checked and balanced	Figures were entered however, some **money was not accounted for,** made losses and outstanding money was not accounted for	/4
Evaluation	All aspects of the project was **well** discussed and evaluated, a thorough report finalized and presented in the correct layout and on time	The overall project was **fairly** discussed and evaluated, a general report finalized and presented on time	The project report was **partially** finalized and submitted with information gaps and recommendations that lack the basis of the project	The project report was **incomplete** and lack information and was not satisfactory compiled	/4
Folio Compilation and Submission	The folio contained **all** the requirements of the project in a logical order, was **well documented** and submitted on time	The folio contained **most** of the requirements of the project, was documented and submitted on time	The folio was **adequately** complied, some sections lacked details of the project and submitted after the due date	Folio **lack sufficient** information due to lack of teamwork, and, was submitted very late	/4

1. How to Score using the rubric

Scoring Rubrics

Criteria	Advance 4	Achieved 3	Progressing 2	Novice 1	Marks
Gathering information	Participants were well versed of the information and provided **accurate** results on time	Participants were knowledgeable and provided **satisfactory** results on time	Participants completed **some** tasks with care. Others were incomplete and needed help	Participants attempted to complete **few** tasks, and not all were attempted. Lack of motivation	3/4
Survey Results and Recommendations	Questionnaires provided **precise** answers, **well-structured** information compiled, analyzed and logically presented	Questionnaires provided answers and information **satisfactorily** compiled, analyzed and presented	Questionnaires provided **partial** answers and some were irrelevant to topic and purpose	Questionnaires provided very **few** answers, information **incomplete,** not presented in a logical manner	4/4
Food Product Development Planning	Menus and recipes are **well-structured** and contain precise instructions with nutritional considerations	Menus and recipes are of the **correct layout** with nutritional considerations	Menus and recipes are correctly structured, but **some had information gaps**	Menus and recipes are poorly structured but noted for **incomplete information**	2/4
Technology Application	Successful uploading of information on social media accommodating **smart marketing strategies** and attracted many customers. Display good team work	Successful uploading of information on social media. Able to employ **some marketing strategies** to convince customers to buy food product or place food orders	Successful attempts to connect on social media. **Lack marketing skills** but attracted customers	Struggled with social media. Encountered problems getting started but convinced **only a few** customers and shows less team work	3/4
Costing and Budget	Have an **in-depth** understanding on calculating food costs and develop realistic and reliable budget	Have **basic** understanding on calculating food costs and skills of budgeting	Have **partial** understanding on calculating food costs per portion, completed a budget plan with figures that seem exaggerated and unreal	Encountered **difficulty** in calculating food costs per portion and struggled to plan a budget	3/4
Food Product Development	Food product/lunch **well** prepared, processed and package as per order with consideration of	Food product/lunch prepared, processed and package as per order with **little** consideration of	Food product/lunch was **not well** prepared, processed and package as per order with little	Food product/lunch **lacked** the process of development, poor order done and no	2/4

	food safety	food safety	consideration of food safety	consideration of food safety	
Outdoor Presentation – Nutrition Awareness and Lunch sale	Awareness was **well organized** and logically presented with tasks delegated well. Awareness messages were delivered with in-depth knowledge, creativity and confidence. **Exceptional** selling skills/techniques displayed, food sold and sales techniques maturely evident	Awareness was **satisfactorily** organized and presented with tasks delegated. Awareness messages were delivered with sound knowledge and confidence. Good selling skills/techniques displayed, food sold and sales techniques evident	Awareness was **partially** presented, some tasks not fairly delegated. Food was sold, errors occurred during money handling. Needed supervision and guidance at some stages. Organization was evident but team work was lacking	Awareness was **difficult to organize.** Students' roles were not specified correctly. Disorganization was evident, Food sales was slow and showed lacked of coordination and team work	3/4
Cash Book Entry	Figures entered **correctly**, checked and all balanced well. No outstanding/ uncollected money	Figures entered **correctly with minor errors** identified, checked and all balanced. No outstanding/ uncollected money	Figures were entered however, **food was sold on credit** resulting in the delay of recouping all money for the records to be entered, checked and balanced	Figures were entered however, some **money was not accounted for,** made losses and outstanding money was not accounted for	3/4
Evaluation	All aspects of the project was **well** discussed and evaluated, a thorough report finalized and presented in the correct layout and on time	The overall project was **fairly** discussed and evaluated, a general report finalized and presented on time	The project report was **partially** finalized and submitted with information gaps and recommendations that lack the basis of the project	The project report was **incomplete** and lack information and was not satisfactory compiled	4/4
Folio Compilation and Submission	The folio contained **all** the requirements of the project in a logical order, was **well documented** and submitted on time	The folio contained **most** of the requirements of the project, was documented and submitted on time	The folio was **adequately** complied, some sections lacked details of the project and submitted after the due date	Folio **lack sufficient** information due to lack of teamwork, and, was submitted very late	3/4
Total Mark					**30/40**

2. How to Grade using the rubric

Grading Rubrics

Score Range	Grade	Qualifier (Proficiency)	Descriptor	Percentage
30 – 40	A	Advanced	Description reflecting **highest** level of performance.	76% - 100%
20 - 29	B	Achieved	Description reflecting **mastery** level of performance.	46% - 75%
10 – 19	C	Progressing	Description reflecting **movement towards** mastery level of performance.	26% - 45%
0 - 9	D	Novice	Description reflecting **beginning** level of performance	0% - 25%

3. How to Report using the rubric

Reporting an individual student's performance on the task

Assessment Task Report					
Assessment Task:	**School Lunch Project**				
Name:		**Grade:**	**Class:**	**Marks and Grade:**	**/40**
Criteria	**Advance** **76% - 100%** **30 – 40** **A**	**Achieved** **46% - 75%** **20-29** **B**	**Progressing** **26% - 45%** **10 – 19** **C**	**Novice** **0% - 25%** **0 – 9** **D**	**Scoring**
Gathering information	Participants were well versed of the information and provided **accurate** results on time	Participants were knowledgeable and provided **satisfactory** results on time	Participants completed **some** tasks with care. Others were incomplete and needed help	Participants attempted to complete **few** tasks, and not all were attempted. Lack of motivation	3/4
Survey Results and Recommendations	Questionnaires provided **precise** answers, **well-structured** information compiled, analyzed and logically presented	Questionnaires provided answers and information **satisfactorily** compiled, analyzed and presented	Questionnaires provided **partial** answers and some were irrelevant to topic and purpose	Questionnaires provided very **few** answers, information **incomplete,** not presented in a logical manner	4/4
Food Product Development Planning	Menus and recipes are **well-structured** and contain precise instructions with nutritional considerations	Menus and recipes are of the **correct layout** with nutritional considerations	Menus and recipes are correctly structured, but **some had information gaps**	Menus and recipes are poorly structured but noted for **incomplete information**	2/4
Technology Application	Successful uploading of information on social media accommodating **smart marketing strategies** and attracted many customers. Display good team work	Successful uploading of information on social media. Able to employ **some marketing strategies** to convince customers to buy food product or place food orders	Successful attempts to connect on social media. **Lack marketing skills** but attracted customers	Struggled with social media. Encountered problems getting started but convinced **only a few** customers and shows less team work	3/4
Costing and Budget	Have an **in-depth** understanding on calculating food costs and develop realistic and reliable budget	Have **basic** understanding on calculating food costs and skills of budgeting	Have **partial** understanding on calculating food costs per portion, completed a budget plan with figures that seem exaggerated and unreal	Encountered **difficulty** in calculating food costs per portion and struggled to plan a budget	3/4

Food Product Development	Food product/lunch **well** prepared, processed and package as per order with consideration of food safety	Food product/lunch prepared, processed and package as per order with **little** consideration of food safety	Food product/lunch was **not well** prepared, processed and package as per order with little consideration of food safety	Food product/lunch **lacked** the process of development, poor order done and no consideration of food safety	2/4
Outdoor Presentation – Nutrition Awareness and Lunch sale	Awareness was **well organized** and logically presented with tasks delegated well. Awareness messages were delivered with in-depth knowledge, creativity and confidence. **Exceptional** selling skills/techniques displayed, food sold and sales techniques maturely evident	Awareness was **satisfactorily** organized and presented with tasks delegated. Awareness messages were delivered with sound knowledge and confidence. Good selling skills/techniques displayed, food sold and sales techniques evident	Awareness was **partially** presented, some tasks not fairly delegated. Food was sold, errors occurred during money handling. Needed supervision and guidance at some stages. Organization was evident but team work was lacking	Awareness was **difficult to organize.** Students' roles were not specified correctly. Disorganization was evident, Food sales was slow and showed lacked of coordination and team work	3/4
Cash Book Entry	Figures entered **correctly**, checked and all balanced well. No outstanding/ uncollected money	Figures entered **correctly with minor errors** identified, checked and all balanced. No outstanding/ uncollected money	Figures were entered however, **food was sold on credit** resulting in the delay of recouping all money for the records to be entered, checked and balanced	Figures were entered however, some **money was not accounted for,** made losses and outstanding money was not accounted for	3/4
Evaluation	All aspects of the project was **well** discussed and evaluated, a thorough report finalized and presented in the correct layout and on time	The overall project was **fairly** discussed and evaluated, a general report finalized and presented on time	The project report was **partially** finalized and submitted with information gaps and recommendations that lack the basis of the project	The project report was **incomplete** and lack information and was not satisfactory compiled	4/4
Folio Compilation and Submission	The folio contained **all** the requirements of the project in a logical order, was	The folio contained **most** of the requirements of the project, was documented and	The folio was **adequately** complied, some sections lacked details of the	Folio **lack sufficient** information due to lack of teamwork, and,	3/4

	well documented and submitted on time	submitted on time	project and submitted after the due date	was submitted very late	
Total Mark					**30/40**

Note: The shaded is the student's proficiency score for each task.

Moderation Assessment in Technology and Industrial Arts

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 overtime can prevent this in a number of ways.

- Always applying the same standardized 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 co-coordinator?
It is preferable that the leader/co-coordinator has the authority to make decisions for 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

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.

Moderation – Using the Design Process

The design process will be assessed as it is the driver of the design portfolio evolving into the food product development in the case of food technology. Each stage of the food product development process will be assessed with their specific rubrics developed.

These are some guidelines given for the designing process;
1. Set the task descriptions, step by step on what is expected to be done by the students to complete the task.
2. Create and develop a design brief out of the tasks that indicates the design product or solution.
3. Ensure that the activities of the project are guided by the design brief.
4. Nominate essential knowledge, skills, attitudes and values to be taught and or assessed. Assessment can be in stages or on the entire project or product.

Develop Criteria for Assessing Learning

These criteria would normally be communicated to students with the activity.

Example: Students will be assessed on their ability to:

- Prepare a nutritious dish with consideration to dietary or health needs, constraints in food preparation, proficiency in manufacture and time management.
- Select and use appropriate kitchen equipment, techniques and materials to prepare a meal or dish.
- Document project work and show evidence of:
  - inspiration and evaluation
  - presentation of final dish
  - collection and justification of resources
  - appropriate food safety standards
  - 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. Food Product Development
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.

2. **Food Product Development**

List the essential phases of the project. Example, develop the product or preparing the dish.

1. The method and techniques used to develop the dish
2. The rationale behind developing the food recipe
3. Produce or prepare the nutritious dish
4. Select and use appropriate kitchen equipment, techniques and materials to prepare the dish
5. Evaluate the project

The different phases of the project will guide the teacher to develop an analytic as well as a holistic rubric. Refer to the assessment sections on the steps to develop a rubric.

Reporting, Monitoring and Evaluation

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 an 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 effected across all Business and Technology Subjects, recognized certification of attainment.

Glossary

Terms	Definitions
Acetic acid	A compound found in vinegar, amongst other foods, that gives a sour and pungent smell
Acid	A substance with pH below 7 that can break down to release hydrogen ions
Acrylamide	A by-product made when foods high in starch are fried, roasted or baked at a high temperature
Additive	Ingredients added to foodstuffs to alter them in order to preserve or enhance specific qualities e.g. taste, colour
Additives	Substances added to food to preserve or enhance appearance or flavours
Aftertaste	The after-effect of flavour leaving a coating in the mouth after chewing food
Allergy	A negative response triggered by the immune system from a range of causes such as consuming certain common food ingredients
Amino acids	Simple organic compounds containing an amino group and a carboxyl group: the building blocks of proteins
Antioxidant	A substance that inhibits oxidation, particularly important in the preservation of stored food products
Aroma	The smell given off by food (e.g. baked bread) and drink which is detected by receptors in the nose
Ascorbic acid	The scientific name for vitamin C; essential for growth and defense against infection
B vitamins	Water-soluble vitamins which help the body release energy from food. There are many B vitamins, all of which are required in a healthy diet
Bacteria	Group of single-celled organisms with a cell wall but no organelles (structure in a cell with a specific function)
Base	When added to an acid, will form a salt. Accepts hydrogen ions from an acid
Biotechnology	Controlled manipulation of biological systems for a desired outcome
Bitterness	A strong flavour, generally lacking in sweetness and usually quite sharp e.g. in coffee and citrus fruit
Blanching	A process where foods, such as vegetables, are boiled for a very short time, then plunged into cold water to stop the cooking process

Brewing	Producing beer by soaking starch in water, then fermenting the sweet liquid with yeast, producing ethanol and carbon dioxide bubbles
Browning	When the surface of food becomes darker and browner in colour as a result of cooking
Bulking agent	A food additive that increases the weight and/or volume of food without altering its nutritional value
Butyric acid	A carboxylic acid which can be found in, for example, milk and parmesan cheese
Canning	Process used to preserve foods where food is heated in a can to kill microorganisms
Caramelisation	A process by which monosaccharides and disaccharides are browned by the application of heat; a form of non-enzymatic browning
Carbohydrase	An enzyme that breaks down carbohydrate into simpler sugars
Carbohydrate	One of the key macro nutrients made up of carbon, hydrogen and oxygen; main source of energy in the diet
Carbonation	A process when carbon dioxide dissolves in a liquid and produces gas bubbles, producing a fizzy sensation
Carotenoid	A pigment in plants causing bright red, orange and yellow colours like those found in tomatoes, carrots and bananas
Carrageenan	A polysaccharide found in seaweed, used as a food additive e.g. for thickening, gelling, stabilizing
Casein	A protein found in milk
Cholesterol	A type of lipid, found in most body tissues; an essential part of cell membranes, vital for healthy body function. Made by the body and also found in dietary sources
Clouding agent	A food additive that makes beverages look more cloudy by creating an oil-droplets emulsion; used in fruit juices
Collagen	A protein found in connective tissue, acting as a structural component and often aiding elasticity
Colloid	A mixture in which one substances (solid, liquid or gas) is evenly dispersed in another (solid, liquid or gas) e.g. milk
Critical temperature zone	The temperature range of 5-63°C in which harmful microorganisms can grow and which must be avoided as much as possible during food-storage
Crystallisation	A process where molecules come together in a highly ordered arrangement forming a solid with a high melting point

Curing	A method of preserving meat (e.g. pork) and fish (e.g. salmon), usually using salt or compounds such as nitrites
Deficiency	The lack of essential nutrients leading to malnutrition and disease
Deformation	A process where the shape of an object is altered
Denaturation	A change in protein structure where the proteins bond together, usually by heat, acid or shear; solubility is lost and the helix structure breaks apart
Density	A physical property; relationship between mass and how much space (volume) it takes up. An indication of how open the internal structure is
Deterioration	The process of food decaying or losing freshness
Dextrin	What is produced when starch or glycogen is broken down with water (hydrolysis), forming short-carbohydrates of a few glucose molecules joined together
Diet	The total overview of foods eaten by an individual. Often based on personal taste or culture, some dietary choices can be healthier than others
Disaccharide	The molecule formed when two sugar molecules (monosaccharides) bond together and lose water e.g. sucrose, lactose, maltose
Emulsifier	An additive used in processing to stabilise a solution to prevent separation of components, typically fat/oil and water
Emulsion	A mixture of liquids which do not naturally combine: oil-in-water emulsions e.g. milk, or water-in-oil emulsions e.g. butter
Enrobing	The process of coating a food product with another ingredient
Essential nutrient	A nutrient required for normal function which cannot be synthesised by the body, so these nutrients must come from a dietary source
Esterification	A chemical reaction between alcohol and carboxylic acid forming an ester
Extrinsic sugar	‘Free’ sugars (e.g. table sugar) or added sugar. When fruits are juiced, they release these sugars
Extrusion	A cooking method where mixture of ingredients usually containing starch is forced through small openings at high pressure to form shapes e.g. breakfast cereal
Fatty acid	A molecule made up of carbon and hydrogen, which can be unsaturated or saturated; basic building block of oils and fats
Fermentation	A process carried out by bacteria and yeasts to convert simple sugars to acids or alcohols, altering food properties
Fibre	A material that cannot be broken down by enzymes and resistant to digestion. Provides bulk to many foods

Flavour	The experience involving taste and smell
Foam	When gas bubbles are trapped within a liquid or solid, providing an aerated structure e.g. whipped cream
Food Science	The study of scientific and technical disciplines to help ensure the safety, availability & consistency of food globally
Fortification	The process of adding nutrients to food
Gel	A network formation of long-chain molecules which trap water to form a semi-solid material
Gelatine	A protein derived from collagen, which dissolves in water and forms a gel on cooling, then melts at body temperature. Alternative spelling is gelatin
Gellan	A vegan gelling agent (gelatine substitute) produced by the bacterium Sphingomonas elodea; used in milk
Genetic modification	The alteration of genetic material to artificially produce a desired characteristic, outcome, resistance or novel trait
Glucose	A simple sugar; main source of energy in the body, and the preferred fuel in the brain
Gluten	A protein found in wheat, responsible for elastic qualities in dough and chewy texture in bread
Insulin	The hormone which controls blood glucose levels; insufficient insulin production can cause diabetes
Iodine value	The amount of grams of iodine absorbed by 100g of substance; often used to calculate the level of unsaturated fatty acids
Irradiation	The process of preserving food by exposure to radioactive sources to kill pathogens, with limited impact on appearance and quality
Keratin	A fibrous, structural protein present in animal (including human) skin and hair
Lactase	An enzyme with only one function: breaking down lactose into smaller sugars. Lactase deficiency is the most common cause of lactose intolerance
Lactic acid	Produced from lactose in milk by bacteria involved in the production of cheese and yoghurt. Also produced in anaerobic exercise
Lactose	A small sugar present in milk, which provides energy and adds body and sweet flavour to the milk
Leavening agents	Substances that promote volume increase by aeration e.g. yeast, baking soda. Also called raising agents.
Lecithin	A substance commonly used as an emulsifier, found in egg yolk for example

Legumes	Plants in the pea family, often nutrient-rich. Many help to fertilise the soil around them (e.g. peas, peanuts, navy beans)
Lipid	A group of compounds insoluble in water; includes fats and oils with various functions e.g. energy yielding and structural components
Liposoluble	A substance that can dissolve in fats and oils
Macronutrient	Required in large amounts in the diet; the main types are proteins, carbohydrates and lipids
Maillard reaction	A chemical reaction between amino acids and reducing sugar, which creates colour and flavour compounds
Malnutrition	The condition of having excessive nutrients, a lack of nutrients, or wrong proportion of nutrients
Malting	The process of soaking grain in water and heating, to allow germination and enzymes to develop
Maltose	A small sugar produced when starch breaks down; found in beer and malted products such as milkshakes
Melting point	The temperature at which a compound transitions from a solid to a liquid
Micronutrient	Required in small amounts in the diet; includes certain vitamins and minerals
Minerals	A group of essential nutrients e.g. calcium and potassium
Mollusc	Invertebrate with a soft body, often covered with a shell (e.g. mussels, squid)
Monosaccharide	A single sugar unit (e.g. glucose, galactose, fructose), formed by condensation of disaccharides with water added
Monosodium glutamate	White, odourless, crystalline powder with good water solubility. Functions as a flavour enhancer with an umami taste which can intensify the meaty, savoury flavour of food
Mouth feel	The way food and drink are felt in the mouth other than taste
Myoglobin	Protein that binds to oxygen, usually found in the muscle of vertebrae
Non-reducing sugar	A sugar which cannot act as a reducing agent, donate electrons to other molecules or participate in redox reactions e.g. sucrose
Nutrient	A nourishing substance required for maintaining growth and good health in living things
Oil	A blend of various triacylglyceride (TAG) molecules, typically liquid at room temperature

Panning	The process of building thin layers of sugar, sweetener or other coating onto food (e.g. nuts, fruits)
Pasteurisation	Using temperature and time to reduce microorganisms to a safe level without major alteration to the properties of the product e.g. milk (72°C for 15 sec.)
Pathogen	Microorganisms (e.g. bacteria, virus) that can cause disease
Pectin	A structural component found in plant cell walls which can be used for thickening and gelling
Polysaccharide	A complex carbohydrate formed by long chains of monosaccharide units, joined together by glycosidic bonds
Prebiotic	Indigestible plant component whose consumption promotes the growth of beneficial bacteria in the large intestine
Preservative	Extends the shelf life of a food product by inhibiting microbial growth
Protein	One of the main types of macronutrient; made up of chains of amino acids
Retrogradation	Realigning of amylose and amylopectin chains during cooling of a gelatinised starch mixture to a crystalline structure
Rheology	The study of the food behaviour when force is applied; deformation of solid or flow of liquid. Impacts food texture, equipment and packaging
Riboflavin	Vitamin B2; found in eggs, vegetables and meats
Salmonella	A genus of bacteria that can cause food poisoning. Poor hygiene practices can lead to salmonella infections
Saturated fat	A fatty acid molecule with no double bonds between carbon atoms; it is solid at room temperature
Sensory	Relating to the five basic senses: hearing, touch, taste, sight and smell
Stabiliser	A food additive that helps with structure stability, typically seen in salad dressing to stop oil and water from separating
Starch	A polysaccharide made up of many glucose molecules, joined via glycosidic bonds; contains amylose and amylopectin
Sterilisation	The process for eliminating microbes from foods e.g. bacteria, moulds, viruses
Sucrose	A table sugar derived from cane or beet crops

Sugar	A small chain carbohydrate, soluble in solution, that adds a sweet taste to foods
Sweetener	An additive that replaces sugar to provide sweetness, usually with lower energy content. Can be found in nature or produced synthetically
Taste	One of the basic senses. Food is detected in the mouth by receptors in the tongue. The five tastes are sweet, bitter, sour, salty and umami
Taste panel	A group of people having a joint duty to taste and/or evaluate a food or beverage product
Tempering	A process used to give chocolate a glossy appearance, 'melt in the mouth' sensation and prevent chocolate bloom
Thickener	A substance that increases the viscosity of a liquid
Trans fat	A type of unsaturated fat, found in margarine and spreads, not commonly occurring in nature
Unsaturated fat	A fatty acid chain with one or more double bonds between carbon atoms and is liquid at room temperature
Vegetable	Edible plant parts such as roots, leaves and stems e.g. spinach, carrots, celery
Viscosity	The measurement of a fluid's internal friction and resistance to flow. Typically used to measure the thickness of a liquid
Vitamins	A group of essential nutrients e.g. B vitamins important for normal growth and nutrition
Volatile	Evaporates easily at room temperature
Wheat	An important cereal crop, ground into flour to produce bread and pasta
Yeast	A single celled organism capable of fermenting sugar into alcohol and carbon dioxide
Zinc	A mineral which helps to process foods in the body. Good sources include dairy, bread and meat

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Appendices

Appendix 1: 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 2: 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 spirit to score more than their peers to win small prices.	Go into groups and organize. Follow the instructions and play to win
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 outlines 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 and generate engagement <u>depending on the age of the students</u>	Show a full movie, an animated one, a few episodes form documentaries, you tube movies and others depending on the lesson. Provide questions for students to answer before viewing.	Viewing can provoke questions, debates, critical thinking, emotion and reaction. After viewing, students engage in critical thinking and debate

Appendix 3: A Sample Portfolio

This refers to a collection of student work and additional information gathered over a period of time that demonstrates learning progress from a subject or/ integrated subjects project. **Certain sections of the portfolio such as the safety and uses of equipment /or tools have to be adjusted /or altered accordingly to suit the subject specifics.**

Sample Student Portfolio Template

Name: _____ **Class:** _____ **Term:** _____ **Date:** ___/___/___

Subject: _____

Strand: _____

Unit: _____

Content Standard: _____

Benchmark: _____

Name of Project: _____

Purpose of the Project: _____

1. Idea Generation

a. Inform the students that most of the projects for example; sewing shirt, making a bowl, preparing food or making a 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?

2) Explain what is safety?

Students draw the FIRST AID SYMBOL here

_____

3) How can safety be enforced in working practices to minimize the risks associated in the 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**	**Tools/Equipment Needed**
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:

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

d. 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%

a. 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** 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.												

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.

Source:*https://www.emergingedtech.com/2015/09/top-5-multi-platform-student-response-systems/*

Appendix 4: Steam Assessment Template

The template is divided into four (4) parts to help the teacher better understand the general connections of each part in developing a STEAM Assessment Project/Activity.

1. Information from Syllabus and Teacher Guide – Subject Concept Connections

Subject: (*Name of the Subject)* ……..

Strand: (*Identify and write the nominated Strand)* ……

Unit: (*Write the name of Unit under the Strand)* ……

Content Standard: *(Write the Content Standard for the Strand)* ……...

Benchmark: (*Write the nominated Benchmark for the STEAM Project/Activity)*

……

Benchmarks from Related Subject Areas:

Identify related subject areas with linking concepts or skills to be used to solve the problem (Authentic Situation). Organize them in a table as shown below.

Subjects *(List of related Subjects)*	**Benchmarks** *(List the nominated Benchmarks Codes)*	**Essential KSAVs** *(Unpack and list the specific KASVs for each of the Subject Benchmarks)*

2. Unpacking Standards for the STEAM Assessment Project/Activity

Topic: (*Unpack the nominated Benchmark to come up with the topic)*

……

Learning Objective(s): (*Unpack Standards to write broad learning objective in relation to the Topic)*

……

Purpose of Assessing the Topic: *(Describe the intentions of teaching and learning through conducting the STEAM Assessment Project/Activity)*

……

How the Performance Task will be done: (*List down the assessment strategy to use to execute the task or project, for example; group work, peer, etc.)*

……..

Performance Standard: *(Unpack standards and write a statement to describe students' attainment of standards)*

……

3. STEAM Assessment Problem, Task Descriptions and Materials

Authentic Situation: *(Describe the problem and possible solutions with its benefits. Use the guide for paragraphs 1-3 to help develop Authentic Situations).*

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: *You 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.*

……

Task Descriptions: (*List the Task Descriptions or Requirements in order to approach the Authentic Situation or Problem).*

- ……
- ……
- ……..

Materials: (*List the type of teaching and learning materials needed for the activity or project)*

- ……..
- ……
- ……

4. Developing Rubrics to Assess the STEAM Project/Activity

1. Decide on the Type of Rubric to be used (Holistic or Analytic)

Categorizing Task Descriptions

2. Decide what to assess from the Task Description.

3. Reword the Tasks descriptions to create Criteria.

4. Identify and list down categories/criteria of tasks for the Rubric and organize them in a table as shown below.

Table 1

Category *(List the main assessment task components in logical order (steps) to come up with the end product)*	**Task Description** *(Copy paste the task descriptions)*

Essential KSAVs to assess the STEAM Project/Activity

5. Unpack the task descriptions and identify the essential KSAV that can be assessed and organize them in a table as shown below.

Table 2

Category *(Copy and paste Table 1 – Column 1)*	**Task Description** *(Copy and paste Table 1 –Column 2)*	**Essential KSAVs** *(Unpacked Task Description KSAVs)*

Completed Table of Rubric

6. Reword the task descriptors with the inclusion of KSAVs into a descriptor statement for each criterion and distribute into each competency level/level of achievement.

7. Identify appropriate descriptive words or numerals (Choose to use 3, 4 or 5 point-scale) for the intended rubric. The table below shows examples of descriptive terms used as rating scales to show level of competency or achievement.

8. Upon the completion of the above steps in developing rubrics, the information is tabulated as shown below.

Table 3

Criteria	**Advance**	**Achieved**	**Progressing**	**Novice**	**Mark**
Copy and paste Table 2 – Column 1	*Description reflecting of highest level of performance*	*Description reflecting achievement of mastery level of performance*	*Description reflecting movement toward mastery level of performance*	*Description reflecting beginning*	*/4*

9. Consider the Application of the STEAM Rubric

Note: *Refer to the STEAM assessment section for a Sample STEAM Assessment Project/Activity and further deliberations on how to Score, Grade and Report using the rubric.*