

**Technology and Industrial Arts**

# **Food Technology**

**Senior High  
Grade 12**

**Teacher Guide**

**Standards-Based**



**Papua New Guinea**

**Department of Education**

**'FREE ISSUE  
NOT FOR SALE'**



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**Technology and Industrial Arts**

**Food**

**Technology**

**Junior High**  
**Grade 12**

**Teacher Guide**

**Standards-Based**



Papua New Guinea  
**Department of Education**

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**Issued free to schools by the Department of Education**

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# Acronyms

<b>AAL</b>	Assessment as Learning
<b>ARS</b>	Audience Response System.
<b>AFL</b>	Assessment for Learning
<b>AOL</b>	Assessment of Learning
<b>BoS</b>	Board of Studies
<b>CDD</b>	Curriculum Development Division
<b>CP</b>	Curriculum Panel
<b>DA</b>	Diagnostic Assessment
<b>IHD</b>	Integral Human Development
<b>GoPNG</b>	Government of Papua New Guinea
<b>KSVA</b>	Knowledge Skills Values and Attitudes
<b>MTDG</b>	Medium Term Development Goals
<b>NDoE</b>	National Department of Education
<b>OBC</b>	Outcomes-Based Curriculum
<b>OBE</b>	Outcomes-Based Education
<b>PNG</b>	Papua New Guinea
<b>SAC</b>	Subject Advisory Committee
<b>SBC</b>	Standards-Based Assessment
<b>SBC</b>	Standards-Based Curriculum
<b>SBE</b>	Standards-Based Education
<b>SCG</b>	Subject Curriculum Group
<b>STEAM</b>	Science, Technology, Engineering, Arts and Mathematics
<b>SRS</b>	Student Response System
<b>UOW</b>	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 12 Food Technology Teacher Guide to be used in all High Schools throughout Papua New Guinea.



.....  
**UKE W KOMBRA, PhD**  
Secretary for Education

# Introduction

Food Technology aims to equip students with the 21<sup>st</sup> 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 12 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 guide to plan, program, teach and assess the units and topics, and the essential knowledge, skills, attitudes and values (KSAVs) described in the grade-level benchmarks,
- understand the Food Technology Subject national content standards, grade-level benchmarks, and evidence outcomes,
- effectively make sense of the content (KSAVs) described in the Food Technology Subject 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 Subject skills, processes, concepts, ideas, principles, practices, values and attitudes,
- confidently interpret, translate and use Food Technology Subject 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 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 12 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 12 Food Technology 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, 21<sup>st</sup> 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 12 Food Technology Teacher Guide is closely aligned and complementary to Technology and Industrial Art Syllabus.

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

<b>Syllabus and Teacher Guide Alignment</b>	
<b>Syllabus</b>	<b>Teacher Guide</b>
<p>Outlines the ultimate aim and goals, and what to teach and why teach it.</p> <ul style="list-style-type: none"> <li>• Overarching and SBC principles</li> <li>• Content overview</li> <li>• Core curriculum</li> <li>• Essential knowledge, skills, values and attitudes</li> <li>• Strands and units</li> <li>• Evidence outcomes</li> <li>• Content standards and grade-level benchmarks</li> <li>• Overview of assessment, evaluation, and reporting</li> </ul>	<p>Describes how to plan, teach, and assess students' performance.</p> <ul style="list-style-type: none"> <li>• Determine topics for lesson planning, instruction and assessment</li> <li>• Formulate learning objectives</li> <li>• Plan SBC lesson plans</li> <li>• Select teaching and learning strategies</li> <li>• Implement SBC assessment and evaluation</li> <li>• Implement SBC reporting and monitoring</li> </ul>

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 12 Food Technology 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.

Standards Alignment

Standards in Syllabus	Standards in Teacher Guide
<ul style="list-style-type: none"> <li>SBC Aims and Goals</li> <li>Content Standard</li> <li>Benchmarks</li> <li>Evidence Outcomes</li> </ul>	<ul style="list-style-type: none"> <li>Learning Objectives</li> <li>Lesson Objectives</li> <li>Essential Knowledge, Skills, Values and Attitude</li> <li>Performance Standard</li> </ul>

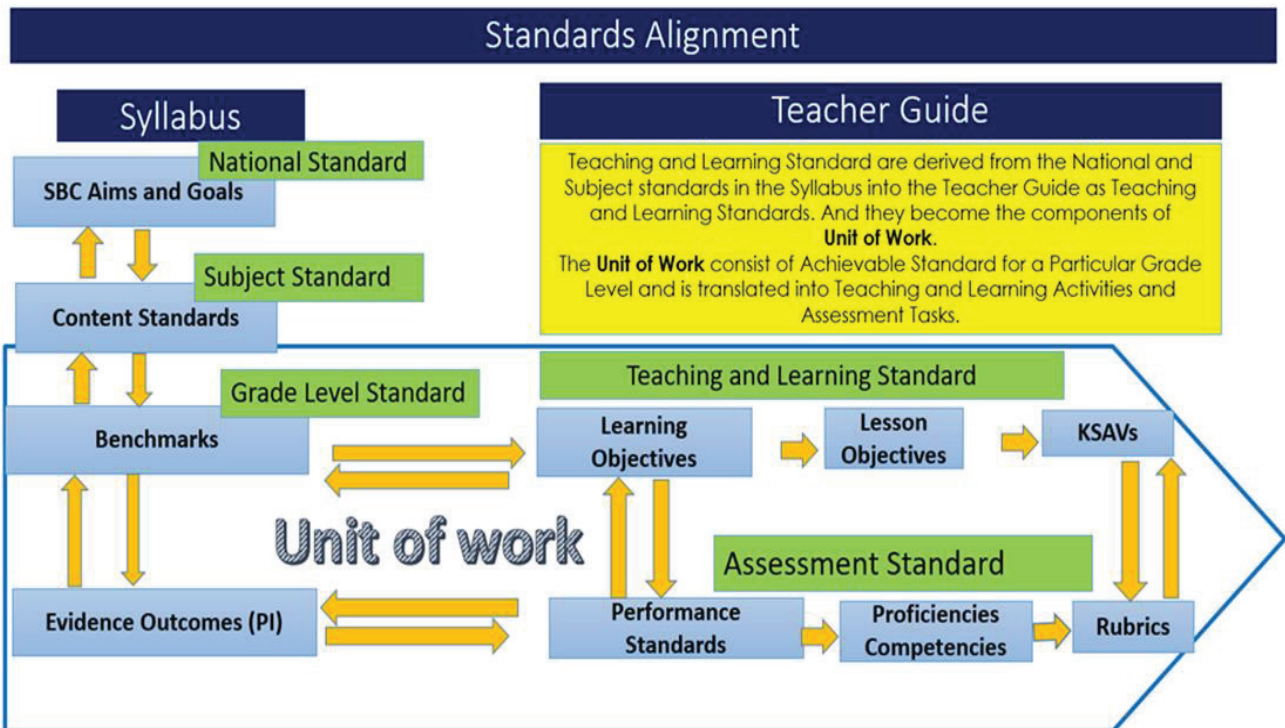
Standard Alignment

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.

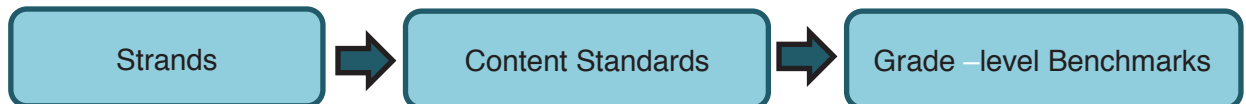
## Benchmarks

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.

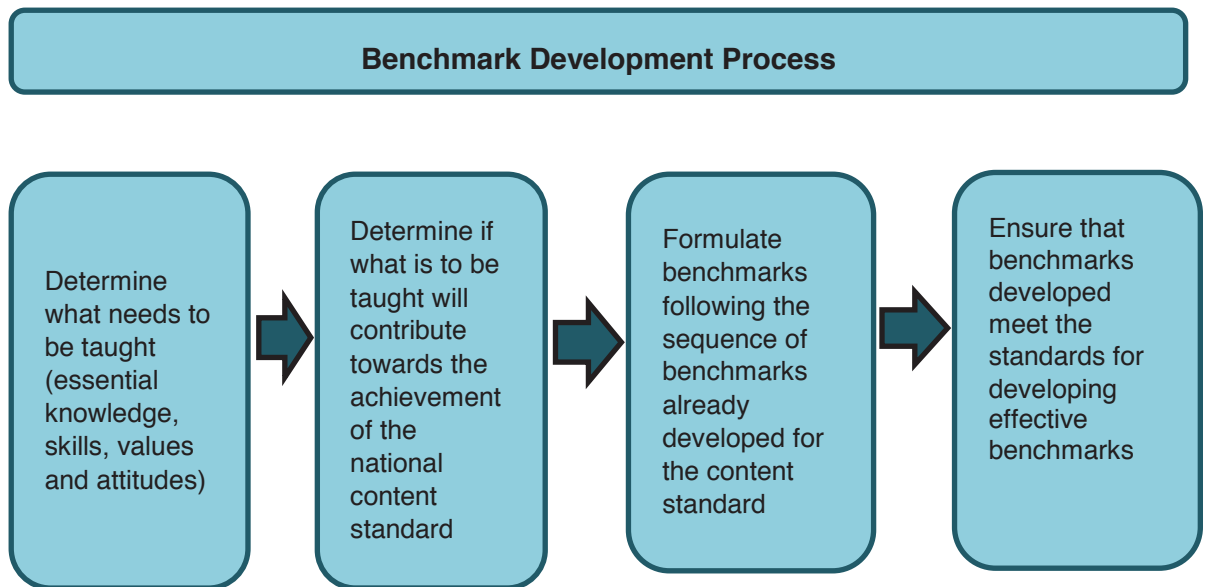
### Approach for Setting National Content Standards and Grade-Level Benchmarks



## Development of Additional Benchmarks

Teachers should develop additional benchmarks to meet the learning needs of their students. They should engage their students to learn about local, provincial, national and global issues that have not been catered for in the grade-level benchmarks but are important and can enhance students' understanding and application of the content. However, it is important to note that these benchmarks will not be nationally examined as they are not comparable. Only the benchmarks developed at the national level will be tested. This does not mean that teachers should not develop additional benchmarks. An innovative, 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**” or “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),
- 21<sup>st</sup> 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.

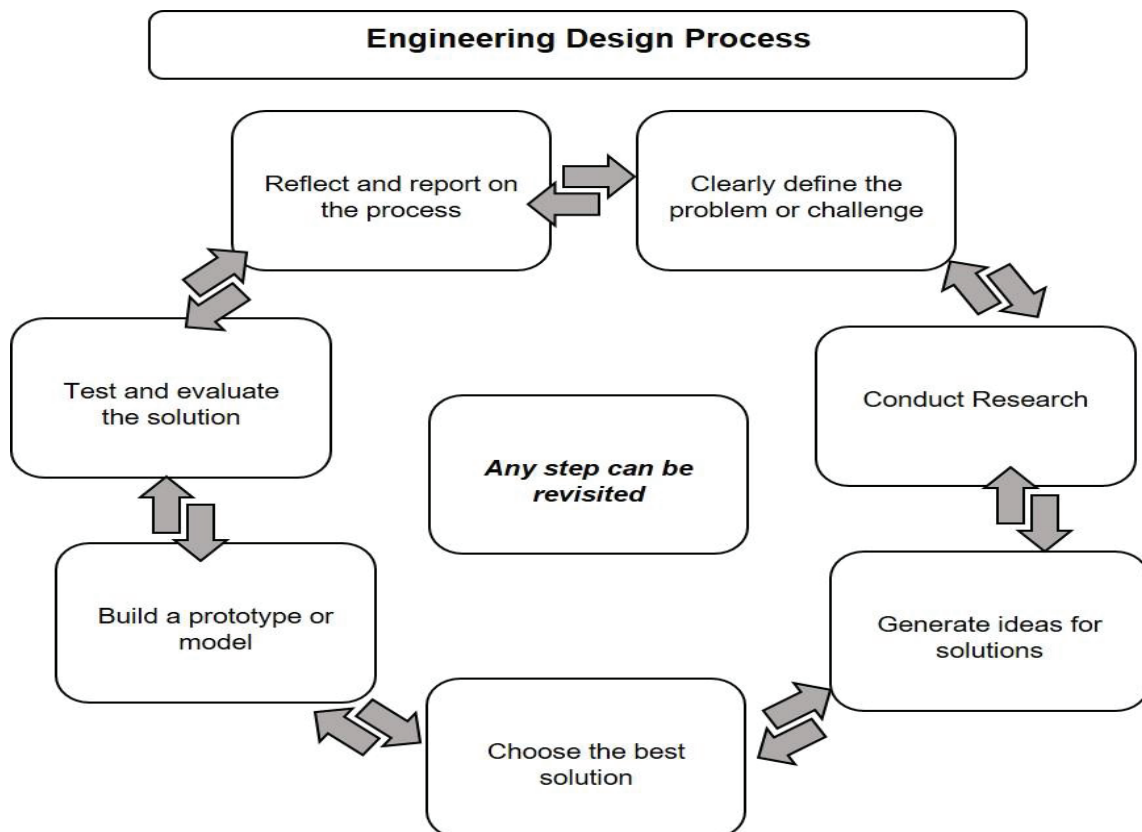
### Engineering Design Process

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.

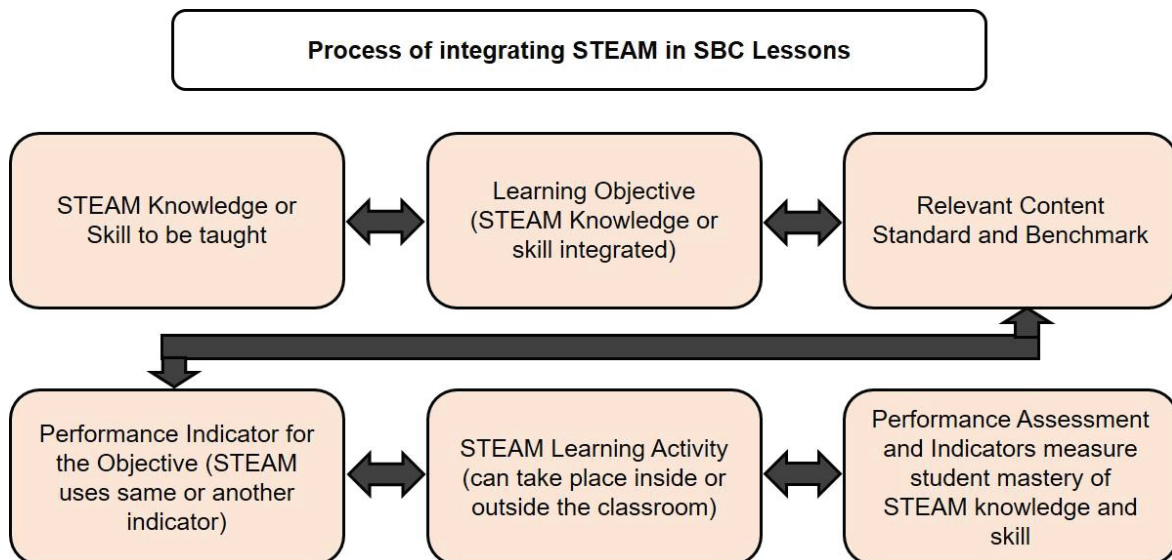
It is also important to review the **HACCP** system to determine if identified hazards were monitored effectively and the corrective actions were successfully implemented.

### 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 21<sup>st</sup> 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 21<sup>st</sup> 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.

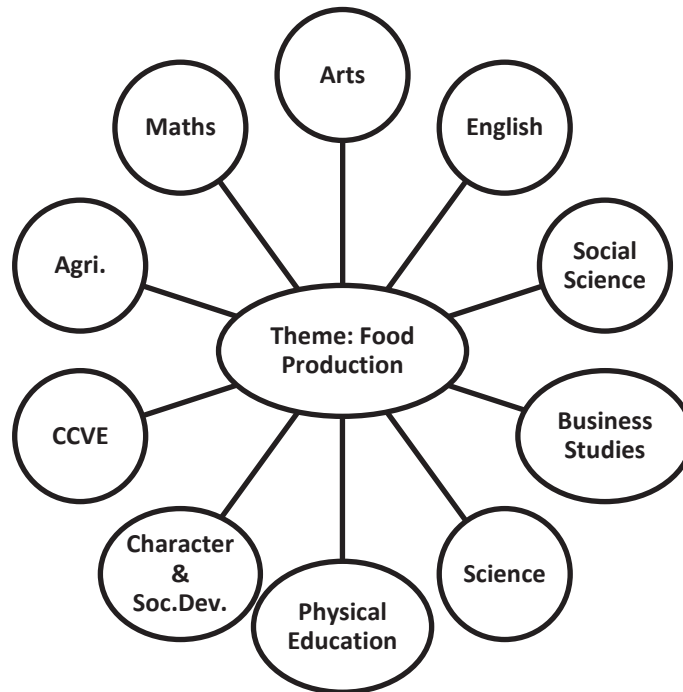
Curriculum integration is a holistic approach to learning thus curriculum integration in SBC will equip students with the essential 21<sup>st</sup> Century knowledge, skills, values and attitudes. Teachers must develop intriguing curriculum by going beyond the traditional teaching of content based or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

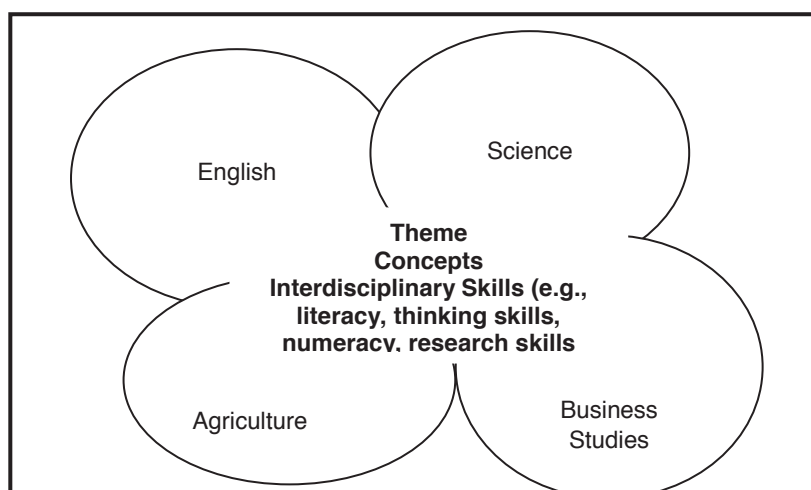
In this approach, learning involves a theme or concept that will be taught right across all subject area of study by students. For instance, if the theme is; “Food Production” all subject areas create lessons or project-based learning and assessment as per their subjects around this theme. The content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

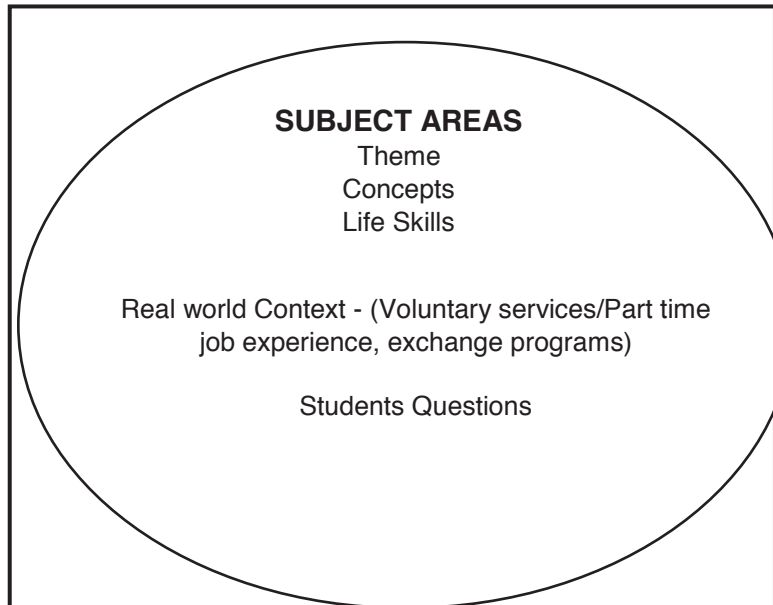
The three steps to planning project-based curriculum.

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

# Essential Knowledge, Skills, Values and Attitudes

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

These knowledge, skills, values and attitudes have been integrated into the content standards, benchmarks and performance standards developed for Technology and Industrial Arts subject. Teachers are expected to plan and teach these in their lessons, and assess students' performance and proficiency, and progression towards the attainment of content standards.

## 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;	
<ul style="list-style-type: none"> <li>• Creativity</li> <li>• Branding</li> <li>• Communication skills</li> <li>• Technical expertise</li> <li>• Industry expertise</li> <li>• Critical thinking</li> <li>• Information technology skills</li> <li>• Innovation</li> </ul>	<ul style="list-style-type: none"> <li>• Building and engineering knowledge</li> <li>• Physical strength and stamina</li> <li>• Mathematical formulas in technology</li> <li>• <b>Technology and Industrial</b> language coordination</li> <li>• Technology skills</li> <li>• Problem solving skills</li> <li>• Prototype</li> </ul>

## Food Technology

The Food Technology Subject 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;	
<ul style="list-style-type: none"> <li>• Nature and properties of food</li> <li>• Classification of food</li> <li>• Food preservation</li> <li>• Food storage and packaging</li> <li>• Menu considerations</li> <li>• Food selections</li> <li>• Food safety</li> <li>• Food Science</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical, physical and sensory properties of n food when subject to product development</li> <li>• Food processing</li> <li>• Food sources and the role of nutrients of food sources in the body.</li> <li>• Food for special needs and occasions</li> <li>• Nutrition</li> </ul>

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

<b>These are specific content Skills for the strand. They include;</b>	
<ul style="list-style-type: none"> <li>• Creativity</li> <li>• Critical thinking</li> <li>• Technical knowledge</li> <li>• Commercial awareness of food industries/catering services</li> <li>• Research and data handling capacity</li> <li>• Critical analysis and interpretation of materials</li> <li>• Management skills</li> <li>• Organizational skills.</li> <li>• Problem solving skills</li> <li>• Mathematical skills</li> <li>• Language literacy skills</li> <li>• Leadership</li> <li>• Innovative skills</li> <li>• Transformational skills</li> </ul>	<ul style="list-style-type: none"> <li>• Food server skills</li> <li>• Focus communication skills (approachability, circumstantial awareness, diligence, efficiency, thoroughness)</li> <li>• <u>Multitasking</u> skills</li> <li>• Attention to detail skills (multitasking, approachability)</li> <li>• Technical skills</li> <li>• Decision making skills</li> <li>• Coding</li> <li>• Information technology soft skills</li> <li>• Logical thinking</li> <li>• Collaboration</li> <li>• Teamwork</li> <li>• Software engineering</li> <li>• Software quality assurance</li> <li>• Customer service</li> <li>• Modeling</li> </ul>

### 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.

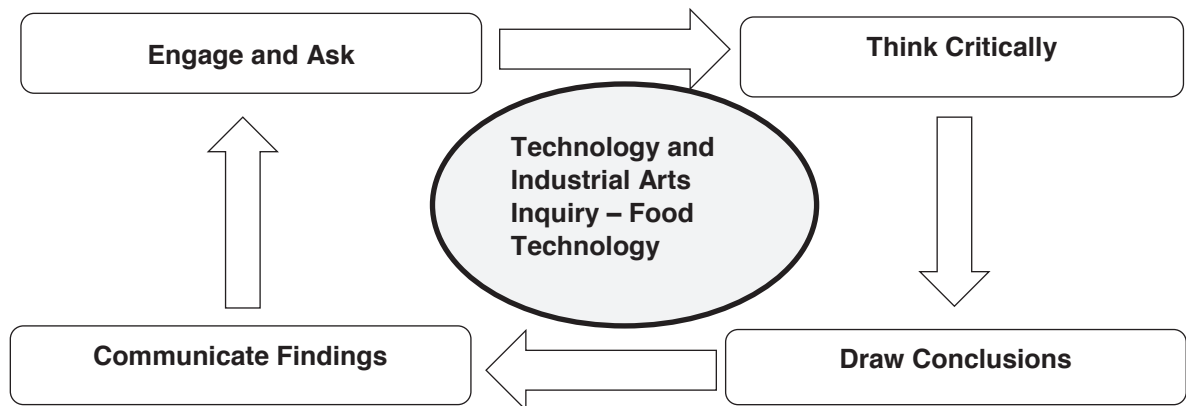
### Types of Processes- Inquiry processes for Technology & Industrial Arts subject

<p><b>Technology &amp; Industrial Arts Inquiry processes include:</b></p> <ul style="list-style-type: none"> <li>• Gathering information</li> <li>• Analysing information</li> <li>• Evaluating information</li> <li>• Making judgements</li> <li>• Taking actions</li> <li>• Instructional technology</li> <li>• Integration process</li> <li>• Project planning process</li> <li>• Organization of learning experiences</li> </ul>
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### Technology & Industrial Arts Inquiry Processes

<p><b>Engage and Ask</b></p>	<p>How will I engage my students in the topic and prompt them to ask questions?</p> <ul style="list-style-type: none"> <li>• Determine the enduring understandings about the topic being studied.</li> <li>• Engage your students with the topic by grabbing their interest with a hook connected to the enduring understandings.</li> <li>• Allow students to generate questions based upon the topic.</li> <li>• Determine what questions will be essential to achieving the enduring understandings. (Student generated or teacher determined)</li> <li>• With students, determine what other information is needed in order to fully answer the questions.</li> </ul>
<p><b>Think Critically</b></p>	<p>How will students access and analyse information about this topic?</p> <ul style="list-style-type: none"> <li>• Have students think about where they can find answers to the questions posed about the topic.</li> <li>• Gather and organize multiple primary and secondary sources.</li> <li>• Ensure that sources used expose students to different perspectives and viewpoints about the topic.</li> <li>• Students should use sources to collect, analyse, and interpret data.</li> <li>• Ensure students are analysing sources for credibility, bias, and perspective in order to identify gaps in the research.</li> </ul>
<p><b>Draw Conclusion</b></p>	<p>How will students synthesize ideas to answer the questions posed based on sources used?</p> <ul style="list-style-type: none"> <li>• Students should engage in civic discussion to answer the questions posed while respecting diverse opinions.</li> <li>• Engage students in evaluating possible courses of action and their consequences.</li> <li>• Students should make and justify an informed decision or choice and/or design an action plan supported by evidence from sources.</li> <li>• Have students evaluate the consequences of a decision or choice.</li> <li>• Allow students to make revisions based on feedback and further study.</li> </ul>
<p><b>Communicate Findings</b></p>	<p>How will students demonstrate what they have learned and take action on that learning?</p> <ul style="list-style-type: none"> <li>• Determine how students will apply what they have learned and share their findings with others.</li> <li>• Explore appropriate audiences for students to present conclusions.</li> <li>• Determine if there is an opportunity for students to take action and influence others to make more informed decisions.</li> <li>• Have students develop strategies to persuade others, including policy makers when applicable.</li> <li>• Prepare students to defend their analysis against alternative.</li> </ul>

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 12 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               | - Detecting bias                          |
| - Comparing and contrasting | - Evaluating                              |
| - Grouping and classifying  | - Metacognition (Thinking about thinking) |
| - Sequencing                | - Making informed conclusions             |
| - Prioritising              |   |
| - Analysing                 |   |

#### 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                  | - Synthesising      |
| - Deconstructing and reconstructing | - Making hypothesis |
| - Relating                          | - Making analogies  |
| - Creating                          | - Inventing         |
| - Making inferences                 | - Transformation    |
| - Predicting                        | - Modelling         |
| - Making generalisations            | - Simulating        |
| - Visualizing                       |                     |

**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
<ul style="list-style-type: none"> <li>• Sanctity of life</li> <li>• Truth</li> <li>• Aesthetics</li> <li>• Honesty</li> <li>• Human</li> <li>• Dignity</li> <li>• Rationality</li> <li>• Creativity</li> <li>• Courage</li> <li>• Liberty</li> <li>• Affectivity</li> <li>• Individuality</li> </ul>	<ul style="list-style-type: none"> <li>• Self-esteem</li> <li>• Self-reflection</li> <li>• Self-discipline</li> <li>• Self-cultivation</li> <li>• Principal morality</li> <li>• Self-determination</li> <li>• Openness</li> <li>• Independence</li> <li>• Simplicity</li> <li>• Integrity</li> <li>• Enterprise</li> <li>• Sensitivity</li> <li>• Modesty</li> <li>• Perseverance</li> </ul>

## 2. Social Values

Core Values	Sustaining Values
<ul style="list-style-type: none"> <li>• Equality</li> <li>• Kindness</li> <li>• Benevolence</li> <li>• Love</li> <li>• Freedom</li> <li>• Common good</li> <li>• Mutuality</li> <li>• Justice</li> <li>• Trust</li> <li>• Interdependence</li> <li>• Sustainability</li> <li>• Betterment of human kind</li> <li>• Empowerment</li> </ul>	<ul style="list-style-type: none"> <li>• Plurality</li> <li>• Due process of law</li> <li>• Democracy</li> <li>• Freedom and liberty</li> <li>• Common will</li> <li>• Patriotism</li> <li>• Tolerance</li> <li>• Gender equity and social inclusion</li> <li>• Equal opportunities</li> <li>• Culture and civilization</li> <li>• Heritage</li> <li>• Human rights and responsibilities</li> <li>• Rationality</li> <li>• Sense of belonging</li> <li>• Solidarity</li> <li>• Peace and harmony</li> <li>• Safe and peaceful communities</li> </ul>

### Types of Attitudes

Attitudes - Ways of thinking and behaving, points of view	
<ul style="list-style-type: none"> <li>• Optimistic</li> <li>• Participatory</li> <li>• Critical</li> <li>• Creative</li> <li>• Appreciative</li> <li>• Empathetic</li> <li>• Caring and concern</li> <li>• Positive</li> <li>• Confident</li> <li>• Cooperative</li> </ul>	<ul style="list-style-type: none"> <li>• Responsible</li> <li>• Adaptable to change</li> <li>• Open-minded</li> <li>• Diligent</li> <li>• With a desire to learn</li> <li>• With respect for self, life, equality and excellence, evidence, fair play, rule of law, different ways of life, beliefs and opinions, and the environment.</li> </ul>

# 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 21<sup>st</sup> 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 in the delivery of lessons.

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 21<sup>st</sup> 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 12. 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.

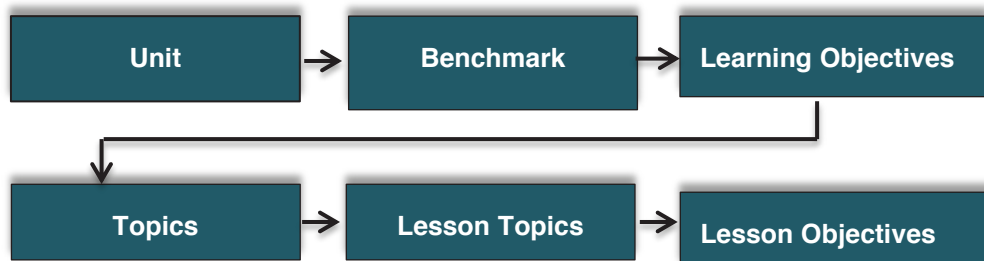
Benchmarks show grade level expectations of what students are able to do to demonstrate that they are making progress towards attaining the content standard.

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 12 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.

<b>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 their production and compliance with ethical principle and standards.</b>			
<b>Units</b>	<b>Benchmarks</b>	<b>Topic</b>	<b>Suggested Lesson Titles</b>
1. Food and Nutrition	<b>12.2.1.1</b> Describe the processes that transform raw materials into manufactured food products	Food production (1)	<b>Lesson 1:</b> Modified food products
			<b>Lesson 2:</b> The process of product development
			<b>Lesson 3:</b> The design process
	<b>12.2.1.2</b> Describe the processing techniques, equipment, storage and distribution systems used in industry and compare with those used domestically	Food production (2)	<b>Lesson 1:</b> Commercial food production
			<b>Lesson 2:</b> Food production systems
			<b>Lesson 3:</b> Create new food products
			<b>Lesson 4:</b> Food Packaging
	<b>12.2.1.3</b> Identify critical control points and describe quality control procedures in food production systems	Food quality control	<b>Lesson 1:</b> Food quality control process
			<b>Lesson 2:</b> Food quality production systems
	<b>12.2.1.4</b> Apply the principles of food preservation to create safe food products	Principles of food preservation	<b>Lesson 1:</b> Importance of food preservation and traditional practices of preservation
			<b>Lesson 2:</b> Methods of food preservation and storage
			<b>Lesson 3:</b> Hazard analyses
	<b>12.2.1.5</b> Investigate through experimentation, the suitability of packaging materials for different food products	Packaging of food products	<b>Lesson 1:</b> Importance and function of packaging
			<b>Lesson 2:</b> Packaging materials and systems
			<b>Lesson 3:</b> Future trends in packaging

<b>Content Standard 2.2:</b> 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)			
2.Food Science	<b>12.2.2.1</b> Investigate useful and harmful microorganisms and their effects on food products	Introduction to food microbiology	<b>Lesson 1:</b> Useful and harmful microorganisms
			<b>Lesson 2:</b> Types of bacteria
			<b>Lesson 3:</b> Food spoilage
	<b>12.2.2.2</b> Analyse and describe methods of food preservation and their relationship to food safety	Food preservation	<b>Lesson 1:</b> Principles of food preservation
			<b>Lesson 2:</b> Food packaging
			<b>Lesson 3:</b> Plan and design to preserve a food product
	<b>12.2.2.3</b> Explore and analyse food additives, the types, functions, and their roles in food products	Food additives	<b>Lesson 1:</b> Types of food additives
			<b>Lesson 2:</b> Roles of food additives
			<b>Lesson 3:</b> Create a food product with additives
	<b>12.2.2.4</b> Establish a safe working environment within the food industry	Safety standards	<b>Lesson 1:</b> Food safety standards legislation
			<b>Lesson 2:</b> Safety standards in food industry
			<b>Lesson 3:</b> Global food safety standards organisation
	<b>12.2.2.5</b> Explore and describe technological advances in food science	Advancement in food science	<b>Lesson 1:</b> Food design and innovation
			<b>Lesson 2:</b> Advancement in Science and Chemistry Research
			<b>Lesson 3:</b> Genetically Modified Food

**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 12**

## **Food Technology** Teaching Content

# **Grade 12**

## **Food Technology** Teaching Content

# 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 their production and compliance with ethical principle and standards.

Benchmark	Topic	Lesson Titles
<b>12.2.1.1</b> Describe the processes that transform raw materials into manufactured food products.	Food production (1)	<b>Lesson 1:</b> Modified food products
		<b>Lesson 2:</b> The process of product development
		<b>Lesson 3:</b> The design process
<b>12.2.1.2</b> Describe the processing techniques, equipment, storage and distribution systems used in industry and compare with those used domestically.	Food production (2)	<b>Lesson 1:</b> Commercial food production
		<b>Lesson 2:</b> Food production systems
		<b>Lesson 3:</b> Create new food products
		<b>Lesson 4:</b> Food Packaging
<b>12.2.1.3</b> Identify critical control points and describe quality control procedures in food production systems.	Food quality control	<b>Lesson 1:</b> Food quality control process
		<b>Lesson 2:</b> Food quality production systems
<b>12.2.1.4</b> Apply the principles of food preservation to create safe food products.	Principles of food preservation	<b>Lesson 1:</b> Importance of food preservation and traditional practices of preservation
		<b>Lesson 2:</b> Methods of food preservation and storage
		<b>Lesson 3:</b> Hazard analyses
<b>12.2.1.5</b> Investigate through experimentation, the suitability of packaging materials for different food products.	Packaging of food products	<b>Lesson 1:</b> Importance and function of packaging
		<b>Lesson 2:</b> Packaging materials and systems
		<b>Lesson 3:</b> Future trends in packaging

**Unit 1: Food and Nutrition**

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

**Unit 1:** Food and Nutrition

**Benchmark: 12.2.1.1** Describe the processes that transform raw materials into manufactured food products.

**Topic:** Food production (1)

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

- Discuss and identify various processes that change raw food materials into manufactured food products.
- Analyse various manufactured food products.
- Analyse the principles of food processing.
- Investigate different food processing stages and its impact on food development.
- Identify and analyse the nutritional effects on food processing.
- Explain and appreciate the food production process.

**Essential Questions**

- How are raw materials transformed into manufactured food products?
- What are the different ways of food processing?
- What are the nutritional values of food products and its benefit to health and wellbeing?
- What are the key elements of primary and secondary production of food in PNG and other countries?
- What are the principles of food processing?
- What is the design process in creating new food products?
- How is design brief used with the application of commercial principles such as research, design, product testing, production, evaluation and marketing?

**Essential knowledge, skills, values, attitudes**

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Raw materials/food</li> <li>• Manufactured food products</li> <li>• Food processing stages</li> <li>• Nutritional effects of processing</li> <li>• Food production processes</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Investigate the food production processes and its impact on food development</li> <li>• Compare raw food materials and manufactured food products</li> <li>• Discuss and analyse nutritional value on food processing</li> </ul>
<b>Attitudes/Values</b>	<ul style="list-style-type: none"> <li>• Appreciate the different food product development process and consider their food choices</li> </ul>

- |  |   |
|--|---|
|  | <ul style="list-style-type: none"><li>• Make informed decisions on the role of specific nutrients in the body and the balance required for optimum health</li><li>• Be responsible of their food choices in food processing</li></ul> |
|--|---|

### Teaching and Learning Strategies

The emphasis is on food production being subjected to project based learning using the design process. Allow for students to explore and investigate food production to create new food products using the design process.

### Learning Activities

#### Lesson 1: Modified food products

**Activity 1:** Explain what modified food products are and give examples of them.

**Activity 2:** Why is food processing important and how are foods processed?

#### Lesson 2: The process of product development

**Activity 1:** Identify and discuss the various stages of processes that change raw food materials into manufactured food products.

**Activity 2:** Choose any manufactured food product and explain the different stages of production.

#### Lesson 3: The design process

**Activity 1:** What is the design process in creating new food products?

**Activity 2:** How is the design brief used with the application of commercial principles?  
(can be a practical lesson)

## Content Background

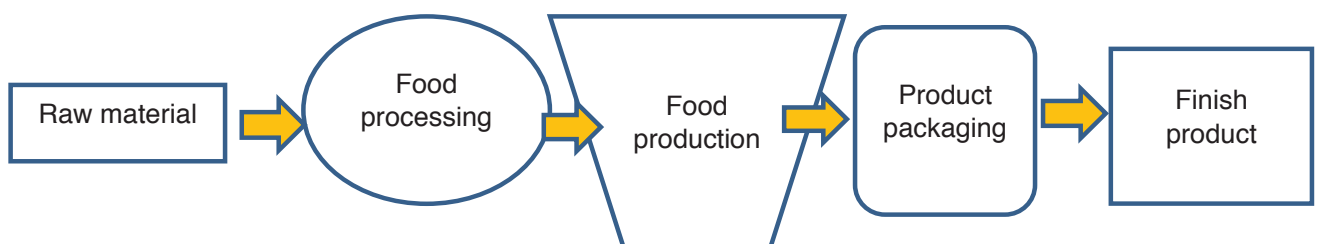
Food manufacturing and technology have developed rapidly over the last 100 years. Food was previously manufactured and sold locally to a small area, and processing and technology were very limited.

In PNG, most of our food is grown and animals are raised for either sale or own consumption. Food processing starts in the kitchen and in for commercial reasons, they are processed in food industries. There are relatively a good number of food processing companies/ factories that produce several kinds of food products in PNG. In addition, some of these processing companies often owned large areas of farm land where farmers grow food specifically for the company to process. For example, they grow vegetables for freezing or canning. These companies also import food from other countries to be sold.

Most of the food products we purchase today in the shops are processed overseas or are food imported from industrialized countries. There are remaining challenges of the quality of food products and their nutritional value to health. PNG is the major supplier of raw materials/ingredients. Fruits and vegetables are unprocessed and sold directly in the local markets. However, while these fresh foods are not being processed, they go through a production system to get them into the commercial market. This system involves being harvested, often washed, graded and labeled, and finally being packed and stored in cold storage before being transported to the wholesale fruit and vegetable market. This process is aimed to get to the consumer in peak conditions in order to avoid food spoilage.

### What is food processing?

Food processing is defined as the alteration of food by a series of actions in a factory or kitchen. Food is processed, or changed mechanically, chemically, or enzymatically for a variety of reasons. For such reasons, several processes have been developed to provide consumers with a safe food supply. The Government regulates food safety standards. Producers and processors together are responsible to, work to deliver wholesome food to the consumer. In food production, food safety is important which includes the proper cleaning and sanitization of processing equipment.



## Why is food processing important?

The processing of food is important to ensure that consumers have a safe and consistent supply of food. Food manufacturers process food for a variety of reasons to;

- ensure a safe food supply by preventing or slowing down the growth of micro-organisms that cause food contamination. For example, through using the process of pasteurization or dehydration,
- ensure availability of food supply all year round and there is no shortage of food supply,
- maintain the quality of food by extending the shelf-life. The food is preserved and safe for consumption,
- increase convenience for the consumer through the production of a range of pre-prepared products such as home-meal replacements,
- enhance the appeal to consumers by improving the flavor or appearance of product,
- improve the health benefits of some foods such as producing low fat, low salt, low sugar, and high fibre varieties,
- provide for the needs of consumers with special needs such as gluten-free products and products for diabetics, and
- improve transportation and storage of food products.

## Stages of food processing

Food processing normally takes clean, harvested crops or butchered animal products and uses these to produce attractive, marketable and often long shelf life food products. All food products go through different production stages depending on its nature and characteristics. For example, bread, biscuits, cakes or bakery products have specific raw ingredients/goods, machinery, equipment, experts and quality control checks as the product moves through each stages of the food production line.

There are two food processing stages;

**1: Primary Processing** involves altering a basic food to preserve it or prepare it for sale or cooking. E.g milling wheat into flour, descaling and gutting fish, cleaning and jointing a meat carcass, heat treating milk, skimming cream from milk, sorting and washing vegetables, peeling, stoning, slicing, canning fruit, extracting oils from seeds and nuts.

**Primary processing of cereals** includes cleaning, grading, hulling, milling, pounding, grinding, tempering, parboiling, soaking, drying, sieving.

Primary food processing is an economic activity within food supply chains, which focuses on first-stage processing of agricultural raw materials. First stage processing is transformation of or extraction of different components from the raw material for use as food or feed or ingredients for further processing; during secondary processing, the products of primary food processing are further processed into a wide range of processed foods.

### **Production of vegetable oils and protein meals**

The main factors in vegetable oils and vegetable proteins supply chain are crop farmers, traders of oilseeds, processors of oilseeds and of crude vegetable oils into refined oils and protein meals, secondary processors, like food, feed, biodiesel and chemical industries, and distributors to the end users. The end users are other industries (e.g. producers of biodiesel, oleo-chemical, cosmetics, compound feed industry), animal farms (feed material) and consumer households (edible oils or food containing vegetable oil).

Transportation and storage and (international) trading play an important role in the supply chain in delivering the products from one stage in the chain to another. Some companies are active on more than one stage of the supply chain. The level of integration of the supply chain differs per product and per market. For example, some oilseed processing companies are also active in storage and trade (transport and sales) of products across the chain, some may be involved in downstream processing of vegetable oils (bottling, margarine production, or biodiesel) and some also in the production of compound feed.

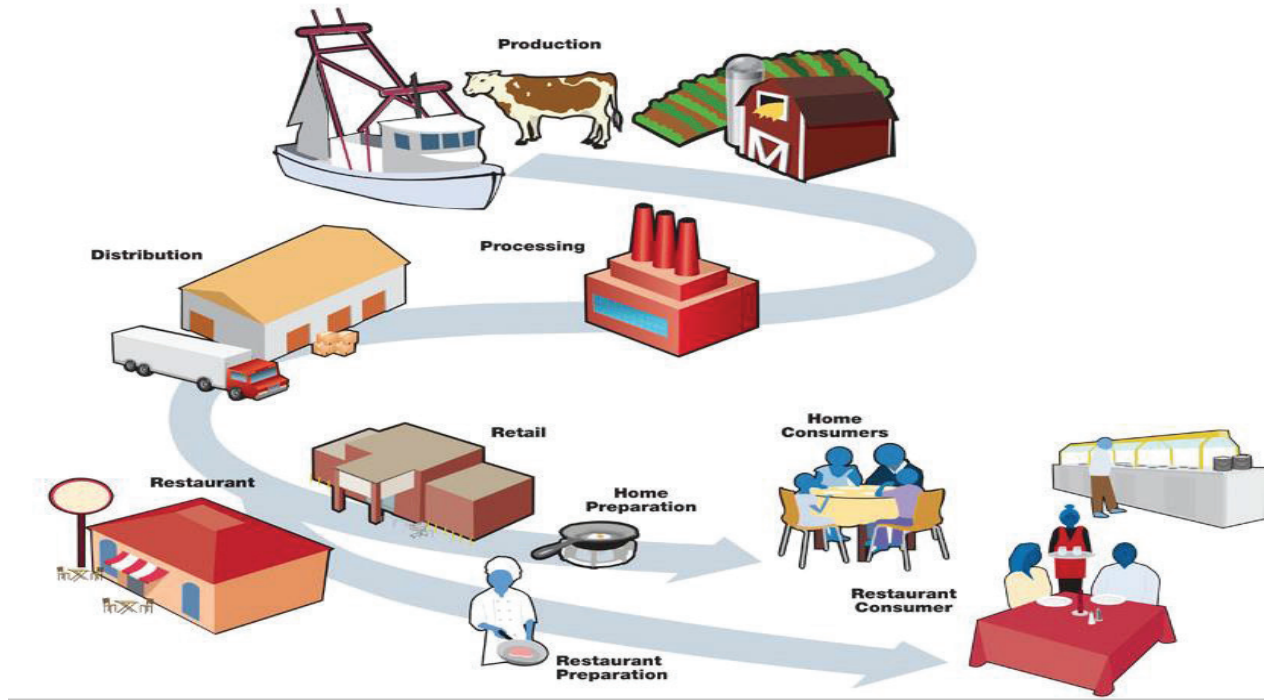
**2: Secondary Processing** involves turning basic process food into food products or combining food into a particular way to change its properties. For example, making margarine from oil, baking breads, cakes and biscuits from flour, fat, sugar etc, making cooking sources from vegetables, meat, fish etc.

### **3: Tertiary Processing**

**Tertiary food processing** is the commercial production of what is commonly called **processed food**. These are ready-to-eat or heat-and-serve **foods**, such as TV dinners and re-heated airline meals.

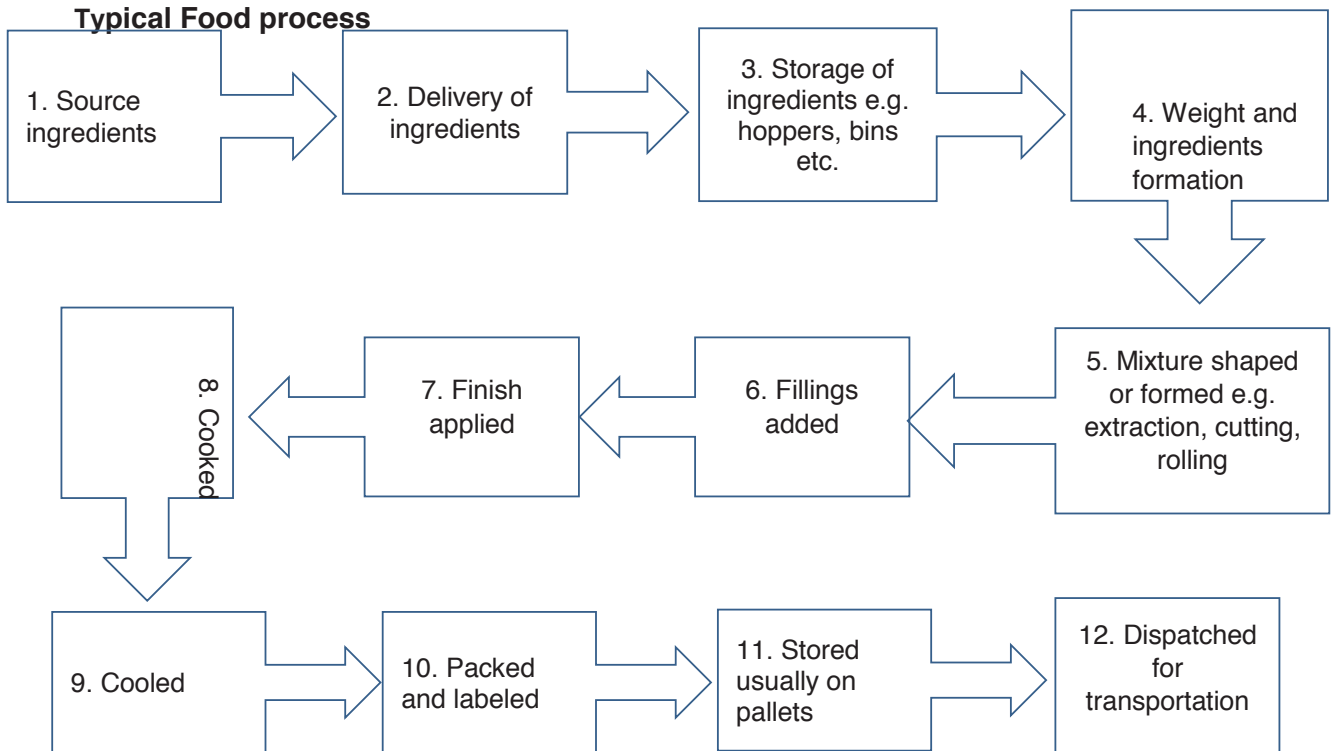
Food are prepared and presented as to be easily and quickly ready for consumption.

# The Food Production Chain



The diagram illustrates the different stages of meat production.

## Typical Food process



## How are new food products developed and introduced into the marketplace?

### 1. Develop ideas of the new product

Food scientists or are also known as product developers come up with ideas that may be generated by consumer complaints or suggestions, new regulations, new findings about nutrition, etc.

### 2. Test ideas on small scale or bench-top development

Research is carried out to form a number of recipes and specify the ingredients to be used. Several versions of the product are using slightly different ingredients or processes. That is the production of prototypes in the company's test kitchen. A small number of staff, experienced in sensory evaluation, test the products and evaluate them informally.

### 3. Sensory evaluation

This evaluation is carried out at many stages of the development process. Do consumers like the taste, color, etc. Trained assessors comment on the appearance, odour, taste, texture of the products to ensure that the product being developed displays the desired sensory characteristics.

### 4. Modify product

Changes made to size, shape, colour, texture, taste etc. to be a product either to add to improve or remove to make it more suitable for us.

### 5. Pilot plant production

A pilot plant is a small version of the equipment used in manufacture. Scientists evaluate the production process in the development of the new product.

### 6. Engineering services

Various activities classified under important stages such as planning and development, design, construction, maintenance and management.

### 7. Marketing surveys

To determine if the product meets the desires of consumers.

### 8. Economic Analyses

To determine the cost of the product.

### 9. Finalize product specification

The specifications detail exact ingredients and precise methods of production. The specification is very important as it will be used for the production of each batch of the product to ensure consistency.

### 10. Perform consumer testing or test marketing

To determine if consumers will buy product.

### 11. Produce product on large scale or National roll-outs

The company commits to sell product.

### 12. Advertise the product

Advertising campaigns are conducted to advertise the new product.

### 13. Launch the new product

To market the product for sale, and attracting people's attention.

### 14. Brand maintenance

The company monitors the performance of the product.

**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 their production and compliance with ethical principles and standards.

**Benchmark: 12.2.1.2** Describe the processing techniques, equipment, storage and distribution systems used in industry and compare with those used domestically.

**Topic:** Food production (2)

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

- Compare the processing techniques used domestically and in a food industry.
- Identify and describe the food production systems in a food industry.
- Evaluate food product development along the different processing stages.
- Create a food product using the design process.

**Essential Questions**

- What are the differences between processing food domestically and in a food industry?
- Why are food production systems important in food processing?
- How are manufactured food products safe for consumption?

**Essential Knowledge, skills, values and attitudes**

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Food processing techniques used domestically and in industries</li> <li>• Food equipment used domestically and in industries</li> <li>• Food storage practices applied domestically and in industries</li> <li>• Storage control and environment</li> <li>• Self-life of food – depends on the chemical nature of the food, method of processing, packaging, distribution and storage</li> <li>• Food quality control</li> <li>• Measurement and control in food processing</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Investigate on the different systems used in food processing</li> <li>• Analyse the difference between processing food in small and large scales</li> <li>• Design a food product and evaluate its design</li> </ul>
<b>Attitudes/Values</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Appreciate the different food systems used in food production process and consider their food choices</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> </ul>

## Teaching and Learning Strategies

The emphasis is on food production being subjected to product based learning using the design process. Students must be encouraged to observe, make decisions, think critically and practice the processes of designing or making a product using the design process.

## Learning Activities

### Lesson 1: Commercial food production

**Activity 1:** Explain what commercial food production is. Give examples of manufacturing food industries in PNG and explain what food products they produce.

**Activity 2:** Compare the processing techniques used domestically and in a food industry.

### Lesson 2: Food production systems

**Activity 1:** Why are food production systems important in food processing?

**Activity 2:** Identify and describe the food production systems in a food industry.

### Lesson 3: Create new food products

**Activity 1:** Evaluate food product development along the different processing stages.

**Activity 2:** Create a food product using the design brief.

### Lesson 4: Food Packaging

**Activity 1:** How are manufactured food products kept safe for consumption and distribution?

**Activity 2:** What are the different ways in which manufactured food products are packaged and distributed?

## Content Background

### Food product development

When the need for a product is established, food technologists design and develop it. Machinery designers develop the most efficient way of making a product on factory production line, and packaging designers present the product to the consumer in a cost-effective, safe, protective, informative and attractive way. A very important part of food product development is sensory analysis. This is used to produce, measure, examine and explain people's reactions through the senses of smell, sight, taste, hearing and touch. The food assessors record their observations using:

1. **Hedonic description** which describe likes and dislikes e.g. horrible, appetizing, delicious, bad, unpleasant, tasty,
2. **Sensory description** which describe texture, mouth feel, taste, appearance and smell e.g.; crisp, crunchy, smooth, greasy, fruity, salty, sweet, watering, shiny, sour, and,
3. **Attitudinal description** which describes belief about the product or attitudes to it; e.g.; healthy, satisfying, tasty.

### What is commercial production?

Commercial food processing includes performing mechanical and chemical operations on food in a large scale. In any food industry, sequencing for commercial production is very important. Any product that is produced is based on the development of a series of carefully planned stages. The series of stages is commonly referred to as system and includes three fundamental components. They are;

- *Inputs*  
This includes all of the raw ingredients required to produce the product as well as all other components in the development of the product. This can be very diverse such as the specifications of the product to be produced, human and non-human energy, manufacturing equipment and packaging materials.
- *The process*  
This is the procedure used to change the raw ingredients into the new product using all of the other components of input.
- *Output*  
This is the outcome of the production process, resulting in the finish product as well as any waste materials or by products that can be recycled.

In the manufacture of a complex product, a series of sub-systems will be developed to make sure that the complete process is streamlined and has limited opportunity for problems to arise. As each subsystem completes its production, it will produce its own finished product or output. The output from each of these subsystems then comes together to complete the production of the product.

## Food production system

In food production, structure and organisation is vital for effective flow of work to be done. These are the general aspects of things that must be done systematically for food production;

### Preparing a production schedule

Good planning is the key to efficient production and to the preparation of products that will prove to be successful in the market place. The production schedule will include a number of key features such as;

- The purchase of ingredients and other components such as packaging materials.
- Appropriate storage of ingredients.
- All equipment and personnel required during production.
- The timing of the beginning of the production process.
- The stages of the production process.
- When production will cease or stop.
- The packaging and storage of the completed products.
- Dispatch and delivery of the product.

### Flow charts

In any food manufacturing industry a flow chart is developed to ensure that the production schedule is clearly understood and followed. The flow chart directs and informs all the members of the production team on how each stage is to be completed and how it is connected to the whole production process. In doing so, there are important factors to consider when developing of the flow chart;

- Show that each of the processes is separated.
- Minimise wasteful movements between each production stage by the workforce.
- Maximize the use of available space and equipment.
- Include quality control checking points.
- Ensure health and safety procedures are maintained.

### Time and resource schedules

This schedule is to ensure that production is completed within the required time frame. Identifying the resources that are needed at each stage of the process is also important to ensure that all ingredients, equipment and personnel are available at the required time. This will also mean that waste is minimised and production costs are kept as low as possible.

### A time and resource schedule - Production of a new food product

Wk1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Decision about new product to be manufactured Evaluation of resource availability: -ingredients -equipment -staff -factory capacity				Train new staff, update skills of current staff											
		Check stock Order in additional ingredients								Recorder ingredients/ material as required					
		Service equipment							Check equipment						
				Check with packaging manufacturer					Finalize packaging requirements						
						Undertake a trial run Check quality control points			Quality control checks			Quality control checks			
									Begin production						
	Consult with marketing department. Review marketing strategy								Finalize marketing strategy						
			Review distribution arrangements									Distribution and product launch			
															Customer distributor feedback
															Product evaluation

### Production Control

Quality control is one of the most important areas to be considered when planning a food production system. This is to ensure that checks occur at each of the key stages of the process in order for the manufacturer to overcome any problem which arise during production, for instance, temperature variations in baking or containers are being incorrectly filled. Quality control procedures also ensure that the production schedules are met. By having consistent checks or critical point checks throughout the production, any breaches of health and safety regulations will also be identified and overcome.

## Continuous processing

Continuous processing enables food manufacturers to produce large quantities of a product quickly and efficiently, therefore keeping the unit cost of each item relatively low.

The introduction of automated systems of continuous processing in the past century has a major impact in the way food is processed today. Continuous processing is used in the mass production of many of the food products that are consumed today. Food manufacturers are able to produce large quantities of a product quickly and efficiently. Foods that are manufactured in this way include soft drinks, processed milk, canned fruit, dry and sweet biscuits, breakfast cereals and snack foods.

During continuous processing, the product moves along the production line, often on a conveyor belt from one process or stage to the next. During each stage, experts in the area will supervise and inspect the process, generally taking samples of the product as it passes along the production line. This critical point inspection is important to ensure both health and safety, and quality control procedures are maintained.

In the production process, specialist machinery is purposely built to complete individual stages of the manufacturer. For example, Golden Circle Company has specialist machines that process pineapples.

It is important for food manufacturing companies to maintain all the equipment used in food production to avoid breakdowns which would result in disruptions to the production process and may lead to increased cost.

However, in the production of some foods, large numbers of people are employed on the production line to undertake specific tasks that cannot adequately be completed by machines. This task may involve packing delicate products to minimize breakage or to check the colour or shape of individual items.

## Batch systems

Batch systems produce small quantities of a specific producer, for example, in the production of boutique preserves or chocolates. A batch system may be used in small-scale manufacturing. However, larger food producers such as those involved in the manufacture of specialist cheeses or bakery products can also use a batch system. Some aspects of batch system production may be automated, but generally it relies on significant human input.

### Batch system for Mud Cake

This cake is very popular and therefore customer demand on it is very high. Since it is on a high demand the manufacturer prepares more than fifty of these cakes each day.

1. The cake tins are greased and lined.
2. The cake mix is weighed and flours are sifted ready for production.
3. The cake mix is completed and filled into cake moulds or tins.
4. The cakes are loaded onto mobile banking trolleys and rolled into the ovens to be baked.
5. Later in the day, the team of pastry workers de-mould the cakes and allow them to cool.
6. The chocolate glaze is prepared for the decorations of the cake.
7. Once cool, the cakes are coated with the glaze and a small chocolate plaque placed on the center of the cake.

8. When the glaze has set, the Browns ribbon is wrapped around the cakes before they are placed on boards ready for despatch.
9. Drivers arrive between 4:00 am and 7:00 am to deliver the cakes and other products to the shops that ordered the cakes.

### **Characteristics of batch production**

1. The volume of output is generally large and goods are produced in anticipation of demand.
2. The material should be as per the specifications and should be delivered on time.
3. The product design and the sequence of operations must be standardized that is identical products are produced.

### **Food storage**

Food storage is the idea of 'storing' food to keep the food fresh, reduce the risk of contamination and food spoilage. Correct food storage is important to avoid food spoilage and to prevent the acquisition of food borne diseases. Different foods have different storage requirements and therefore it is important to always check the packaging dates and storage instructions. It is also important to be aware of the variety of food storage options available at any markets, shops or food outlets.

### **Storage controls**

The shelf life of different food products very much depend on the chemical nature of the food and the methods of processing, packaging, distribution and storage. Fresh foods are fragile and spoilage is primarily caused by bacteria and so its shelf life is short. If fresh foods are not properly stored or have poor temperature control, these reduce their quality. Processed foods which have been canned, frozen, dried or packed in a modified atmosphere have an extended shelf life in terms of food quality.

**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 their production and compliance with ethical principles and standards.

**Benchmark: 12.2.1.3** Identify critical control points and describe quality control procedures in food production systems.

**Topic:** Food Quality Control Process

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

- Identify and describe the HACCP steps in relation to food production.
- Investigate and analyse the food quality control process in the production chain from food processing to packaging, storage and distribution.

**Essential Questions**

- What are the HACCP steps?
- Why is food quality control important in food production?
- How are the critical control points related to nutrition and food safety?
- What are some steps taken by the manufacturer in terms of labelling to enhance the quality of the product?

**Essential Knowledge, Skills, Values and Attitudes**

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Food quality control processes               <ul style="list-style-type: none"> <li>- Safe food</li> <li>- Hazard Analysis Critical Control Points (HACCP)</li> <li>- Design of food premises</li> <li>- Storage controls</li> <li>- Labelling of food</li> <li>- Percentage of labelling</li> <li>- Health claims</li> <li>- Food Nutrient content claim</li> </ul> </li> <li>• Food quality production system</li> <li>• Critical Control Points and monitoring procedures (Catering cycle)</li> <li>• Food laws and standards</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Investigate on the HACCP steps</li> <li>• Evaluate the food quality control process in food production</li> <li>• Analyse the food quality standards</li> </ul>
<b>Attitudes/Values</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Appreciate the different food systems used in food production process and consider their food choices</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> </ul>

**Teaching and Learning Strategies**

In this topic emphasis is placed on food safety and food quality in terms of quality checks or assurance processes. The teacher will use a range of teaching methods to teach the prescribed content. Students must be allowed to explore, investigate and develop an awareness of the importance of quality checks, production controls in both small and large scale production operations. Students will also examine and discuss the 'Food Laws' the involvement of health authorities in product development as well as measures taken by the manufacturer to further improve the quality of their products.

**Learning Activities****Lesson 1 Food quality control process**

**Activity 1:** Explain why food quality control is very important in small and big scale operations.

**Activity 2:** Discuss what HACCP means and its function in the food industry. Which organization is responsible for food safety in PNG?

**Lesson 2 Food quality production systems**

**Activity 1:** Explain how the food quality production control system function in small and big scale operation.

**Activity 2:** Discuss the importance of the following in maintaining good quality;

- 2a.** the cold chain,
- 2b.** nutrient labeling,
- 2c.** nutrient content claims and,
- 2d.** legal requirements.

## **Content Background:**

### **Food quality check along the production line/chain**

Food moves along different food production stages from one stage to the next. During each stage, experts in the area will supervise and inspect the process, generally taking samples of the product as it passes along the production line. This critical inspection line is important to ensure both health and safety and quality control procedures are maintained.

Consistent quality control is critical to the production of each of the products in their range. As each product has specific features, quality control is based on the skills and training of employees of the manufacturing company. Quality control occurs at every point in the chain with responsibility being vested in every employee, at every point in the production process, from the initial preparation to the dispatch and delivery of the product.

Compliance with health and safety regulations is also a key feature of all production work as well as all aspects of retail sales. For example, in a bakery factory, cleaning is on-going throughout the day, with set schedules implemented in each area of the bakery. All the work areas are emptied and cleaned out thoroughly and all walls, floors and benches are cleaned down.

### **Production Controls**

Quality control is one of the most important issues to be considered when planning a food production system, ensuring that checking occurs at each of the key stages of the process which enable the manufacturer to overcome any problems which arise during production, for example, temperature variation in baking or containers being incorrectly filled. Quality control procedures also ensure that the production process is efficiently run and that production schedules are met. By having consistent checks or critical point checks throughout production, any breaches of health and safety regulations will also be identified and overcome. It is important that quality control procedures will lead to the development of a consistent product and ensure minimal variations between product batches.

### **Food quality check using technology in large scale operations**

Many large scale food manufacturing company may use new computer technology to assist in ensuring quality control. The recent development of sophisticated computer programs used in the food industry can detect variations in raw materials and conditions. As part of this system, electronic sensors are often used to detect changes in quality such as the colour of the batch during the baking process, or temperature changes in freezing units.

In food manufacturing, metal detectors are used to ensure that pieces of metal do not accidentally find their way into the finish product. Load detectors monitor the variations in the amount of filling being placed into a product. They check the weight of each product.

In the final stage, feedback of each stage of the production process is sent back to a central monitor, which analyses the data and can signal whether adjustments to the production process need to be made. Records of processing and production conditions as well as batch numbers can also be kept through the use of computer programs, assisting food manufacturers to track the progress of a particular product.

### **Food quality check in small scale operations**

Quality control is often reliant on the experience, skill and judgement of the employees. It is often a far less technical process than occurs in large scale operation and can involve the development of specifications for each stage of the production process. This may include the speed at which food processors are set or the length of time ingredients are blended on commercial mixes. Accurate measurement of ingredients is accomplished by using electronic scales. A consistent shape and size can be achieved by using baking tins of a set of size and shape.

### **Quality assurance**

It is the promise or guarantee made by the manufacturer to the consumer that the food they supply is of a particular standard, that it is safe, reliable and honestly described. Control stages in food processing could occur;

- During stock control.
- During measuring and weighing fresh produce or raw ingredients.
- After grading and cleaning fresh produce or raw ingredients.
- During checks for micro-organism growth along processing line.
- After making or cooking to check consistency, texture, tenderness, colour and flavour.
- During storage and display of the products.

Many food processors promote quality assurance by using high quality ingredients, offering a replacement or a refund of the product if the product does not meet consumers' expectations, displaying the company's policy about quality and using a company logo as a symbol of quality.

Food safety is important across the entire food industry in PNG from primary production to point of sale. Its mission is to ensure that food in PNG is safe and correctly labelled and that consumers are able to make informed choices about food they eat. Complaints about food safety and hygiene can be made to the authorities concerned such as Independent Consumer and Competition Commission (ICCC).

### **Food Authority**

Let us learn about Food Laws from other countries. Teacher can expand on these notes by researching on Food Regulatory Authorities and Food Safety Standards in PNG.

For example; Food Authority administers the *Food Act 2003 (NSW)* objectives of which are to:

- Ensure that food for sale is safe and suitable for human consumption.
- Prevent misleading conduct in connection with the sale of food.

- Provide for the application in this state of the Food Standards Code.

The Food Safety Standards were developed to provide more effective and nationally uniform safety legislation for the country.

The Food Standards Code has requirements relating to;

- Labelling and advertising.
- Substances added to foods – food additives, vitamins and minerals, processing aids, identity and purity.
- Contaminants and residues – metals and toxicants, environmental residues, packing materials, moisture absorbers, mould inhibitors, promotional materials, graphics, prohibited and restricted plants, and fungi.
- Foods requiring pre-market clearance – novel foods, food produced using gene technology and food irradiation.
- Microbiological and processing requirements.
- Food product standards – food safety programs, food safety practices and food premises and equipment.
- Primary production standards.

### Food Laws

**Note:** The teacher is encouraged to search for the PNG Food Sanitation Act 1991 on line and expand on the content in relation to PNG context.

### Hazard Analysis and Critical Control Points (HACCP)

HACCP is a systematic, preventative approach to food safety used in the food industry to identify potential hazards. It addresses physical, chemical and biological hazards as a means of prevention rather than an inspection of the finished product. HACCP is used at all stages of food production and preparation processes, including packaging and distribution.

HACCP is used in the food industry to detect possible food safety hazards so that strategic actions can be taken to decrease or remove the risk of the hazards. These strategic actions are known as Critical Control Points (CCPs).

Although hazardous situations may still arise in the food chain, a system such as HACCP reduces the risk of unsafe food reaching the consumer. It is a system basically to find out where the really serious problems occur, monitoring these steps so you know there are problems, and fixing the problems as they arise.

The HACCP steps involved are;

- *Hazard Analysis.* Work out the safety hazards from the hygiene and food production point of view.
- *Identify the critical points.* This is where important things can go wrong in relation to temperature control and sanitation points
- *Set the critical limits for each critical control point.* This varies in each business but examples would be the cooking temperature or the chilling temperature.
- *Monitor the critical control points.* Keep track that the target is being met is important so that it is easy to see if things go wrong
- *Establish corrective actions.* Consider what actions are to take place if the monitor highlights a problem

- *Verify the HACCAP system is working correctly.* Check that there is improvement in the end product. Microbiological testing could indicate the micro-organism count is in the target range or sanitation procedures have improved or food handling practices have changed
- *Set up records.* Records of results must be kept for auditing and to check for improvements.

### Design of food premises

In the food industry, best practices ensures that the premises where food is prepared, stored and sold is well designed and maintained in a clean and sanitary manner. These procedures help to protect food and make sure it is free from contamination.

The Health Department has the duty to assist and ensure that retailers of food and employers are educated about the best practice to safeguard the quality of food sold.

The main considerations for owners of restaurants, cafes and small food outlets when designing their layout of premises are:

- Logical workflow that is the efficient movement from raw ingredients to finished product. This includes the safety of staff at each work station.
- Separate areas for preparation of raw and cooked food.
- Appropriate facilities to enable staff to maintain high personal hygiene. An example is foot operated wash basins.
- Equipment for cleaning and sanitising, and workstations are designed for easy cleaning and maintenance.
- Adequate supply of hot and cold water.
- Temperature control for refrigeration, cooking and food display.
- Lightening, ventilation and exhaust facilities.
- Pest control methods.
- Food delivery requirements.
- Garbage disposal.
- Smoke free areas.
- Maintenance of leaking taps, flaky paintwork, condensation, and temperature control (food storage temperature control is important in the production of safe food).

### Storage controls

Environmental control of temperature, humidity and pests, as well as proper stock rotation is needed to minimize changes in the quality of food during storage. Food quality includes the nutritional value and aesthetics qualities such as colour, flavour, texture and appearance. Functional properties such as the ability to thicken a sauce or set a desert are also desirable properties that make food acceptable to eat.

Shelf life is the period of time in which the quality of a food product remains satisfactory after processing and purchases. The shelf life of the food will vary depending on the chemical nature of food and the methods of processing, packaging, distribution and storage.

The storage environment is the most important factor to consider in maintaining quality and extending the shelf life of fresh food. Inventory control is vital where proper stock rotation is essential to maintain food quality during storage. The best practice follows the rule: **first in, first out**. This means food is used in the order it was received regardless of whether it is to be used by the wholesaler, retailer, or the consumer.

A good food inventory has a code dating system that labels new deliveries and places them at the rear of the storage area. Then the food that has already been stored is used first.

### The cold chain

Managing the cold chain in the food industry is like a relay race where everyone needs to play their part to deliver safe, quality frozen foods to consumers. It involves the processing, transport, storage, distribution and selling aspects of frozen food industry. In this case, fresh food must be stored below -18 degree Celsius and provide the consumer with an acceptable food product that can be stored for a long period of time.

### Controlling the quality of frozen foods

Temperature abuse	Temperature control	Transfer points
<ul style="list-style-type: none"> <li>• These occurs when frozen foods are held at too high a frozen temperature or when the frozen temperature is allowed to fluctuate. It affects the sensory and nutritive quality of the food.</li> </ul>	<ul style="list-style-type: none"> <li>• The temperature must be monitored regularly for quality control. Store food below -18 degree Celsius. This ensures the quality of flavour and texture.</li> </ul>	<ul style="list-style-type: none"> <li>• Temperature abuse should be avoided when moving frozen food from one cold area to another, for example, from factory cold store to truck, truck to supermarket cold store to display cabinets and display cabinets to home. The frozen food should not be left standing in a non refrigerated area for a long period of time.</li> </ul>

### Nutrition labelling

It is legal in most countries to put nutrient claims on food labels.

### Health claims

Health claims are generally about something in the food and how it can influence a disease or condition or an indicator of a serious disease.

### Nutrient content claims

Nutrient content claim relate to levels of nutrients or energy in food. Examples of such claims include; 'High in calcium' and 'Reduced in saturated fat'. The Nutritional Information is legally required on food packaging.

### Labelling symbols

Many types of symbols are used on food labels. The two types commonly found are: the glycaemic index and Health Foundation Tick.

### Glycaemic Index

The glycaemic index (GI) is a ranking system for carbohydrates according on their effects on blood glucose levels (see table below). Carbohydrates are digested into glucose, which is absorbed into the bloodstreams and transferred through the body as energy. The rate at which high carbohydrate foods are able to increase the level of blood glucose is important to health.

Carbohydrate foods that are broken down slowly, making energy available to the body for longer periods of time, are better for health and referred to as low Glucose foods. Low GI foods are better for your body as the body endeavours to maintain a constant blood glucose level and helps to sustain levels throughout the day. High GI foods increase blood glucose levels, resulting in the body's physiological control mechanisms attempting to lower the blood glucose level as soon as possible. This often results in tiredness and hunger.

Low GI	Medium GI	High GI
<ul style="list-style-type: none"> <li>• GI value less than 5.5</li> <li>• Broken down slowly</li> <li>• Makes energy available for longer periods of time</li> <li>• Foods include milk, legumes, rolled oats, apples and spaghetis</li> </ul>	<ul style="list-style-type: none"> <li>• GI value of 55 -69</li> <li>• Broken down more slowly than high GI foods and more quickly than low GI foods</li> <li>• Foods include untoasted muesli, rock melon, crumpers, Arborio rice and full cream ice cream</li> </ul>	<ul style="list-style-type: none"> <li>• GI value of 70 or above</li> <li>• Broken down quickly</li> <li>• Large amounts of energy are made available for a short period of time.</li> <li>• Foods include watermelon, potatoes, sports drinks, jasmine rice, gluten free bread and broad beans</li> </ul>

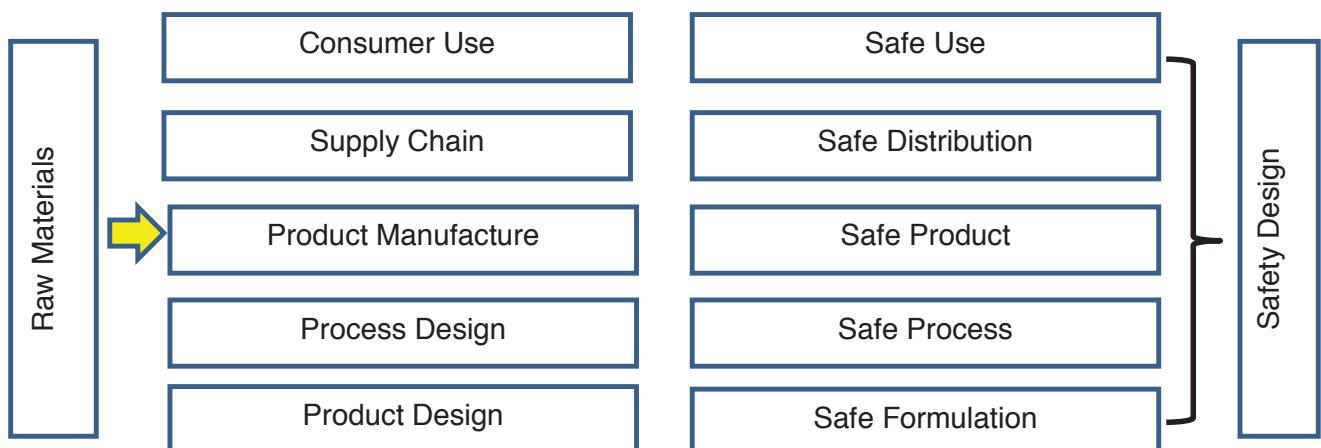
It should be remembered not to select food solely on their GI. Some low GI foods such as chocolate and corn chips are high in saturated fats, while some high GI foods such as watermelon and potatoes are nutritious. Low GI food should be consumed as a part of a meal as they will contribute to the overall GI of the meal.

### Heart Foundation Tick

The National Health Foundation developed the Heart Foundation Tick as a guide to assist individuals to make healthier food choices quickly and more easily. Food manufacturers pay to use the Heart Foundation Tick on their products, but only as long as the food products meet the strict nutritional selection criteria devised by the Heart Foundation. Generally the foods with the heart Foundation Tick have a lower fat (especially saturated fat) salt and added sugar content and a higher fibre and calcium content.

Although not all food manufacturers pay and use Heart Foundation Tick symbol, this does not mean that their products are any less healthy than a similar product with the Heart Foundation Tick symbol. And while the Heart Foundation Tick symbol means that food product meets the National Heart Foundation criteria, it does not necessary mean that the food product is low in fat. For example, some margarines have the Heart Foundation Tick symbol but not low in fat.

### Food Safety Design



**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 their production and compliance with ethical principles and standards.

**Benchmark: 12.2.1.4** Apply the principles of food preservation to create safe food products.

**Topic:** Principles of Food Preservation

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

- Investigate and identify different methods of food preservation.
- Analyse the advantages and disadvantages of food preservation.
- Apply preservation principles in food product development.

**Essential Questions**

- Why is food preservation important in food product development?
- What are the different methods of food preservation?
- What are the principles of food preservation and storage?

**Essential knowledge, skills, values, attitudes**

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Importance of preservation</li> <li>• Traditional methods of preservation</li> <li>• Modern practices in food preservations and storage               <ul style="list-style-type: none"> <li>- Moisture level (drying)</li> <li>- Addition of chemicals</li> <li>-Temperature control</li> <li>*Freezing</li> <li>*Refrigeration</li> <li>*Canning and bottling</li> <li>*Pasteurization</li> <li>*Ultra Heat Treatment (UHT)</li> </ul> </li> <li>• Safe food packaging</li> <li>• Hazard analyses</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Research and investigate on the principles behind food preservation</li> <li>• Analyse the different methods of food preservation and storage</li> <li>• Apply preservation methods in food product development</li> </ul>
<b>Attitudes/Values</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Appreciate the different food systems used in food production process and consider their food choices</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> </ul>

## Teaching and Learning Strategies

In the topic the concepts of food preparation will be reinforced where emphasis is on methods of preservation, how these methods are used in product development, as well as applying hazard analyses before product development. The teacher will use a variety of teaching and learning methods to teach the prescribed content. The students must be allowed to gather, analyze and differentiate between different modern methods as compared to the traditional methods. Students will also investigate the various food packaging methods in relation to different food preservation methods as well as apply hazard analysis in food product development.

### Learning Activities

#### **Lesson 1: Importance of food preservation and traditional practices of preservation.**

**Activity 1:** Explain the importance of food preservation and discuss the different methods used in the past to preserve food.

**Activity 2:** What are the advantages and disadvantages of traditional food preservation practices compared to modern methods used?

#### **Lesson 2: Methods of food preservation and storage**

**Activity 1:** Research and discuss the different methods of food preservation methods used today.

**Activity 2:** Apply methods in food product development and preservation.

#### **Lesson 3: Hazard analyses**

**Activity 1:** What is a Hazard analysis and why it is very important to analyze hazards before developing a food product?

**Activity 2:** Identify possible hazards that can occur in your product development and preservation.

## Content Background:

In the past or traditionally, our ancestors 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. Preserving food allows;

- Preservation of excess or surplus to avoid wastage.
- Storage of food for time of famine.
- Increased range of food choices year around.
- Transportation of food over long distances.
- Retain as much of the nutritive value of food.
- Flexibility of time as preserved foods makes meal preparation easier and more convenient.

Food is preserved to prevent food spoilage. The two major causes of food spoilage are;

- **Enzymes** – the proteins found in all animal and plant cells. They cause food to ripen or age by acting as catalyst for chemical reactions in cells. Food preservation methods aim to control enzymes slows down the aging process and so makes food edible for a long time.
- **Micro-organisms** – the moulds, yeast and bacteria that live in air, water and soil, and are in all fresh food. These micro-organisms must be controlled to successfully preserve food. There are many factors that inhibit microbial growth in food.

**Time** - The rate at which bacteria multiply varies depending on the type of bacteria.

**Food** - Micro-organisms need food to grow; yeasts prefer carbohydrates, bacteria prefer protein.

**Moisture** - The growth rate depends on the amount of moisture available.

**Temperature** - Each micro-organism has an optimum growth temperature between 5 degree Celsius and 60 degree Celsius.

**Oxygen** – Aerobic micro-organism require oxygen from the atmosphere and anaerobic microorganisms do not need it.

**pH level** – Most microorganism prefer a natural pH but some yeasts and moulds grow in an acid environment.

**Preservatives** – Safe chemicals are added to food in order to inhibit microbial growth. These are known as **food additives**.

## Methods of preservation

Successful methods of preservation limit or prevent altogether, the actions of enzymes and microorganisms that make food deteriorate and become unsafe. They also transform flavours and textures of fresh produce to create the sweet - sour flavours of pickled onions or the range of flavours and textures in mixed citrus and marmalade. The reason behind preservation of food is to harvest fresh produce in its natural season when it has superior flavour and texture.

Preservation methods such as freezing, canning and bottling involve the withdrawal or application of heat.

## Temperature

An effective method of preserving food is the temperature at which food is cooked or stored. The temperature can be increased or decreased to preserve food.

### **Freezing (preservation by low temperature)**

Food can be preserved by decreasing the temperature and this is known as freezing food. The very low temperatures slows down the action of enzymes and stop the growth of microorganisms, 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. Foods such as meats, fish, vegetables, poultry and fruits are preserved by freezing.

### **Refrigeration**

The refrigerator is used to chill foods. Chilling is another common method 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-organism. For example, milk will last five to ten days when refrigerated, though it will eventually spoil. Foods are often chilled at the temperatures below 0 degree Celsius and 5 degree Celsius. The growth of micro-organisms is determined by the decrease or increase of temperature.

### **Canning and bottling (preservation using heat)**

Canning and bottling is a method of preserving food using temperature. In this case, the temperature is being decreased. The food is heated or cooked to a high temperature that kills the micro-organisms and the hermetic seal prevents contamination from the outside environment. High acidic fruits such as strawberries require no preservatives prior to canning and a short boiling cycle. Whereas, low acidic type of food such as vegetables and meat require longer cooking process in a pressure cooker and additional acidic ingredients to ensure that all micro-organisms are destroyed.

Canning and bottling use two methods of preserving food:

- Heating to kill micro-organism 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 as it is exposed to the presence of micro-organism in the air.

### **Pasteurisation**

It is a heat process that kills most pathogenic bacteria and enzymes that cause food spoilage in certain foods and beverages. Pasteurisation is named in honour of French Scientist/Chemist Louis Pasteur who in the 1860's developed a technique to heat wine to 50-60 degree Celsius before aging it to kill microbes and reduce acidity.

Pasteurization aims to decrease the number of pathogenic micro-organism so that they are unlikely to cause disease. It is assumed that the pasteurized food is refrigerated and consumed before it's used by date. Pasteurisation typically uses temperature below boiling to prevent the loss of the flavour and nutritional value of food. The food is then cooled rapidly. Pasteurized food is perishable and requires refrigeration; however it has a longer shelf-life than unpasteurized food.

Examples of commonly pasteurized products include; beer, canned food, dairy products, eggs, fruit juices, milk, nuts, syrup, vinegar, water and wine.

### **Ultra-heat treatment (UHT)**

Milk and fruit juices are examples of foods that can be preserved using ultra-heat treatment (UHT). Food can be stored without refrigeration for up to about six months. UHT refers to the partial sterilization of the food by heating it for a short time, around one to two seconds, at the temperature exceeding 135 degree Celsius.

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.

### **The pH level of food**

pH refers to the potential (or power) of hydrogen and is a measure of the acidity or alkalinity of a liquid. The pH range is commonly considered to extend from 0-14. A pH value of 7 is neutral because pure water has a pH value of exactly 7. Values less than 7 are considered acidic, while those greater than 7 are considered alkaline. Very few foods such as egg whites, sweet corn and some baked goods are alkaline. pH value are important in food technology. Micro-organisms including yeasts, moulds and bacteria are sensitive to food's pH. Very low or high pH values will prevent the growth of micro-organisms. For example, adding vinegar to food being pickled increases the acidic levels of the food because the vinegar contains ascertic acid. Vinegar has a pH less than 4.6, which causes the bacteria in the food to be destroyed. Chutney is another example of a food being preserved by using acid (along with sugar and salt).

Sodium hydroxide (lye) makes food too alkaline for bacteria to grow. Examples to food which lye is added include;

- Lutefisk, a traditional dish from Scandinavia
- Some olive recipes
- Modern recipes for century eggs

### **Moisture removal/Moisture levels (drying and dehydration of fruits and vegetables)**

Microorganisms such as bacteria need moisture to grow. When food is dried it prevents the growth of micro-organism and it is preserved for long period of time.

When the food is rehydrated or the liquid is returned, the food must be treated as the same way as fresh food.

Drying reduces the water in the food enough to prevent or delay the growth of bacteria.

Foods suitable for drying are;

- Dried- beef jerky.
- Fruits such as apricots, apples, mangoes and papaya and plums.
- Cereal grains such as wheat, oats, barley, rice and rye.

Examples of drying methods include;

- Sun-drying – a traditional technique used in many parts of the world.
- Oven drying, including micro-wave drying.
- 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 water stage.

### **Chemicals/Addition of chemicals**

Substances can be added to food to inhibit the growth of enzymes and micro-organisms. Some of the natural substances are sugar, salt and acids such as vinegar in sauces, relishes, chutney and prickles, and salt in the curing of meats.

**Sugar** (Preservation of high concentration of sugar/preservation by using 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 the moisture levels are restricted and so helps prevent food spoilage.

Examples of food include raw sugar, honey, golden syrup, jams and jellies. 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 syrup. Fruits such as peaches, apricots and plums can be preserved by immersing in the syrup.
- Sugar can be used in a crystallized form. The food that is preserved is cooked to the point of crystallization, and the product is then stored dry.
- Glace is where the fruit is preserved in sugar and then extracted from the syrup so that the preservation is maintained by the sugar content of the fruit and the coating of the syrup. Examples of such fruits include cherries.

### **Pickling using salt and vinegar**

Pickling is the process of preserving or extending the shelf life of food by either anaerobic fermentation in brine or immersion in vinegar. The pickling procedures typically affect the food's texture, taste and flavour.

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/or lid are boiled to sterilize them and then the raw foods such as vegetables, and vinegar or brine are placed in the jar. The jar is sealed with the lid and packed in a pot of boiling water for several minutes.

The use of solutions in which micro-organisms cannot grow is another popular method of preserving food. A strong acid solution that has a low pH is used for pickles. Salt solutions (Preservation by using salt) are used for preserving hams, bacon and salted beans are other examples of this method of preservation.

### **Removal of oxygen**

The removal of oxygen is another form of preservation as most micro-organisms are not able to grow in the absence of oxygen. As discussed above, canning and bottling use the exclusion of air through hermetic sealing for preservation. A hermetic seal is a seal that is considered airtight and watertight.

Modern technology has also developed many techniques that utilize a vacuum to extend the shelf life of food as most micro-organisms cannot live in an environment where the air is removed. This vacuum environment means that micro-organisms cannot obtain the oxygen necessary for their survival.

This lack of oxygen therefore, slows down food spoilage. Food is usually stored in airtight bags or bottles. Foods such as nuts, coffee, pasta and processed meats (salami) are examples of food that use vacuum packaging to decrease the loss of flavour from oxidation. Vacuum-packed foods often still require refrigeration to extend their self-life.

	Moist foods	Neutral foods	Unrefrigerated foods
<b>Foods that spoil quickly</b>	Milk, yoghurt, watermelon	Fish, banana	Milk, meat on bench
<b>Foods that do not spoil quickly</b>	Pasta, rice, legumes, flour	Lemons, onions, tomatoes	Milk, meat in refrigerator
	Dry foods	Acidic foods	Refrigerated foods

## 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 their production and compliance with ethical principles and standards.

**Benchmark: 12.2.1.5** Investigate, through experimentation, the suitability of packaging materials for different food products.

**Topic:** Packaging of food products

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

- Analyse the importance and functions of food packaging.
- Investigate on the systems of packaging.
- Evaluate the suitability of different materials that are used for food packaging.

### Essential Questions

- What are the functions of food packaging?
- What are the different systems of packaging?
- What are the different types of materials used in food packaging?

### Essential Knowledge, Skills, Attitudes/Values

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Importance of packaging</li> <li>• Functions of packaging</li> <li>• Packaging systems</li> <li>• Food packaging for different food products</li> <li>• Suitability of packaging materials for different food products</li> <li>• Future trends in packaging</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Investigate on the different functions of food packaging</li> <li>• Explain the importance of packaging food</li> <li>• Evaluate the suitability of different materials that are used for packaging food</li> </ul>
<b>Attitudes/Values</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Appreciate the different food systems used in food production process and consider their food choices</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> </ul>

### Teaching and Learning Strategies

The emphasis is on packaging of food product. The teacher is to be familiar with the content aspects to guide and direct student learning. The teacher will utilize a wide range of teaching and learning methods to teach, knowledge, skills, attitudes and value in this topic. Students are required to participate in all organized learning activities. Teaching and learning approaches must be aimed at developing curiosity of discussing, finding and solving problems. Students must be involved in contributing ideas and decision making as they are consumers.

They should be able to assess and evaluate the different types of food packaging, packaging material, importance and function of packaging food.

Teachers should also research other texts to gather and collate learning notes for students.

### **Lesson 1: Importance and function of packaging**

**Activity 1:** Discuss the importance of food packaging. Outline why packaging is a significant part of our contemporary lifestyle?

**Activity 2:** What are the different functions of packaging?

### **Lesson 2: Packaging materials and systems**

**Activity 1:** What are the four main materials used in packaging? Provide an example of a food that uses each of the four materials identified in Question 1.

**Activity 2:** What is a barrier packaging? Describe the following types of packaging;

2a) active

2b) vaccum

2c) gas

### **Lesson 3: Future trends in packaging**

**Activity 1:** Discuss some reason why many new types and techniques of packaging are developed.

**Activity 2:** What are some factors that may have impact on future trends in packaging?

## **Content Background:**

Food is packaged to contain it, to preserve and protect it, and to ensure that it is hygienically safe. The package must be designed to meet these requirements and yet be economical for food processors and so it would be difficult to over package food.

## **Importance of Packaging**

Packaging plays a key role in production, preservation, distribution, and marketing of fresh and processed food. It is an integral part of physical distribution of food: From the farm to the factory to the consumer. Packaging has several roles in the distribution of food. It must:

- Contain the food.
- Preserve and protect the food.
- Communicate information about the product.
- Be convenient.
- Prevent waste.
- Enable distribution.

Packaging protects the food we buy from wastage and damage. Without it handling food would be messy ineffective and costly. Packaging prevents more waste than it creates. Packaging revolves around the protection and preservation of food. All food are subject to spoilage. Food is not packaged appropriately its sensory properties may change. For example: Biscuits come soft, Cheese develop green moulds and soft drinks lose their bubbles.

Packaging provides a barrier around food that either permits or excludes the passage of water vapour, carbon dioxide and oxygen gases. It must be sealable so the product is air tight that is hermetically sealed. Packaging that is in indirect contact with food, must be chemically inert and must not allow any odours, flavours or other substances such as printing ink, to be absorbed by the food. The materials used for packaging food should be puncture resistant to prevent microbial deterioration.

## **Functions of Packaging**

### **Containment**

Most food products need to be contained before they can be moved from one place to another. Food must be in manageable size parcels so it can be transported from the source of primary production, to the food manufacturer, to the retailer and finally to the consumer. The size and material used in each stage of the chain varies depending on the type of food and the stage of processing. Effective packaging ensures that there is no spillage along the food distribution chain that results in major losses or damage.

**Communication**

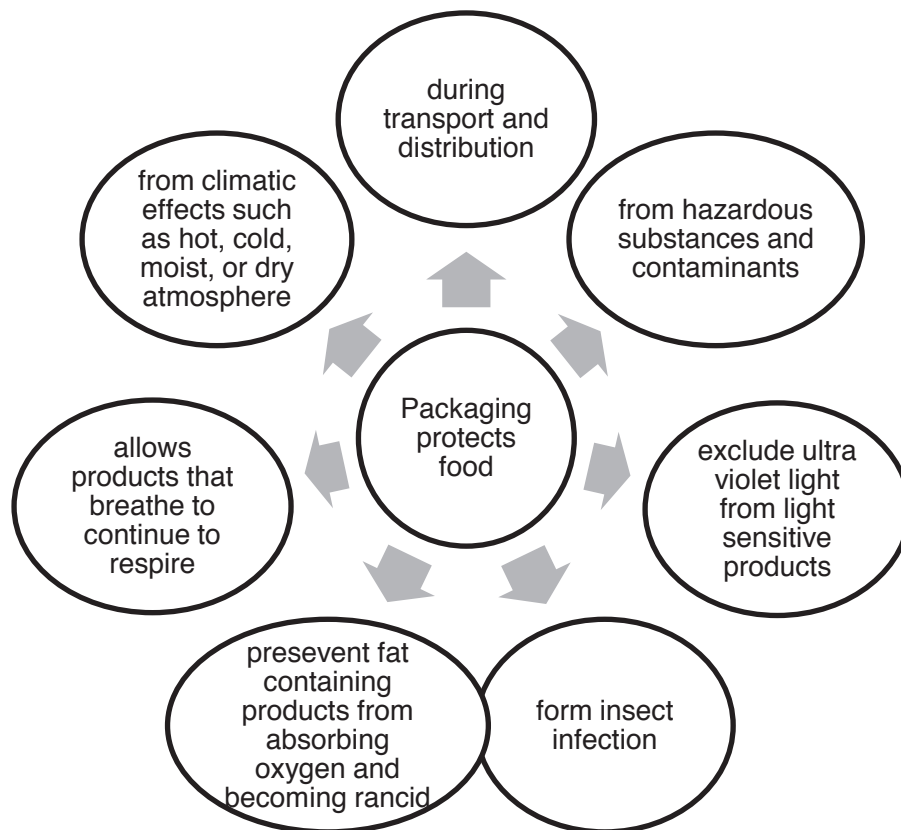
Marketing of food relies heavily on the messages communicated on the package. The information on the package helps consumers select the food products and provides instructions on how to use them. The information on the package also allows the consumers to make informed decisions about the freshness and nutrient content of the product.



**Convenience**

Packaging designers work together with packaging and food manufacturers to develop food containers in portion sizes and using appropriate materials which will satisfy the demands of consumers. Consumers expect a wide range of foods to be available in different flavors and portion sizes. Quick and convenient food preparation which guarantees freshness is important for modern consumers.

**Preservation and protection**



Packaging protects food products in many ways.

Packaging technology has made significant improvements to the quality of fresh and manufactured food products by reducing spoilage and increasing the safety of the food.

### New food packaging:

- Reduces time taken in daily preparation of meals, e.g.: microwave soups, snacks and main meals.
- Acknowledges that food shopping habits vary; some shop daily while others make a once a week supermarket visit.
- Ensure left over food can be stored safely in convenient, re-sealable containers without deterioration of quality.
- Provides the consumer with the precise amount of a product to reduce waste and labor costs. E.g. individual wrapped portions of stock cubes, butter, tomato sauce and sugar.
- Controls dispensing by way of a spout, squeeze bottles, spray cans and aerosols, e.g. flavouring for milkshakes, honey and olive oil spray.

### Materials used for packaging

Packaging materials can be broadly classified by the materials they are made from, by their basic function, or by the common property. In the food processing chain rigid bulk steel drum may transport the raw material to the point of processing, a semi rigid carton may contain and protect it during distribution, and then consumers may use a flexible carry bag to take their purchases home from the supermarket. Primary packaging describes the material which contains the food as it is sold to the consumer. Bulk shippers and auxiliary packing are used during the transportation of raw and processed food.

<b>Packaging classification</b>			
<b>Type of packaging</b>	<b>Rigid</b>	<b>Semi-rigid</b>	<b>Flexible</b>
Bulk shippers	Containers Tanks Drums Barrels Boxes Crates	Cartons Drums Barrels Baskets	Liners Sacks Bags
Auxiliary packaging		Cards Carriers Dividers	Wrappers Liners Carriers Cushions
Primary packaging	Boxes Cans Canisters Bottles Jars	Containers Blisters Cartons Bottles Tubes Baskets	Bags Pouches Sachets Tubes Envelopes Casings

## Glass

Glass is chemically inert so it does not react with food and does not cause flavor or colour changes to the contents it holds. It is impermeable and non-porous which prevents loss or gain of moisture from food, and it retains the oxygen and other gases in aerated beverages. It is a very hygienic packaging material because it can withstand high temperatures. Glass can be clean and sterilized easily. Food can be stored safely for longer period of time. The glass containers can be hermetically sealed making them impervious to microorganisms, water, odours and dust. It is a strong but heavy material, over the years it has been designed so containers are thinner and lighter.

Food processors prefer transparent glass to be used because the glass allows the contents to be inspected at the time of packing. Glass also has strong consumer appeal because the contents are visible when being purchased. Glass can be coloured, transparent or opaque. It can be made into variety of shapes and sizes, and can be printed on or have transfers or labels attached easily.



### Glass as a packaging material for food products

Benefits	Disadvantages
Contents are visible	Glass breaks or fractures easily on impact
Easy to open and to reseal to store leftover contents	It is heavy and bulky so increases the cost of transport and distribution
Flavour of food is retained	There is some waste space when stacking so more shelf space is required
Food has a long storage life	Cost of recycling can be high
Suggests quality with the sparkle of glass	Metal detectors cannot detect broken glass in contents on the processing line
Can be designed to pour liquids without splash or drips	
Microwavable	
Can be recycled	
Some can be refilled	
Suitable to serve at the table	
Can be stacked without crushing	
Can be used to preserve	

### Paper and paperboard

Cardboard and paper are made from a renewable resource, particularly when plantation timbers are used, and can be recycled. It can be white in colour or shades of cream through to brown or multi-coloured. Cutting, creasing, folding and gluing can make a variety of shapes. Cardboard and paper may be a single sheet or corrugated board, virgin or recycled or a combination. This packaging material cannot prevent moisture, oxygen or gases coming into or out of a product unless it is laminated with plastic or metal foil. Greaseproof papers are used for packaging food such as butter and confectionery. They are used because they offer a barrier to unwanted odours and moisture. Waxed papers are tasteless, odourless, non-toxic and inert and can be used for most foods.



### Metal: Cans and Aluminum Foils

Metal cans are made from thin steel strips coated electronically with thin layer of tin on both surfaces. The metal can is hermetically sealed ensuring a long shelf life, and the food can be stored safely in various temperatures. Tinsplate, steel and aluminum are the most common metals used for canning food. These are strong and rigid materials but can be dented. Metals prevent loss or gain of moisture, oxygen or other gases but the inner surface must be properly sealed as some metals react with food. For acid foods such as beetroot and plums, the interior of the cans are lined with an organic compound to separate food from the metal and so prevent any chemical reaction. The heat sterilizing process is a thorough system of processing food and the industry was one of the first to adopt the Hazard Analysis Critical Control Points (HACCP) principles of food safety. This is a preventative approach to food safety as it identifies potential hazards at stages in the production line, assesses the risks, and at the critical points, introduces effective control procedures.

After canning poor transport or storage practices could cause problems to the food if the seams of the cans are dented or damaged. Poor handling and storage over time may also cause rusting on the outside of the can but rarely does this affect the food.

However, aluminum is more difficult to seal. Its malleability makes it a useful material for the ring-pull lids on the can, making it easy to open. As well as that many ring-pull cans use aluminum for the lid. Both aluminum and steel cans are recyclable.

Metal cans can be printed or labeled, and are made into variety of sizes. They are used for carbonated drinks, fruit, vegetables, meat, fish, soups, puddings, spice bases, milk and cream. Designers of food packaging in metal use new technology and innovations to meet the needs of food processors and consumers.

The aluminum foil is used to package many foods because it;

- Is impervious to moisture, air and light.
- Is strong and durable.
- Can be made into variety of shapes and sizes.
- Resists creaking at low temperature.
- Has an attractive surface for package design.

Metallized films can be made by vaporizing aluminum onto a surface of paper or plastic and are used to package crisps, snacks, lollies, biscuits and cakes. Metals can also be used to laminate paper and cardboards cartoons or package liquids such as fruit juice, milk and ready served custard.

### **Cellulose**

Cellulose package films are made from wood pulp and were discovered in the early 1900s. They are known as cellophane in the market place. They are transparent materials that are non-reactive with food. As technology advances, the laminating technology that is the fusion of two or more thin layers, have improved the strength and barrier effectiveness of cellulose films. This packaging material is useful for packets consumers wish to see into and it maintains the freshness off the food. Package nuts and dried fruit are often contained in this way. Plastic coated cellophane is ideal for biscuits because it provides a barrier to water and gases. It is strong and has some rigidity and the shiny surface can be printed on and decorated effectively for marketing.

### **Plastics**

Plastics are strong, versatile and flexible materials that provide a solution to ensure food reaches the consumer in perfect condition. Much of the raw materials for plastics come from waste in the petroleum refining industry. Plastics are made up of atoms of several elements linked together to form gigantic molecules. The building blocks of plastics are relatively small molecules called monomers. Linking the monomers in the long chains to form polymers creates the special properties of plastics.

Plastics have different characteristics because of;

- The number of monomers linked together vary and this has an impact on the strength, the way it flows in a molten state and its resistance to chemicals.
- The way the monomers are linked together to create low density polyethylene (LDPE) or high density polyethylene. (HDPE)
- Modifiers are added to stabilize against heat and light or to brighten colour.
- Different chemical reactions are used during manufacturing to create different physical properties.

Advantages of plastic packaging for food are;

- Light but strong.
- High resistance to breakage.
- Tailor made to the colour, size and shape required by the food manufacturer.
- Can add sales appeal to the product.
- Economical compared other packaging materials.
- Some containers can be recycled.
- Light weight reduces transport cost.
- Safer to handle.

### **Rigid plastic packaging**

Rigid containers are often tailor –made for the product they are to package. They are used for ice cream, margarine, yogurt, dairy desserts and butter. Heat resistant rigid containers are used for freezer to microwave foods and for self-stable microwaveable products. They may have as many as seven layers to give the properties required for the different environments. For example, clear plastic trays form containers for fragile biscuits before over wrapping. The most commonly used rigid used to package food are;

- Polyvinyl chloride (PVC)
- Polyethylene terephthalate (PET)
- Polystyrene
- Polystyrene

PVC and PET are the two rigid plastics used for packaging food. They differ in their strength, barrier properties and the potential to be coloured so food manufactures decide which material is the most suitable for their product.

### **Polystyrene food packaging**

Polystyrene packaging is an effective packaging material for food because it is rigid, strong material that is impervious to moisture so protects food from damage and spoilage during transport, storage and in-store display. It keeps food fresh and safe from bacteria while retaining its nutritional value. Food stays fresher longer, so the need for artificial additives and preservation is reduced. Transparent applications of the material allow consumer to see the product without handling so food hygiene is ensured.

### **Expanded polystyrene packaging**

Expanded polystyrene (EPS) packaging is an economical system of stackable boxes for fresh produce. It is a lightweight polymer, which can be moulded into a variety of shapes and are made from by-products of petroleum, gas and steel industry. The food industry uses the foam of packaging for fresh seafood, fruits and vegetables.



PCV and PVdC both need plasticisers to make them flexible. In the case of PVC the plasticisers is bound physically and not chemically, and therefore there is a possibility of migration or leaching to food.

### Combinations or multi-layer packaging material

Scientists have developed packages of more than one material to protect food so that it maintains its qualities and is safe to consume. The layers within packaging are not always visible but it is common for multi-layer packages to use five or more materials in construction. Packaging for perishable food products must focus on the oxygen permeability and moisture transmission to maximize the fresh eating qualities.

### Lamination

A laminate is a packaging materials composed of two or more layers of component material or materials. Materials such as plastics, paper, cardboard and aluminum foil can be sandwiched together with resin and each contributes one or more desirable property to the final laminate.

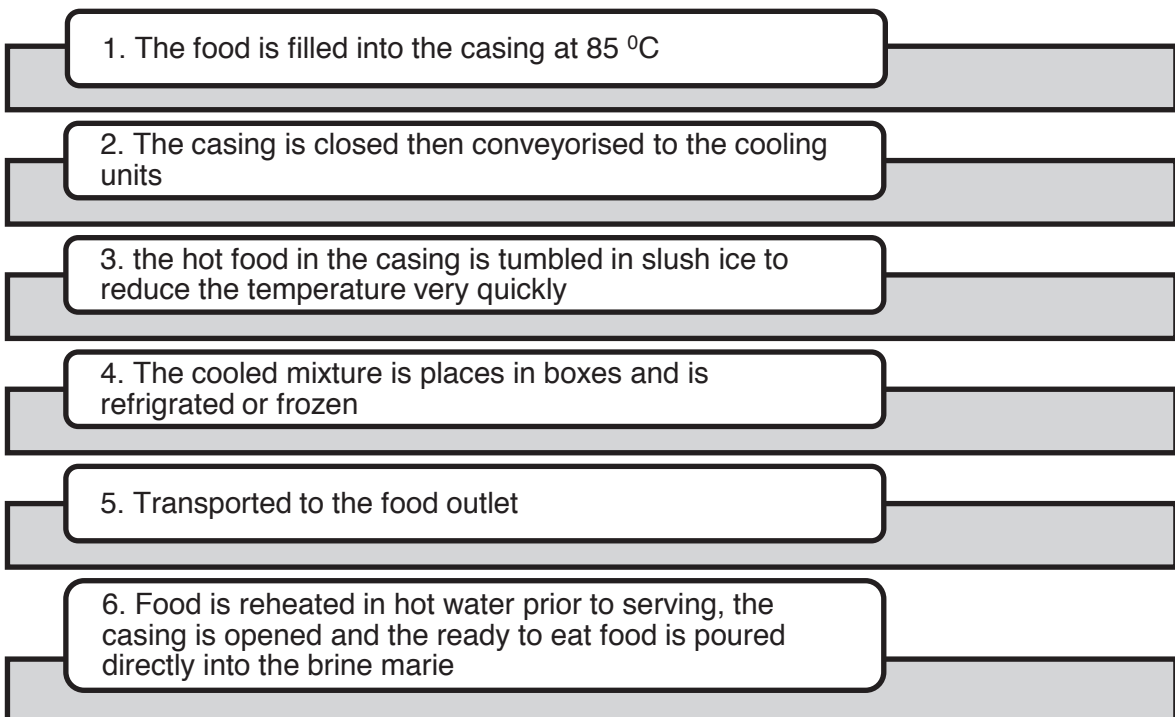
### Co extrusions

Co extrusions are multi-layer plastic films. They are produced with a variety of dyes so the individual materials are not mixed during production. Two or more molten plastics are extruded at the same time and are layered together. After cooling, these combined materials create a film.

Co extrusion laminate can be designed for food packaging with specific needs. It is flexible and can be produced as an overwrap, a pouch or casing.

Food that flows includes; sauces, casseroles, rice and soups.

The diagram below shows the production line for packaging food that flows.



The packaging industries have developed packaging systems which includes the following;

**1. Aseptic packaging** –involves independently sterilizing both the food and the packaging and then performing the filling and sealing operation in a sterile environment. This is to solve the dilemma of using artificial preservatives and salt or sugar of preventing food spoilage. Trends in nutrition which have encouraged consumers to reduce their consumption of sugar and salt and preservatives for better health.

The benefits of aseptic packaging

Food	Container
No preservatives are needed	Pre-formed paper provides stability
Natural flavour and colour are maintained	Different packs sizes produced on same machinery
Nutrient value is maintained	Hand space possible so products can be shaken
Products have a long life without refrigeration	Efficient space for storage and transport
Suitable for range of products	Large print surface for marketing

### Openings and closure of combibloc aseptic packs

Openings and closure are designed for the convenience of consumer. The designer take into consideration the type of food the pack will contain, who will use it and where will it be used. Temper evident seals and resealable closures are also important.

### 2. Intasept packaging

Intasept is a closed transfer aseptic packaging bag –in box system developed by Southcorp packaging for liquid foods. It ensures maximum self-life in known – refrigerated environment with minimal loss of quality, taste and nutritional value. Some of the application beverages such as milk, juices, wine, coffee and tea and food such as soft serve ice –cream, creams, custards, puddings, soups, broths, sauces, fruit and vege-tables purees, oils and fats and sweetened condensed milk. The products are convenient for the food service, industry because they are ready to use and come in range of sizes. The valve can be re-sealed for short term storage to ensure aseptic conditions are maintained.

### Modified atmosphere packaging (MAP) Atmospheric package

Modifying the environment inside a container which stores food can extend the self-life of the product. Packaged food may spoil because of the atmosphere within the container. Gases can penetrate the container and spoil the food, or gases produce by food during storage can cause spoilage.

There are several systems of modified atmosphere packaging (MAP): barrier specific packaging, gas packaging and active packaging.

### 3. Vacuum Packaging

In the past, salting, air drying and smoking were a few of the limited ways of preserving food. Although these methods successful for storing food, they did alter the sensory properties of food. In the recent years, vacuum was the first real attempt made by scientist to preserve food without altering the nature of fresh food. The name 'Cryovac ®' has been associated with vacuum packaging for over fifty years. Today, technological advances in packaging, refrigeration and distribution have made it more convenient for consumers to easily purchases fresh products in peak conditions.

The main goal of packaging is to always retard the microbial growth that naturally leads to food spoilage. However, it is not possible to preserve chilled food forever but to extend the self-life of the fresh food. The greater the level of perseveration and protection required, the greater the level of sophistication of packaging required. On the other hand, packaging materials or materials used for packaging plays a very important role in food packaging. Plastics in his many forms have proven to be versatile in containing food.

Vacuum packaging is a very basic and cost effective of packaging chilled products. It requires basic equipment and it is easily to detect leaking packs. The 'Cryovac ®' Barrier Bag which is used in vacuum packaging has high strength, a high oxygen barrier and is shrinkable. The shrink factor increases the appeal of the food and thickens the gauge of the bag which gives a second skin effect.

Vacuum chilled packs are used almost widely for red meats, including pork and some poultry sold in supermarkets. Cured and smoked goods such as ham also utilize shrink vacuum packaging.

### 4. Barrier specific packaging

Barrier specific package are specially made to admit some gases at different rates and exclude others. For example, the respiration of fresh food produces water and this can cause changes to the gases in the packaging container in which it is packed. There are other factors that influence the effectiveness barrier specific packaging are the temperature of the storage area, the age and quality of the fruit or vegetable, and the original microbial content of the food. To enhance the technique of MAP, specific materials have been designed for these particular foods.

- Lifespan is a breathable film used for packaging a range of fruits and vegetable products. It enables the consumer to receive produce harvest fresh and effectively extends the domestic market season.
- NuWave barrier containers uses technology where layers of specifically selected plastic resins are co extruded into one sandwich like structure. This allows the individual characteristics of each material is utilized. For example, one layer can provide oxygen protection, one moisture protection and another can withstand hot filled temperature. This material offers a microwavable packaging system for food sterilization or aseptic filling, and provides contents with shelf stability without refrigeration or preservatives.

These containers improve the marketability of food by creating a shelf presence with distinctive clear or colored packaging, provide long product life, are easily reheated in a microwave or hot water and the has the perception of quality. The materials can be produced in a wide range of shapes and sizes. Closures can be easy open metal can ends, foil or film lids with heat fusion, or peelable seals.

## 5. Gas packaging

This method of packaging involves gas mixtures that are tailored to the requirements of each food and replace the air in the headspace of containers before sealing. The permeability of the packaging material to oxygen, carbon dioxide and water is important to maintain the correct gas balance. Refrigeration storage is often combined with this technique to maintain the quality of fresh food. The amount of oxygen used in the packaging of fresh red meat is calculated accurately to help the product retain the color. And for fresh fruit and vegetables, it is used to allow them to breathe. Fresh pasta have a very short shelf life and therefore they are packed in gas flushed, sealed, thermoformed trays to keep them on the shelf for only 4 to 6 weeks.

## 6. Active Packaging

Active packaging not only contains a food product, it is a system in which the packing material and the enclosed environment can control and or react to changes that occur to food on the shelf. After harvest or slaughter biological systems are still active so the atmosphere inside a fresh food package is changing as metabolic processes take place. In fresh food and vegetable package the oxygen is used up in the head of the package and increase the carbon dioxide concentration. At the same time water is produced and this increases the humidity, and together, this factors combine to cause spoilage to fruit and vegetable tissue. Shelf life can be extended by controlling specific gases within a package using chemical scavengers. These absorb a gas or other chemicals that may release a specific gas. These gases are harmless to human. The alternative is active packaging film, which a transparent film that incorporates the reactive material.

<b>Materials that remove gases in active packaging -scavengers</b>		
<b>Scavengers</b>	<b>What they do</b>	<b>Food examples</b>
Ethylene	Traps ethylene by ripening fruits and vegetables. Extended life valuable for export trade	Fresh fruits and vegetables.
Oxygen	Absorb oxygen to delay browning and rancidity, retain color and prevent moulds.	Dried apples, products containing vegetable oils, packed curds meat, cakes muffins, pizza bases cheese.
Waters	Prevents condensation that can lead to growth of moulds. Food remains dry without breaking down.	Tables grapes, Packet taco shells and burritos.
Carbon Oxide	Absorbed carbon dioxide to prevent of flavours.	Roasted and ground coffee.

Materials that add gases in active packaging: Generators		
Generators	What they do	Food examples
Carbon dioxide	Inhibits growth of surface microorganisms.	Fresh meat, fish, poultry, strawberries
Sulphur dioxide	Acts as a preservative and controls mould growth on some fruit.	Dried tree fruits, table grapes.
Ethanol	Acts as a preservative. Not permitted in Australia. Used in Japan.	Some Japanese cakes

## 7. Future trends in packaging

Competition within food manufacturing is fierce and developments in the technology of packaging food are one way a producer or processor can gain a market advantage over the opposition. Many new types and techniques of packaging are developed;

- To increase shelf life
- To improve safety
- To decrease environmental waste
- For convenience
- To attract new customers
- As a novelty

Some of the factors that may have impact on packaging of food in the future are the electronic business processes and the concentration of ownership. Developments in electronic information transfer will reduce the time taken from the product of raw ingredients to the point of sale. This will allow more effective planning of all members of the supply chain because they will be informed more accurately on how much of their product is required, at what time and at what price. On the other hand, digital artwork will assist in a more integrated approach for packaging in the supply chain.

## 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
<b>12.2.2.1</b> Investigate useful and harmful microorganisms and their effects on food products	Introduction to food microbiology	<b>Lesson 1:</b> Useful and harmful microorganisms
		<b>Lesson 2:</b> Types of bacteria
		<b>Lesson 3:</b> Food spoilage
<b>12.2.2.2</b> Analyse and describe methods of food preservation and their relationship to food safety	Food preservation	<b>Lesson 1:</b> Principles of food preservation
		<b>Lesson 2:</b> Food packaging
		<b>Lesson 3:</b> Plan and design to preserve a food product
<b>12.2.2.3</b> Explore and analyse food additives, the types, functions, and their roles in food products	Food additives	<b>Lesson 1:</b> Types of food additives
		<b>Lesson 2:</b> Roles of food additives
		<b>Lesson 3:</b> Create a food product with additives
<b>12.2.2.4</b> Establish a safe working environment within the food industry	Safety standards	<b>Lesson 1:</b> Food safety standards legislation
		<b>Lesson 2:</b> Safety standards in food industry
		<b>Lesson 3:</b> Global food safety standards organisation
<b>12.2.2.5</b> Explore and describe technological advances in food science	Advancement in food science	<b>Lesson 1:</b> Food design and innovation
		<b>Lesson 2:</b> Advancement in Science and Chemistry Research
		<b>Lesson 3:</b> Genetically Modified Food

## 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: 12.2.2.1** Investigate useful and harmful microorganisms and their effects on food products.

**Topic:** Introduction to Food Microbiology

**Learning Objectives:** By the end of the topic, the students should be able to;

- Investigate on the different types of micro-organisms that cause food deterioration and spoilage.
- Analyse the main causes of bacterial food poisoning.

### Essential Questions:

- What are different types of micro-organisms that cause food deterioration and spoilage?
- What are the useful and harmful micro-organisms?
- What are the factors that affect the growth of micro-organisms?

### Essential Knowledge, Skills and Values/Attitudes:

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Microorganisms               <ul style="list-style-type: none"> <li>-Yeasts and moulds</li> <li>- Bacteria and types of bacteria</li> <li>- Microbial growth and factors affecting microbial growth</li> <li>- Chemicals</li> <li>- Main causes of bacterial food poisoning</li> </ul> </li> <li>• Food spoilage</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Explain the various types of micro-organisms that cause food spoilage and deterioration</li> <li>• Analyse the causes of bacterial food poisoning</li> <li>• Evaluate on the factors that affect the growth of micro-organisms</li> </ul>
<b>Values/Attitudes</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Appreciate the different food systems used in food production process and consider their food choices</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> </ul>

## Teaching and Learning Strategies

Teachers are required to introduce and emphasis food microbiology being subjected to types of micro-organisms that cause food deterioration and spoilage. The teacher is to be familiar with the content aspects to guide and direct students learning. Students are required to participate in all organized learning activities. Teaching and learning approaches must be aimed at developing curiosity and also encourage research skills to be developed. Students must be encouraged to observe and note food micro-organisms and different types of micro-organisms. Students must be involved in contributing ideas and decision making as they are consumers. Teachers should also research other texts to gather notes for students.

## Learning Activities

### Lesson 1: Useful and harmful microorganisms

**Activity 1:** How are microorganisms useful? Give examples and explain.

**Activity 2:** How are microorganisms harmful? Give examples and explain.

### Lesson 2: Types of bacteria

**Activity 1:** Investigate the five different groups of microbes and the different names of bacteria.

**Activity 2:** Identify bacteria that cause food spoilage and are pathogenic.

### Lesson 3: Food spoilage

**Activity 1:** What are the factors that affect the growth of microorganisms?

**Activity 2:** Name foods that are typically affected by bacteria, Yeast and Moulds.

**Content Background:**

Micro-organisms are microscopic plants and animals, many of which are single –celled. Microbiology is the study of micro-organisms. The main micro-organisms responsible for continuation of food are;

- Bacteria
- Moulds
- Yeasts

Each group has many members (species) which are responsible for different forms of contamination. In most cases, consumers fall sick by eating contaminated food. Not all micro-organisms are harmful, some are used in food industry to produce foods such as cheese, yoghurt and soy sauce.

**Food deterioration and spoilage**

Most foods whether it comes from plant or animal have a limited life. The food will begin to deteriorate once it is harvested or slaughtered. This deterioration can lead to food spoilage. Foods as fish, meat, milk, bread, bananas, tomatoes, beans, pumpkins and potatoes are examples of perishable foods that will deteriorate quickly. Other foods such as rice and legumes can be kept for a much longer time without going bad quickly.

The main cause of food deterioration is from the action of micro-organisms and their enzymes.

**Microbial activity**

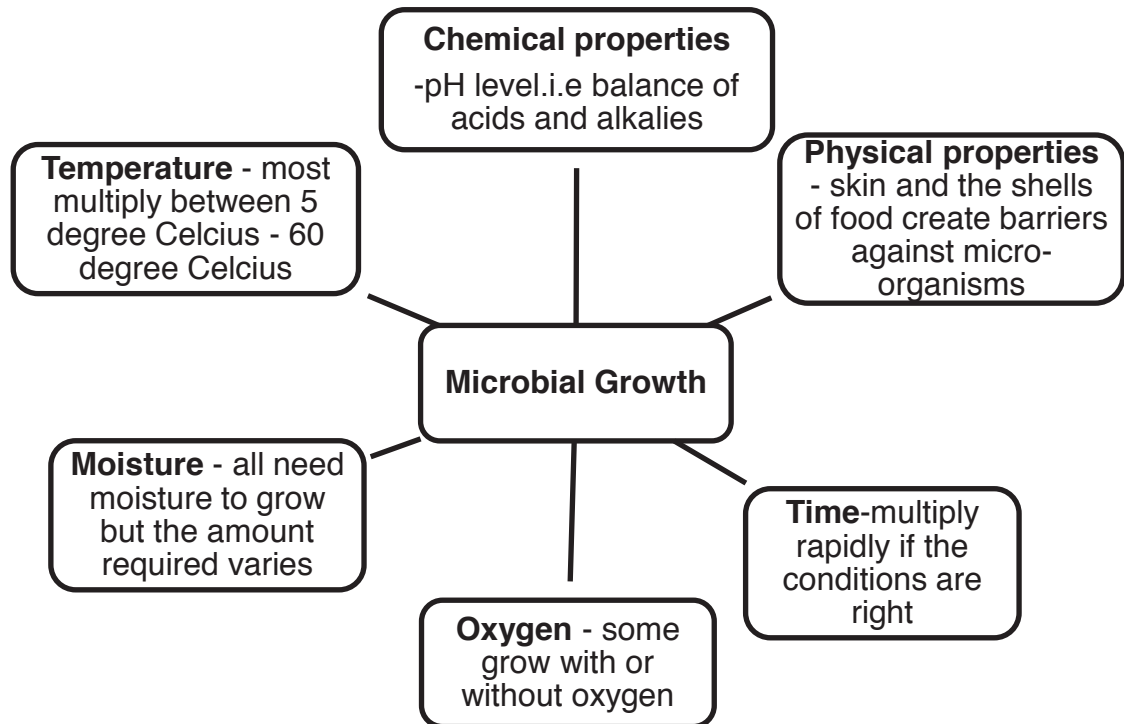
There are three main groups of micro-organisms that are related to food spoilage; bacteria, yeasts and moulds. These micro-organisms multiply or grow fairly rapidly with the right conditions. Their growth is affected or caused by;

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

**Aerobic and anaerobic micro-organisms**

Aerobic micro-organisms require oxygen to grow whereas anaerobic micro-organisms survive without oxygen.

This diagram shows factors affecting the growth of micro-organisms



### Bacteria

- Bacteria are single-celled organisms that cause food spoilage and likely food poisoning. Foods typically affected by bacteria are meats, poultry and dairy products, including milk.
- Bacteria multiply quickly under ideal conditions such as warm and moist environments, oxygen and neutral pH level around 7.
- Some bacteria are not harmful and are used in food preparation such as yogurt and cheese.
- Bacteria release poison into foods and these poisons enter the body when the food is eaten causing illness.

Names of bacteria	Illness they cause
Diplococci	Pneumonia
Staphylococci	Food poisoning
Streptococci	Tonsillitis, scarlet fever
Bacilli	TB, typhoid, food poisoning
Spirilla	Cholera

- Other bacteria are pathogenic or pathogenic bacteria and viruses that contaminate food and cause food spoilage and likely food poisoning. Foods that are contaminated by pathogenic bacteria become slimy, soft and eventually putrid-smelling. Some examples of the different pathogenic bacteria and viruses.

Pathogenic bacteria	Viral bacteria
Salmonella, E.Coil, Listeria	Hepatitis, Rotavirus, Norovirus

**Types of bacteria** – *Salmonella* and *Staphylococcus aureus* bacteria contaminate food and cause symptoms such as stomach cramps, vomiting and diarrhoea, but usually not life threatening. *Clostridium botulinum* is a life threatening bacteria but is very rare. It does not need air to survive so is more difficult to detect.

**Main causes of bacterial food poisoning**

Bacteria type	Name	Illness incubation and duration	Symptoms	Sources
Cocci	<i>Staphylococcus aureus</i>	Incubation: 1-6 hrs Duration: 1-6 days	Severe vomiting, diarrhoea, exhaustion	Nose, skin, cuts, sores, cooked meat, pies, custards, ice cream
Bacilli	<i>Salmonella typhimurium</i>	Incubation: 12-48 hrs Duration: 7 days	Headach, fever, vomiting, abdominal pain	Faeces, sliced or cooked meat, poultry, pies, sausages, eggs
Clostridia	<i>Clostridium botulinum</i> (botulism)	Incubation: 12-36 hrs Duration: fatal within 7 days	Double vision, difficulty with breathing, talking, and swallowing	Improperly canned food esp. meat, vegetables
Clostridia	<i>Clostridium welchii</i>	Incubation: 8-24 hrs Duration: 1-2 days	Diarrhoea, abdominal pain and head ach	Meat pies, gravy, canned meat, soil
Bacilli	<i>Salmonella typhi</i>	Incubation: 1-3 wks Duration: 1-2 months	Headach, tiredness, fever, rash, haemorrhage	Sewage, water, flies, cream cake, watercress, canned meat
Bacilli	<i>Bacilli Cereus</i>	Incubation: 2-18 hrs Duration: 1-3 days	Diarrhoea, vomiting, abdominal pain	Faeces, cold meats, gravy, cream, sausages
Bacilli	<i>Campylobacter jejuni</i>	Incubation: 2-5 days Duration: 2-5 days	Profuse diarrhoea (blood stained abdominal pain, nausea, exhaustion)	Unpasteurised milk, under cooked poultry, raw meat

Bacilli	Listeria monocytogenes	Incubation: 5 days - 5 weeks Duration: Varies	Like flu, still-birth, miscarriage, blood poisoning, pneumonia, meningitis	Widespread in water, manure, soil, milk, milk products, soft cheeses, pate, meat, poultry, prepared salads, cook/chill products
Bacilli	VTEC 0157	Incubation: 12-60 hrs Duration: Varies	Abdominal cramps, vomiting, diarrhoea	Farm animals; under-cooked minced beef, beefburgers, untreated cow's milk and cheese, infected people; untreated water

### Yeasts

- Yeasts are single – celled micro-organisms or plants/fungi that reproduce by budding. This process is known as fermentation.
- Yeasts require warmth, moisture, oxygen and time to reproduce.
- Yeasts are destroyed at temperatures above 60 degree Celsius.
- The actions of yeasts are used in the production of bread, wine and beer.
- Food contaminated with yeasts will usually ferment or become slimy and smell musty and taste acidic with a tingling sensation.
- Foods with high moisture content such as fruits and fruit juices are typically affected by the action of yeasts.

### Moulds

- Moulds are microscopic airborne plant that often appears as fine blue, green, white grey or black clumps or threads on food. They reproduce by the means of sporulation.
- Moulds require warmth and moisture to grow but grow at a slower rate in cool places. For example, mould on stale loaves of bread, jam and cheese.
- Foods such as corn, nuts, breads, cheeses, fruits and vegetables are mostly affected by the growth of moulds.
- In the manufacturing of blue cheeses. Specific moulds are used to create the characteristic flavour and appearance of the blue vein varieties. However, in other cheeses, it is important to discard the cheese as mould forms a network of microscopic strands that extend into the foods and may cause allergic reactions.



## 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: 12.2.2.2** Analyse and describe methods of food preservation and their relationship to food safety and health.

**Topic:** Food Preservation

**Learning Objectives:** By the end of the topic, the students should be able to;

- Evaluate the effectiveness of various methods of food preservation and communicate the information.

**Essential Questions:**

- What are the similarities and differences between food preservation and food safety?
- How are food preservation methods important in food safety?
- What methods of preservation were used in ancient times?
- How successful are modern techniques of food preservation?

**Essential Knowledge, Skills and Values/Attitudes:**

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Methods of food preservation               <ul style="list-style-type: none"> <li>-freezing</li> <li>-canning</li> </ul> </li> <li>• Food packaging               <ul style="list-style-type: none"> <li>- Functions of packaging</li> <li>- Functional properties of packaging materials</li> <li>- Packaging materials and types</li> </ul> </li> <li>• Food Packaging Act &amp; Standards Regulations</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Explain the similarities and differences of food preservation and food safety</li> <li>• Evaluate the importance of food preservation in relation to food safety</li> </ul>
<b>Values/Attitudes</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Appreciate the different food systems used in food production process and consider their food choices</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> </ul>

## Teaching and Learning Strategies

The content of this unit of work is about food preservation including the past and current trends of preserving foods. The teacher is encouraged to engage students in various enquiry teaching approaches to enhance their understanding of food preservation and its impact in the past and present and also create positive attitudes and choices in food preservation. Prepare resources or information to assist students for further research or complete given tasks in both theory and practical lessons.

## Learning Activities

### Lesson 1: Principles of food preservation

#### Activity 1

**1a.** What is food preservation and what are the reasons or aims of preserving food?

**1b.** Research and collate information on food preservation, compare methods used as in cavemen days to modern day methods and practices make inferences based on your findings.

**1c.** Select a modern time food preservation method and compile a report. Do a write – up and present it via power point.

**Activity 2:** Define food spoilage. Explain how the following spoilage mechanism causes the contamination of foods;

**2a.** Contamination by micro-organisms.

**2b.** Degradation by enzymes.

**2c.** Physical and chemical changes to food.

**2d.** How are bacteria and fungi responsible for food spoilage?

**2e.** Suggest effective ways to control microbial contamination.

**2f.** Describe enzymatic action in food spoilage.

### Lesson 2: Food packaging

**Activity 1:** Study these guided questions and respond to them appropriately

**1a.** What are the requirements for food packaging?

**1b.** What is the difference between primary and secondary packaging?

**1c.** What does the future trend for the food packaging industry?

**Activity 2:** Work in groups to devise a strategy to research and collect information about the kind of packaging materials commonly used in your school, community or town. You can use a survey questionnaire as an instrument to collect information, analyse your findings with a document write-up and power point presentation. Your teacher should assist where possible. You may utilize audio-visual aids to assist in the investigation and also to communicate information.

### **Lesson 3: Plan, design and preserve a food product**

#### **Activity 1: Project 1**

Plan, design and produce a food product for preservation method from the list below;

- Drying (using sun, wind, fire)
- Curing (using salt)
- Fermenting (use migorgan)
- Pickling (the use of beer, wine, vinegar)
- Sugaring (use of honey, sugar)
- Freezing (use of underground snow compartments)

Utilize the technology process to plan, design and produce and preserve a food product  
Write a critical evaluation of all stages of the food development process

#### **Activity 2: Project 2**

Plan, design, prepare and preserve a food product using modern methods of preservation.

- The product must be well made and marketable.
- The method to be used is freezing.
- You will work individually to produce a product using local vegetables and blanching as processing method and preserve it through freezing.
- The vegetables to use include beans, carrots, peas and corn.
- You will use the costing formula to price your product for sale.
- Your teacher will assist at different stages of the project.

## Content Background:

The increased knowledge of food science with the use of technology has improved food processing and production. This includes food preservation methods. Food is preserved to prevent natural and microbial decay, by modifying that conditions that favour enzymes activity and the growth of miro-organisms. In the past food is preserved to provide a store of food during wet and /or dry seasons and for cultural reasons such as feasts etc. Today food is preserved for the following reasons;

1. To add variety to the diet, by making foods available out of season.
2. To make use of food when it is cheap and plentiful and to store it for later use.
3. To vary the diet by preserving food in many ways that make a new product out of food (e.g. pickling, jam making).

## Aims of preservation

Preservation also aims to retain as many of quantities of the fresh food as much as possible while preventing decay. For example, it aims to retain flavour, texture, colour, appearance and nutritional value. It also aims to prevent micro-organisms from contaminating the food once it is preserved, by sealing it from the outside air.

## Methods of preservation

Food decayed can be slowed by;

1. Heating to destroy micro-organisms and enzyme activity.
2. Removal of moisture to inhibit microbial growth.
3. Removal of air to prevent further entry of miro-organisms.
4. Reduction of temperature to inhabit microbial and enzymatic activity.
5. Addition of a chemical preservative to destroy or inhibit microbial and enzymatic activity.
6. Irradiation.

**Heat preservation (High Temperature Preservation:** blanching; pasteurization; sterilization; canning)

Most bacteria, yeasts, moulds and enzymes are destroyed by heating at 100 degree Celsius. However, some bacteria and bacterial spores are resistant to such temperatures and higher temperatures are required to destroy them.

Some bacterial toxins are resistant to heat, so that a food which is already contaminated with them may not be made safe to eat by heat treatment.

## The three main methods of heat treatment

### 1. Sterilization

In the 19<sup>th</sup> century a Frenchman named, Nicolas Appert, first discovered that if food was heated in a sealed container at a higher temperature, it would remain edible and free

from decay for some time, unless the seal was broken. Prolong heating will destroy harmful micro-organisms, which are naturally present in the food will only start to decay when new organisms contaminate it.

### **Sterilized milk**

Sterilization kills harmful and souring bacteria more completely and will keep for several weeks if unopened. The milk is first homogenized, put into glass bottles with long necks, and sealed with a metal cap. It is then sterilized inside the bottles in one of the following ways;

- In a **batch process**, where the milk is heated in bottles in an autoclave (a large industrial pressure cooker) at up to 113 degree Celsius for 15-40 minutes.
- In a **continuous process**, where the bottles pass on a conveyor belt through hot water tanks, into a steam chamber (under pressure) at 113 degree Celsius for 15-40 minutes, then into cooling tanks.

### **2. Pasteurization**

Another French scientist, Louis Pasteur later discovered that less severe heat treatment than that used in sterilization could be effective in destroying pathogenic and souring microbes, without adversely affecting the appearance or flavour of a product. This process has been successfully developed and many items are now treated in this way. On the other hand pasteurization only destroys the harmful microbes; the food will not keep for very long, as other naturally occurring microbes in the food will begin to cause decay. Foods that use this process are; milk, milk products, fruit juices, liquid egg for bakery products, vegetable juices, beer, vinegar and wine.

### **3. Canning and bottling**

Today canning is one of the most widely used methods of preservation. A huge variety of foods are canned and bottled, providing a safe and convenient method of preserving food. Both methods rely on heat sterilization to destroy microbes and enzymes and sealing to prevent contamination during storage.

**Cans** – Modern cans are made of steel which is coated in a very thin layer of tin, and often lacquered to prevent corrosion. The cans are first filled with food, then air is removed, and the cans are sealed. They are sterilized under pressure for a carefully calculated length of time, and then removed and cooled. Most cans are cooled by water. They are then labelled and packed.

### **Principles and methods of preservation**

- Preservation using heat.
- Preservation by low temperature.

- Preservation by high concentration of sugar. (Jam/Jelly/Marmalade /syrup /squash)
- Preservation by using salt. (pickling)
- Preservation by using chemicals; (sodium benzoate, calcium propionate)
- Drying and dehydration of fruits .
- Drying and dehydration of vegetables.
- Fermentation of food.
- Preservation of coconut shreds using humectants.

## 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: 12.2.2.3** Explore and analyze food additives, the types, functions, and their roles in food processing and product development.

**Topic:** Food additives

**Learning Objectives:** By the end of the topic, the students should be able to;

- Investigate on what are food additives and their functions.
- Evaluate how food additives are used in food processing.
- Utilize food labels in the selection of food products.

### Essential Questions:

- What are food additives?
- What are their roles in food product development?
- Why are food additives important in food processing?
- What organization approves and certifies the use of additives on locally made food products for the export market?

### Essential Knowledge, Skills and Values/Attitudes:

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Food additives</li> <li>• Functions of food additives</li> <li>• Food additives used in food processing</li> <li>• Food Act and Regulatory Board</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Explain and describe what are food additives</li> <li>• Analyse the functions of food additives in food processing</li> <li>• Investigate on the importance of food additives</li> <li>• Compare food products and analyze product information labels</li> </ul>
<b>Values/Attitudes</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> <li>• Appreciate the food regulating laws that safeguard the production and export of food commodities to the consumer market</li> </ul>

## Teaching and Learning Strategies

The teacher is encouraged to further research on the topic to prepare students to carry out their tasks with ease. The practical lessons require prior and thorough preparations in order to achieve the desired targets and goals of the lesson objective(s). Students need to develop the practice of and know the importance of food labels to be able to familiarize themselves of the food products and make wise food choices as a consumer. There should be learning opportunities provided for the students to explore more on the topic and communicate ideas or findings to others using appropriate means of disseminating information.

### Learning Activities

#### Lesson 1: Types of food additives

##### Activity 1:

Study the table given showing different processing additives. Do a research to complete the table. The first one has been done for you as an example.

Processing Additives and their uses		
Additive Function	Typical Chemical Agent	Typical Product
<i>Example:</i> Conditioning	Potassium bromate	Flour
Anti-caking		
Bleaching		
Clarifying		
Emulsifying		
Leavening		
Stabilizing and thickening		

##### Activity 2:

**2a.** Food additives have side-effects on the human body because additives are synthetically derived chemicals. List some side effects of food additives on the human body or some reactions that additives cause.

**2b.** The following are agencies involved in monitoring to ensure food products are safe before reaching the consumer according to international standards. Explain the roles of each of the organizations listed below;

- i. WHO
- ii. Codex Alimentarius Commission

#### Lesson 2: Role of food additives

##### Activity 1

**1a.** Compile different functional uses of food additives.

**1b.** Name various sources of food additives.

**1c.** What is the role of flavoring agents when added to foods?

**1d.** Preservatives, coloring and sweetening are added to foods. What are their functions as they are added to food?

**1e.** World Health Organisation (WHO) plays a major role in food production to consumption. What are they responsible for in the area of food additives?

### Activity 2

**2a.** The following are different food additives. Explain the functions of each of them.

- i. Anti Caking Agent
- ii. Anti-oxidants
- iii. Artificial sweeteners
- iv. Emulsifiers
- v. Food Acids
- vi. Colours

**2b.** List some common food additives we must try to avoid and why. Complete the table given by explaining the reasons of each food additives.

No	Common food additive	Reason to avoid
1.	Mono Sodium, Glutamate (MSG)	
2.	Artificial food colours	
3.	Sodium Nitrate	
4.	Guar Gum	
5.	Artificial Sweeteners	

### Lesson 3: Create a food product with additives

Students will work in groups to prepare a meal. Use the technology design process to plan, design and develop a food product using food additives. Ensure to select appropriate ingredients to cook their meal.

## Content Background:

### Additives

A food additive is a substance that is added to a food for a precise technological reason and is not a food itself. Food additives allow us to benefit from a diversity of safe, nutritious and flavoursome. Food additives are not necessarily complex chemical compounds and include substances such as salt, baking powder and vanilla. They are often identified in the ingredients list of the label of packaged foods. They can be also referred to natural or artificial substances added to food in small quantities for a particular purpose, for example; a preservative, emulsifier or a colour enhancer.

Additives are approved for various functions in foods:

- Improve the nutritional value of particular foods
- Enhance the taste, texture, consistency or colour of a particular foods and therefore make them more appealing
- Preserve food so they remain wholesome and appealing while being transported to their place of sale; preservatives also extend the storage life of foods.

### Some examples of specific food additives and their functions

Additive	Function
Antioxidants	Prevent foods containing fats and oils from becoming rancid; also impede fruits from becoming brown when cut and exposed to air
Colours	Replace colours that are lost during processing
Flavour enhancer	Boost the flavours in foods
Food acids	Maintain the level of acid in food where there are variations in food's acidity
Humectants	Control moisture levels and keep foods moist; mainly used in baked goods
Preservatives	Enhance self-life by controlling the growth of mould, yeast, fungi and bacteria; Delay food spoilage when food comes into contact with air
Thickeners and stabilisers	Change the texture and consistency of food, including thickening and stabilising emulsions

### Food additives used in food processing

Some examples of how additives are used in processing include;

- Vitamins and minerals may be added to particular foods such as breakfast cereals, flour, dairy products, margarine, bread and fruit juice to compensate for nutrients likely to be deficient in a person's diet or lost during processing. Such vitamins and minerals include folate, thiamine, vitamin C, riboflavin, niacin, calcium and iron.
- Additives can supply leavening or control acidity or alkalinity. Leavening agents produce carbon dioxide bubbles when a reaction takes place between an alkali (bicarbonate of soda) and an acid (cream of tartar, yoghurt or lemon juice), causing baked goods to rise.

- Additives are used to improve flavour or impart desired colour. Various colour or synthetic flavours enhance the taste of the food. Colours are used to improve the appearance of particular foods to satisfy the expectations of consumers.
- Soft drinks, cordials and confectionery, baked goods and jams are some foods that contain additives to improve flavour and impart the desired colour.

It is also important that food additives are carefully control by Government authorities and various international organisations to ensure that they are safe for their proposed use and that food containing the additives are precisely labelled. The food regulatory body must approve additives before they can be legally added to foods. All additives are subject to constant safety reviews as scientific knowledge and techniques of testing continue to develop. The numbering system for food additives is known as the International Numbering System (INS).

### Grouping and coding of additives

Additives	Coding of additives
Colours	Natural colours that are derived mainly from plant extracts. E.g.: <b>Curcumin</b> (turmeric) and has coded number 100. <b>Cochineal</b> (red colour extracted from the bodies of insects). It has coded number 120. Chemical colours that are synthetically constructed azo dyes such as <b>Tartrazine</b> . It has coded number 102. And synthetic 'coal tar' dyes such as <b>Sunset yellow</b> . It has coded number 110
Azo dyes	These dyes have a particular chemical structure of atoms in their molecules. A number of people in the community who are sensitive to aspirin, are also sensitive to azo dyes. The reactions to this additives cause contractions of the bronchi, watering eyes and nose, and swelling of the skin. These people in particular must read labels carefully and acquaint themselves with colours in the azo category.
Preservatives	These have code numbers in the 200s range. These additives make foods last longer by controlling the growth of yeast, mould and bacteria. <b>Sorbic acid</b> (200) inhibits the growth of yeast and mould and is particularly used as a preservative in cheese. <b>Sodium sulphide</b> (211) prevents oxidation, that is the discolouration or browning of peeled apple and potatoes. <b>Sodium nitrate</b> (250) is used for curing meats.
Antioxidants	These have code numbers in the 300s range. Ascorbic acid (300) stops browning in unprocessed fruits and is an improving agent for flour. <b>Butylated hydroxytoluene</b> (321) retards the development of rancidity and the deterioration of flavor in fats and polyunsaturated oils
Emulsifiers and stabilisers	These have code numbers mainly in the 400s range. <b>Propylene glycol alginate</b> (405) helps foods mix together, particularly in ice-cream and salad dressings.
Vegetable gums	These have code numbers mainly in the 400s range. Agar also known as <b>agar-agar</b> , (406) is produced from seaweed and acts as a thickening and gelling agent
Thickeners	Thickeners include vegetable gums and have code numbers mainly in 400s range. These additives such as <b>Carrageenan</b> (407) which is often called Irish moss is used to thicken foods by adding body and texture particularly in dairy foods.
Flavour enhancers	These have code numbers mainly in the 600s range. These additives have little to no flavor themselves but they boost the existing or any artificial flavours. They are used mostly in sauces, meat products and snack and savoury foods. <b>Monosodium glutamate</b> (621) is widely used as a flavor for protein foods.

Sweeteners	These have code numbers mainly in the 900s range. Some of the commonly used intense sweeteners used in diet or low kilojoule foods are saccharin (954), <b>aspartame</b> (951) and <b>cyclamate</b> (952). These sweeteners are artificial. Products using these additives must list them as artificially sweetened on the label.
Flavourings	These additives have no code numbers. They are added to products to add new flavours and to replace those removed during processing. These substances are difficult to analyse as they are usually mixtures of a number of chemicals. For this reason they do not have to be listed on labels.

Additives and enzymes can be defined as the parts that can be used to enhance the flavour or preserve the pre-existing character of the food that we consume. There are varied varieties of enzymes and additives for several purposes. It belongs as a part of food chemistry.

- Additive Numbering
- Preservative additives
- Nutritional additives
- Enhancer additives

### Food advertising

A very important part of food product development process is advertising of food products to consumers. In PNG, commercial food products are mainly advertised using different mediums such as TV, radio, newspapers, posters, leaflets, social media, sales fairs etc. In many countries advertising is carefully regulated to ensure that all advertisements are legal, decent, honest and truthful.

### Food labelling

Food manufacturers invest much money and time in designing packaging to attract customers to their food products. Food labelling laws are set by the Government and are enforced by Food regulatory authorities. Their aim is to;

1. To inform consumers about all the words, pictures, descriptions, trademarks, symbols or brand names that appear on food label.
2. To ensure that labels do not mislead consumers about;
  - What the food is? (its nature and identity)
  - Where it comes from? (its country of origin)
  - Who made it? (its manufacturer)
  - What is in it? (its composition)
  - How it was made? (its method of manufacture)
  - How much there is? (its quality)
  - How long it will safely keep? (its self-life and durability)
  - What it will look, taste, smell and feel like? (its properties)
3. Ensure that the label does not make a false claim about the food. E.g.: aids weight loose; without evidence to support the claim.

Labels must show;

- The name of the product, including any treatment the food has had, e.g, UHT (Ultra High Temperature) Milk, smoked haddock, freeze-dried coffee.
- A list of ingredients including additives, in descending order of weight.

- The net quantity (for pre-packed foods).
  - The weight of the food without the packaging. A large letter 'e' after the weight means that although the average quantity must be right, the weight in individual packs may vary slightly.
4. Instructions about storage, cooking or use.
  5. How long the food will be at its best. There are two ways of showing this;
    - "Best before" or "before end" tells how long the product will be in its best condition if kept according to instructions on the label. It is shown as day/month/year unless the product shelf-life of less than 3 months, in which case the year is not shown. If eaten after the best before date, the food may not cause food poisoning but will not be in best condition. "Use by" tells how long the food will be safe to eat if stored correctly. This is used for perishable food, such as cream and fish, which would become a health hazard if kept too long. Freezing can prolong the safe storage of some perishable foods.
  6. The name and address of the manufacturer packager or retailer.
  7. The place of origin-where the food was originally grown or produced.

Nutritional labelling is essential to help people follow the dietary goals. Guidelines for nutritional labelling are produced by the ministry of Agriculture, fisheries and food, and at present, food manufacturers do not have to use them, unless they are making a nutritional claim for the food, e.g. it is low in fat. The guidelines say how the information should be presented;

1. The nutrient values must be shown per 100g of food
2. If there is less than 100g of food in the package, the amount of nutrients per portion must be shown.
3. Food claiming to be a good source of a nutrient must have at least 1/6 of the RNI.

**1 Nutrition information panel.**

Most packaged foods must have a nutrition information panel. The information must be presented in a standard format which shows the amount per serve and per 100g (or 100ml if liquid) of the food. Examples of a nutrition information panel and the nutrients that have to be listed in the nutrition information have been outlined below.

There are a few exceptions to requiring a nutrition information panel such as:

- very small packages which are about the size of a larger chewing gum packet
- foods with no significant nutritional value (such as a single herb or spice, tea, and coffee)
- foods sold unpackaged (unless a nutrition claim is made)
- foods made and packaged at the point of sale, for example bread made in a local bakery.

NUTRITION INFORMATION		
Serving size: 3		
Serving size: 150g		
	Quantity per Serving	Quantity per 100g
Energy	600kJ	400kJ
Protein	4.5g	3.0g
Fat, total	3.4g	2.3g
Saturated	4.5g	3.0g
Carbohydrate, total	18.0g	12.0g
- Sugar	18.0g	12.0g
Sodium	80mg	53mg

\*Percentage of recommended dietary intake

Ingredients: Whole milk, concentrated skim milk, sugar, banana (2%), strawberries (2%), grape (1%), peach (2%), and pineapple (2%).

All quantities above are averages

**2 Percentage labelling.**

Packaged foods have to carry labels which show the percentage of the key or characterising ingredients or components in the food product. This will enable you to compare similar products. The characterising ingredient for this fruit salad yoghurt is fruit and you can see from the ingredient list that it is banana 8%, strawberry 8%, grape 4%, peach 2%, and pineapple 2%. An example of a percentage of a characterising component would be the amount of cocoa solids in chocolate. Some foods, such as 'white bread' or 'cheese', have no characterising ingredients.

**3 Name or description of the food.**

Foods must be labelled with an accurate name or description, for example fruit yoghurt must contain fruit. If it were to contain fruit flavoured rather than real fruit, the label would need to say 'fruit flavoured yoghurt'.

**4 Food recall information.**

Considering the number of foods available, recalls of unsafe or unsuitable foods are uncommon. Food labels must have the name and business address in Australia or New Zealand of the manufacturer or importer, as well as the lot identification of the food (or date coding). This makes food recalls, on the rare occasion that they are necessary, more efficient and effective. In Australia each year there are about 70 food recalls, most of which are precautionary and due to the food manufacturer identifying a problem from their own testing. Details of Australian recalls are on the Food Standards Australia New Zealand website at [www.foodstandards.gov.au](http://www.foodstandards.gov.au). New Zealand recalls are on the New Zealand Food Safety Authority website [www.nzfsa.govt.nz](http://www.nzfsa.govt.nz).

**5 Information for allergy sufferers.**

Some foods, food ingredients or components of an ingredient can cause severe allergic reactions in some people - this is known as anaphylaxis. Foods such as peanuts, tree nuts (e.g. cashews, almonds, walnuts), shellfish, breaded fish, milk, eggs, sesame and soybeans and their products, when present in food, may cause severe allergic reactions and must be declared on the label however small the amount. Gluten is also included in the list but the caution is more for those with Coeliac Disease rather than allergy. Those who are wheat allergic must stay away from all wheat including gluten. In addition, foods containing sulphite preservatives must be labelled as containing sulphites if they have 10 milligrams per kilogram or more of added sulphites. This is the level that may trigger asthma attacks in some asthmatics. For more information on food allergies see the Anaphylaxis Australia website [www.allergyfacts.org.au](http://www.allergyfacts.org.au) or Allergy New Zealand [www.allergy.org.nz](http://www.allergy.org.nz).



**3 Name or description of the food**

**1 Nutrition information panel**

**7 Ingredient list**

**2 Percentage labelling**

**9 Food additives**

**12 Country of origin**

**4 Food recall information**

**6 Date marking**

**8 Labels must tell the truth**

**10 Legibility requirements**

**5 Information for allergy sufferers**

**6 Date marking.**

Foods with a shelf life of less than two years must have a 'best before' date. It may still be safe to eat those foods after the best before date but they may have lost quality and some nutritional value. Those foods that should not be consumed after a certain date for health and safety reasons must have a 'use by' date. An exception is bread which can be labelled with a 'baked on' or 'baked for' date if its shelf life is less than seven days.

**7 Ingredient list.**

You will usually find the ingredient list on the back of the product. Ingredients must be listed in descending order by ingoing weights. This means that when the food was manufactured the first ingredient listed contributed the largest amount and the last ingredient listed contributed the least, compared to the other ingredients. So, if fat, sugar or salt are listed near the start of the list the product contains a greater proportion of these ingredients.

**8 Labels must tell the truth.**

Suppliers must label food products with accurate weights and measures information. Weights and measures declarations are regulated by Australian State and Territory and New Zealand Government fair trading agencies. Fair trading laws and food laws in Australia and New Zealand require that labels do not misinform through false, misleading or descriptive representations. For example, a food with a picture of strawberries on the label must contain strawberries.

**11 Directions for use and storage**

**9 Food additives.**

Food additives have many different purposes, including making processed food easier to use or ensuring food is preserved safely. They may come from a synthetic or a natural source. For example, emulsifiers prevent salad dressings from separating into layers and preservatives help to keep food safe or fresh longer. All food additives must have a specific use, must have been assessed and approved by FSANZ for safety and must be used in the lowest possible quantity that will achieve their purpose. Food additives must be identified, usually by a number, and included in the ingredients list. This allows those people that may be sensitive to food additives to avoid them. A thickener has been used in this yoghurt - its additive number is 1442. A full list of numbers and additives can be obtained from the FSANZ website. Some additives are derived from food allergens which must be identified, for example lecithin (soy).

**10 Legibility requirements.**

Any labelling requirement legally required in the Food Standards Code must be legible, prominent, and distinct from the background and in English. The size of the type in warning statements must be at least 3mm high, except on very small packages.

**11 Directions for use and storage.**

Where specific storage conditions are required in order for a product to keep until its 'best before' or 'use by' date, manufacturers must include this information on the label. For example, 'This yoghurt should be kept refrigerated at or below 4°C'.

**12 Country of origin.**

Australia and New Zealand have different country of origin labelling requirements. In Australia, packaged, and some unpackaged, foods must state the country where the food was made or produced. This could just be identifying the country where the food was packaged for retail sale and, if any of the ingredients do not originate from that country, a statement that the food is made from imported or local and imported ingredients. Australian legislation also lays down rules about 'product of Australia', which means it must be made in Australia from Australian ingredients, and 'made in Australia', which means it is made in Australia with significant imported ingredients. In New Zealand, country of origin requirements only apply to wines.

## 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: 12.2.2.4** Establish a safe working environment within the food industry.

**Topic:** Safety Standards

**Learning Objectives:** By the end of the topic, the students should be able to;

- Identify and analyse safe working environment within the food industry.
- Investigate food legislation and its impact on consumers.
- Evaluate global food safety standards organisations.

**Essential Questions:**

- Why are safety standards important within a food industry?
- What are the food safety legislations?
- What are the roles of global food safety standards organisation?

**Essential Knowledge, Skills and Values/Attitudes:**

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Safe working environment in the food industry</li> <li>• Safety in food industries</li> <li>• Food safety legislations</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Explain the safety standards in food industry</li> <li>• Analyse food legislations and its impact on consumers</li> <li>• Evaluate the functions of various global food safety standards organisations</li> </ul>
<b>Values/Attitudes</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Appreciate the different food systems used in food production process and consider their food choices</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> </ul>

### Teaching and Learning Strategies

Teachers are required to introduce the concept of safety standards and guide students through discussions, activities to understand the different levels of safety standards, organisations and their roles. It is also very important for teacher and students to discuss and know about the food safety legislations, organizations and their roles in PNG.

## Learning Activities

### Lesson 1: Food Safety Standards

**Activity 1:** Discuss and explain the different levels of safety standards and give some examples.

**Activity 2:** Why are food standards important within the food industry?

### Lesson 2: Food Safety Legislation

**Activity 1:** Identify the food safety legislation in PNG?

**Activity 2:** What is the role of ICCC in PNG?

### Lesson 3: Global Food Safety Standards Organisation

**Activity 1:** Research on the different organization in the global food safety standards and explain their roles.

## Content Background:

The food industry is a complex, global network of diverse businesses that supplies most of the food consumed by the world's population. The food industry today has become highly diversified. It includes regulations or safety standards.

## Safety Standards

Safety standards are standards designed to ensure the safety of products, activities and processes etc. They may be advisory or compulsory and are normally laid down by an advisory or regulatory body that may be either voluntary or statutory. Safety standards can be classified into 4 hierarchical levels with the universal international standards at the top. Each standard is harmonized in content by coordinating with higher – level standards.

1. **International Standards** – standards that can be used commonly by countries around the world. Examples are given as follows;

## International Organizations and Agreements

### Codex Alimentarius

The Codex Alimentarius Commission was created in 1963 by FAO and WHO to develop food standards, guidelines, codes of practice, etc. to protect the health of consumers, ensure fair trade practices in the food trade, and promote coordination of all food standards work undertaken by international governmental and non-governmental organizations.

### Sanitary and Phytosanitary Measures (SPS)

An agreement on how governments can apply food safety and animal and plant health measures (sanitary and phytosanitary or SPS measures) sets out the basic rules in the World Trade Organisation.

Food	Meat, milk, eggs and fish are protein –rich food and are most susceptible to food poisoning.
Acidity	Pathogenic bacteria require a slightly acidic pH level of 4.6 -7.5; they thrive in conditions with a pH of 6.6 -7.5.
Time	Food should be removed from the danger zone within two hours, either by cooling or heating.
Temperature	Pathogenic bacteria grow best in temperatures between 5 <sup>0</sup> C and 60 <sup>0</sup> C; they thrive in temperatures that are between 21 <sup>0</sup> C and 49 <sup>0</sup> C.
Oxygen	Almost all pathogenic bacteria require oxygen to grow. Some pathogenic bacteria, such as Clostridium, do not require oxygen to grow.
Moisture	Water is essential for the growth of pathogenic bacteria.

**2. Regional standards-** They are developed or adapted and promulgated by the regional organisations. For example; European Committee for Standardization.

**3. National Standards** – Standards used in different countries. For example: ICCC in PNG

**4. Group Standards** – Standards used by certain industry association. They are set and used at the level of industries, companies and factories.

#### **Food legislation or laws in PNG**

- Food Sanitation 1991
- Food Sanitation Regulation 2007
- Papua New Guinea National Food Security Policy 2016-2025
- Independent Consumer and Competition Commission (ICCC) Act.

#### **Let us learn about Food Laws from other countries**

For an example; the NSW Food Authority is responsible for food safety across the entire food industry, from primary production to point of sale. Its mission is to ensure that food in New South Wales is safe and correctly labeled and that consumers are able to make informed choices about the food they eat. Complaints about food safety and hygiene can be made to the NSW Food Authority; complaints and reports about food safety may be referred to local councils or other relevant bodies for investigation.

The Food Authority;

- ensure food for sale is safe and suitable for human consumption.
- prevent misleading conduct in connection with the sale of food.
- provide for the application in this state of the Food Standards Code

The Food Standards Code has requirements relating to:

- labeling and advertising,
- substances added to foods-food additives, vitamins and minerals, processing aids, identity, and purity,
- contaminants and residues-metals and toxicants, environmental residues, packing materials,
- moisture absorbers, mould inhibitors, promotional materials, graphics, prohibited and restricted, and
- plants and fungi foods requiring pre-market clearance—novel foods, food produced using gene technology and food irradiation;
  - microbiological and processing requirements.
  - food product standards.
  - food safety standards-food safety programs, food safety practices and food premises and equipment.
  - primary production standards.

- plants and fungi foods requiring pre-market clearance—novel foods, food produced using gene technology and food irradiation;
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  - food safety standards-food safety programs, food safety practices and food premises and equipment.
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## 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: 12.2.2.5** Explore and describe technological advances in food science.

**Topic:** Advancement in Food Science

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

- Identify and describe the various technological advances in food product development.
- Evaluate various food solutions to food engineering related to food preservation and storage.

### Essential Questions:

- What are the various technological advances in food processing?
- Why is food engineering important in food processing?
- What are the influences in food science on consumers?

### Essential Knowledge, Skills and Values/Attitudes:

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Technological and engineering advancement in food science</li> <li>• Food solutions to food engineering</li> <li>• Food biotechnology</li> <li>• Food microbiology technology</li> <li>• Food genetic modification</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Explain the various technological advances in food processing</li> <li>• Evaluate food solutions and present their findings</li> </ul>
<b>Values/attitudes</b>	<ul style="list-style-type: none"> <li>• Make informed decisions on the importance of food processing and be responsible for their well being</li> <li>• Appreciate the different food systems used in food production process and consider their food choices</li> <li>• Be responsible for their wellbeing in making healthy food choices</li> </ul>

### Teaching and Learning Strategies

Teachers are required to introduce the concept and revise or discuss the different technologies and engineering advancement of food covered in grade 11. The teacher and students are encouraged to research and discuss in class the new advancements in Food Science. Many consumers see the finish product but do not know how it was processed. It is very important to be aware of these engineering advancements that are applied in processing food today.

### **Learning Activities**

#### **Lesson 1: Food design and innovation**

**Activity 1:** What are the disadvantages of new food design and innovation?

**Activity 2:** What are the reasons behind new food design and innovation for consumptions?

#### **Lesson 2: Advancement in science and chemistry research**

**Activity 1:** Identify some advancement in food science and technology?

**Activity 2:** Choose from the list in Activity 1 and write about these advancements in the food industry.

#### **Lesson 3: Genetically modified food**

**Activity 1:** What is genetic engineering and why is it used in processing of food?

**Activity 2:** Research and explain a particular food that has been modified using genetic engineering.

## Content Background:

Today the global food processing technology has reached a milestone in earning much profit and creating massive employment in the food industry. Recent advances in food processing and Technology is not only important to meet the increasing productivity demands but to adopt sophisticated automation, control and monitoring methods and techniques. The latest technological innovations in food science have enabled the Food and Beverages Sector to enhance the quality of their products. The new food stuffs include Biotechnology based food products such as genetically modified food, organic crops and food stuffs, protein based diet.

## What is food biotechnology?

Modern biotechnology is making a great impact in the food industry. Food biotechnology is mainly focused on evolving developments and applications of prevailing genetics, metabolic, enzymatic and structures based biochemical processes in food and food – related biological systems. The purpose is to improve and produce foods, functional foods and food ingredients at the stage of processing and beyond agricultural production, genetically modified plants are used to enhance self-life, nutrition, taste and quality food which is synthesized using biological tools.



Advancement in food science or it is also known as rise of Food Technology in this century include;

- Food technology innovations
- Genetically Modified Foods
- Emerging preservation technologies
- Advances in freezing technology
- Advances in in Emulsion Science

## History and future trends of food Engineering

Food engineering was introduced in the 1950's as an academic discipline according to history. Its initial development was mainly on post-harvest operations related to food processing equipment performance. And in the past two decades there have been revolutionary advances in computer technology, molecular biology, and materials science (molecular structure in relation to functional properties of materials), transforming the scope and focus of food engineering. The use of computers for analysis simulation and control of food products plays a vital role in the development of industrial food processes.

Wars and explorations voyages have always had a big impact on the development of food technology. For example, the Napoleonic wars led to thermal sterilization on the Civil War in the US which promoted dehydration and concentrations of food, World War 2 initiated the technical development of protective packaging. NASA's Apollo and Skylab missions led to profound developments.

The recent advances in food engineering have provided a strong basis for making major improvements in processing operations throughout the food chain. Food engineers are seeking new approaches that include synergistically combined processes. As well as that innovations are expected in transforming bench-scale processes into industrial – scale manufacturing of foods while maintain desirable quality attributes. Here are some outstanding achievements in food engineering include;

- Continuous bread-dough making and forming
- Manufacture of low cost, high quality prepared mixes
- Development of instant mashed product
- Production of precooked frozen convenience foods
- Continuous butter churning
- Freeze drying or sublimation
- Extrusion processing
- Preservation of beer and wine by micropore filtration
- Pneumatic bulk handling of dry and liquid
- Aseptic filling of packages
- Automatic control processes
- Controlled atmosphere and modified atmosphere storage of fruits and vegetables
- Ohmic heating
- Irradiation of foods
- High hydrostatics Pressure

Recently, there has been a growing interest in the area of non-thermal processing of foods. Emerging technologies using pulsed electric fields and high pressure have encouraged food engineers to seek new materials for equipment, to determine process conditions for high quality foods, and to ensure the safety and reliability of the process, such as generation of membranes. These materials will significantly enhance a range of applications in food processing, from minimizing water use in processing plants, to improving efficiency in separating high-value components in foods that have desirable food and non-food applications.

These advancements will require food engineers to use highly creative approaches in designing food packaging systems, including the use of edible coatings for increasing shelf-life to deliver a high quality product to consumers.

### **Genetic engineering**

Genetically modified foods are foods produced from organisms that have had changes into their DNA using the methods of genetic engineering as opposed to traditional cross breeding. This new technique is being used in the Agricultural and Food processing industries. All information about a plant or animal including its colour, size, shape and growth is carried in its genes. The information is passed onto the new generation of plant or animal when it reproduces. Using genetic engineering, scientists can alter genes and change certain features of a plant or animal. E.g. tomatoes that do not go soft during transport and can be left on the plant longer to develop flavour, potatoes that are resistant to potato leaf roll virus, yeast that raises bread more quickly. Genetic foods are carefully controlled and regulated.

### **How is technology related to food?**

Food Technology has increased food choice in various ways, including;

1. Producing cheaper versions of basic foods, e.g. margarine instead of butter.
2. Producing new types from unused sources e.g. quorn from mycoprotein.
3. Producing quick to prepare foods and ready-prepared meals.
4. Increasing food production by developing new agricultural practices, e.g. Hormone injections to cattle to improve milk yield, genetic engineering to produce high yield cereal plants.
5. Increasing the shelf-life of food to avoid wastage and preserving the food in good condition.
6. Improving packaging to enable more foods to be eaten away from the home, e.g. ring-pull cans, plastic food trays.

# 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 12 Technology and Industrial Arts subject.

Technology and Industrial Arts has 5 strands and 13 Units.

Grade 12 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.

	<b>Units</b>	<b>Content Standards</b>	<b>Benchmarks</b>
	<b>1:</b> Food and Nutrition	1	5
	<b>2:</b> Food Science	1	5
<b>Total:</b>	<b>2</b>	<b>2</b>	<b>10</b>

## Grade 12 Food Technology in TIA Subject

In grade 11 and 12, Food Technology is a standalone subject but the subject content information is found in 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.

The table below outlines the strands and units for grade 12 Technology and Industrial Arts subject. This helps teachers understand how to deal with units per strand when they are expanded into evidence outcomes and benchmarks at each grade.

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 12 Food Technology Content Matrix

The Grade 12 Food technology Content Matrix shows the total number of units, content standards, Benchmarks and topics to be covered in Grade 12. 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 12 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 are no specialist or trained teachers to teach all the content in the Food Technology subject. 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 12 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 accordingly.

**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 12 proposed set of benchmarks distributed in each term with topics**

<b>Terms</b>	<b>Units, Benchmarks &amp; Topics</b>	
<b>1</b>	<b>Unit 1: Food and Nutrition</b>	
	Benchmark 12.2.1.1	<b>Topic 1:</b> Food production (1)
	Benchmark 12.2.1.2	<b>Topic 2:</b> Food production (2)
	Benchmark 12.2.1.3	<b>Topic 3:</b> Food Quality Control
<b>Term 1 Assessment</b>		
<b>2</b>	<b>Unit 1: Food and Nutrition</b>	
	Benchmark 12.2.1.4	<b>Topic 4:</b> Principles of Food Preservation
	Benchmark 12.2.1.5	<b>Topic 5:</b> Packaging of Food Products
	<b>Unit 2: Food Science</b>	
	Benchmark 12.2.2.1	<b>Topic 1:</b> Introduction to food microbiology
	Benchmark 12.2.2.2	<b>Topic 2:</b> Food preservation
<b>Term 2 Assessment</b>		
<b>3</b>	<b>Unit 2: Food Science</b>	
	Benchmark 12.2.2.3	<b>Topic 3:</b> Food Additives
	Benchmark 12.2.2.4	<b>Topic 4:</b> Safety Standards
	Benchmark 12.2.2.5	<b>Topic 5:</b> Advancement in Chemistry Research
<b>Term 3 Assessment</b>		
<b>4</b>	<b>Preparation for Examination</b>	

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

### Grade 12 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:

Units	Benchmarks	Topic	Suggested Lesson Titles
1. Food and Nutrition	12.2.1.1 Describe the processes that transform raw materials into manufactured food products	Food production (1)	<b>Lesson 1:</b> Modified food products
			<b>Lesson 2:</b> The process of product development
			<b>Lesson 3:</b> The design process
	12.2.1.2 Describe the processing techniques, equipment, storage and distribution systems used in industry and compare with those used domestically	Food production (2)	<b>Lesson 1:</b> Commercial food production
			<b>Lesson 2:</b> Food production systems
			<b>Lesson 3:</b> Create new food products
			<b>Lesson 4:</b> Food Packaging
	12.2.1.3 Identify critical control points and describe quality control procedures in food production systems	Food quality control	<b>Lesson 1:</b> Food quality control process
			<b>Lesson 2:</b> Food quality production systems
	12.2.1.4 Apply the principles of food preservation to create safe food products	Principles of food preservation	<b>Lesson 1:</b> Importance of food preservation and traditional practices of preservation
<b>Lesson 2:</b> Methods of food preservation and storage			
<b>Lesson 3:</b> Hazard analyses			
12.2.1.5 Investigate through experimentation, the suitability of packaging materials for different food products	Packaging of food products	<b>Lesson 1:</b> Importance and function of packaging	
		<b>Lesson 2:</b> Packaging materials and systems	
		<b>Lesson 3:</b> Future trends in packaging	
2. Food Science	12.2.2.1 Investigate useful and harmful microorganisms and their effects on food products	Introduction to food microbiology	<b>Lesson 1:</b> Useful and harmful microorganisms
			<b>Lesson 2:</b> Types of bacteria
			<b>Lesson 3:</b> Food spoilage
	12.2.2.2 Analyse and describe methods of food preservation and their relationship to food safety	Food preservation	<b>Lesson 1:</b> Principles of food preservation
			<b>Lesson 2:</b> Food packaging
			<b>Lesson 3:</b> Plan and design to preserve a food product
12.2.2.3 Explore and analyse food additives,	Food additives	<b>Lesson 1:</b> Types of food additives	

	the types, functions, and their roles in food products		<b>Lesson 2:</b> Functions of food additives
	<b>12.2.2.4</b> Establish a safe working environment within the food industry	Safety standards	<b>Lesson 3:</b> Create a food product using additives
	<b>12.2.2.5</b> Explore and describe technological advances in food science	Advancement in food science	<b>Lesson 1:</b> Food safety standards legislation
			<b>Lesson 2:</b> Safety standards in food industry
			<b>Lesson 3:</b> Global food safety standards organisation
			<b>Lesson 1:</b> Food design and innovation
			<b>Lesson 2:</b> Advancement in Science and Chemistry Research
			<b>Lesson 3:</b> Genetically Modified Food

### 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.A ct	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.no : & Title	Lsn. Obj.	Sug.lsn. 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.**

# Standards-Based Lesson Planning

## What are Standards-Based Lessons?

In a Standards-Based Lesson, the most important or key distinction is that, a student is expected to meet a defined standard for proficiency. When planning a lesson, the teacher ensures that the content and the methods of teaching the content enable students to learn both the skills and the concepts defined in the standard for that grade level and to demonstrate evidence of their learning.

Planning lessons that are built on standards and creating aligned assessments that measure student progress towards standards is the first step teacher must take to help their students reach success. A lesson plan is a step-by-step guide that provides a structure for an essential learning.

When planning a standards-based lesson, teacher instructions are very crucial for your lessons. How teachers instruct the students is what really points out an innovative teacher to an ordinary teacher. 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. Under achievement 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.

### Unit 1: Food and Nutrition

**Content Standard 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 12.2.1.1** Describe the processes that transform raw materials into manufactured food products.

**Topic:** Food Production (1)

**Lesson:** Modified Food Products

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

- Explain and analyze modified food products.
- Investigate on how modified food product is processed.

### Essential Questions:

- What is a modified food product?
- How modified food products are processed?

### Essential knowledge, skills, values, attitudes

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Food processing stages</li> <li>• Food production processes</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Investigate the food production processes and its impact on food development</li> <li>• Compare raw food materials and manufactured food products</li> <li>• Discuss and analyse nutritional value on food processing</li> </ul>
<b>Attitudes/Values</b>	<ul style="list-style-type: none"> <li>• Appreciate the different food product development process and consider their food choices</li> <li>• Make informed decisions on the role of specific nutrients in the body and the balance required for optimum health</li> <li>• Be responsible of their food choices in food processing</li> </ul>

## Teaching and Learning Strategies

Teacher's Activities	Students Activities
<b>Introduction (time in minutes)</b>	
<ul style="list-style-type: none"> <li>Introduce the lesson topic and engage students in groups to brainstorm what are modified food products.</li> <li>Allow students to present their findings.</li> </ul>	<ul style="list-style-type: none"> <li>Participate in groups and discuss and brainstorm what are modified food products.</li> </ul>
<b>Body (time in minutes)</b>	
<b>Modeling</b>	
<ul style="list-style-type: none"> <li>Show a video on food processing and provide students with guided questions.</li> </ul>	<ul style="list-style-type: none"> <li>Students watch the short video and answer guided questions on food processing.</li> </ul>
<b>Guided Practice</b>	
<ul style="list-style-type: none"> <li>Handouts prepared for students on the project on modified food products.</li> </ul>	<ul style="list-style-type: none"> <li>Use the design process to plan a project on making modified food products.</li> </ul>
<b>Independent Practice</b>	
<ul style="list-style-type: none"> <li>Ask students in groups to investigate on modified products and choose an item to make.</li> </ul>	<ul style="list-style-type: none"> <li>Students in groups research, discuss and evaluate modified food products.</li> <li>Compile a report on their findings and the project design.</li> <li>Present their findings/report to the rest of the class.</li> </ul>
<b>Conclusion (time in minutes)</b>	
<ul style="list-style-type: none"> <li>Summarize important points by asking students questions related to their reports – What did the students learn in this lesson?</li> <li>Self-evaluation – Points to consider such as content, teaching and learning strategies for lesson improvement.</li> </ul>	<ul style="list-style-type: none"> <li>Students reflect on their given tasks and identify areas of improvement.</li> </ul>

### Assessment/lesson evaluation

Students can:

- What is a modified food product?
- How modified food products are processed?

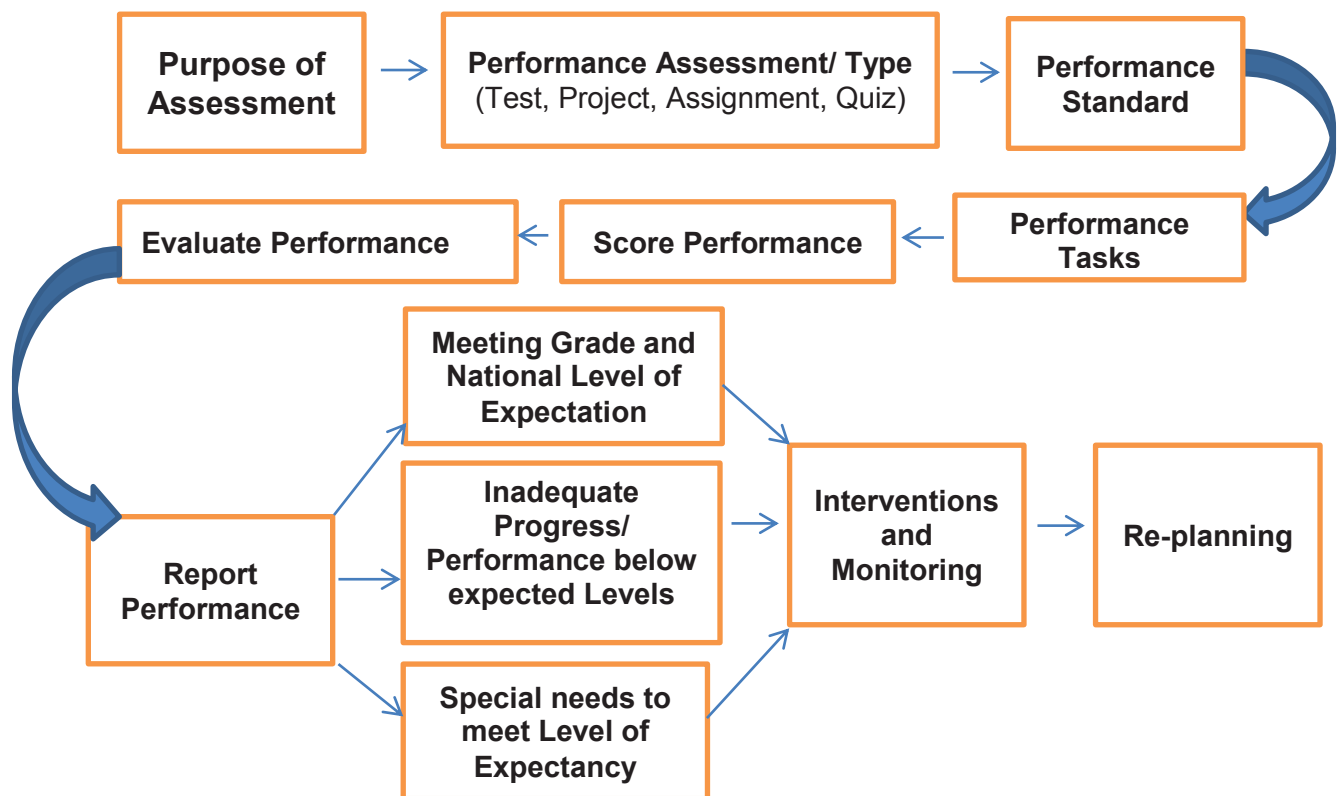
# Assessment, Monitoring and Reporting

## 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.

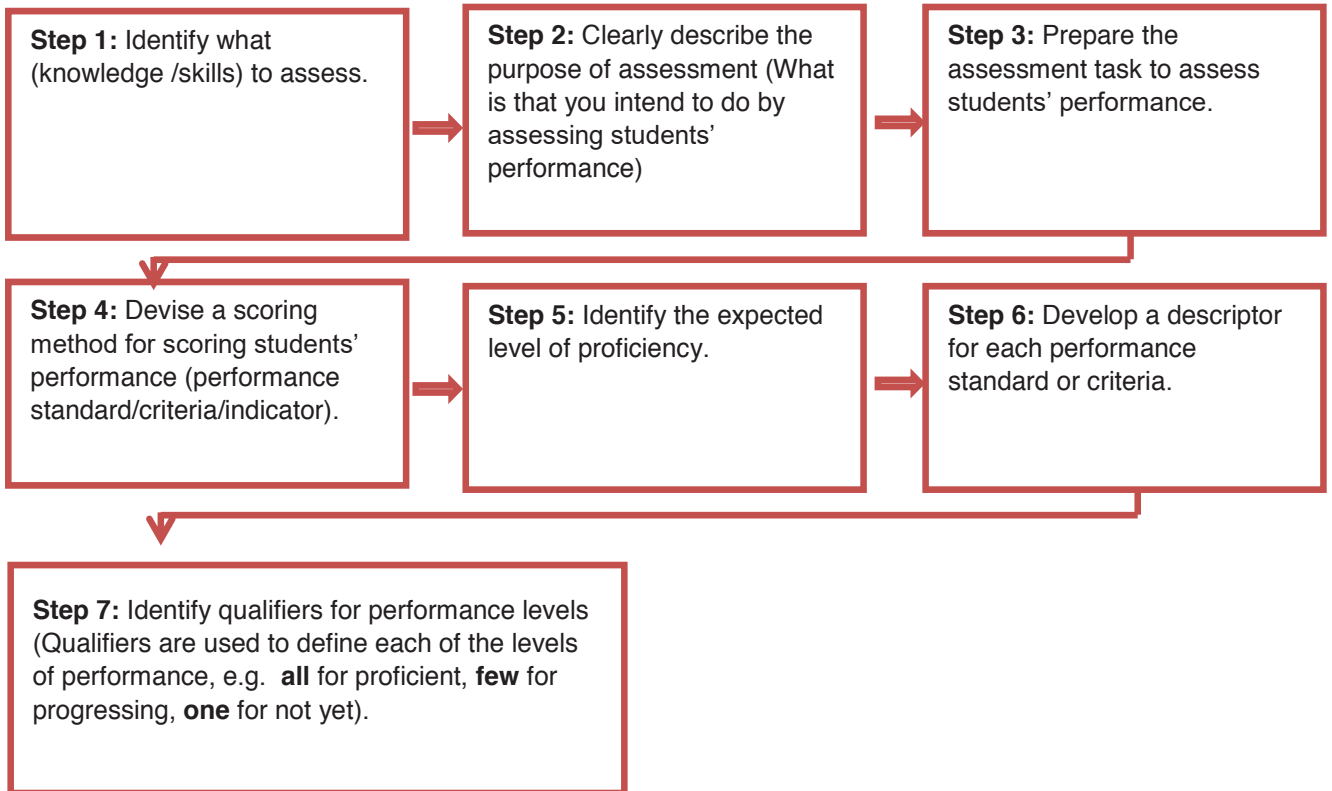
## Principles of Standards-Based Assessment

The principle of SBA is for assessment to be;

- emphasizing 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*

<b>Authentic Assessments</b>	<b>Traditional Assessments</b>
<ul style="list-style-type: none"> <li>• Portfolios, demonstrations, field work, case studies, assignments, lab reports</li> <li>• Students take an active role in process</li> <li>• Qualitative</li> <li>• Interpretive</li> <li>• Focuses on performance, process and product</li> <li>• High level thinking</li> <li>• Use of rubric</li> <li>• Use of criterion levels evaluation</li> <li>• Part of teaching and learning Process</li> <li>• Shows mastery and learning performance</li> <li>• Generally extends over time</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple choice tests, true-false, fill in the blanks, sentence completion, matching, diagram completions</li> <li>• External – (teacher driven – assessing performance of teacher rather than the student)</li> <li>• 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)</li> <li>• Quantitative (driven to collect marks)</li> <li>• Objective</li> <li>• End product (only looking for the end product and not concerned about the performance and process)</li> <li>• Standardised or norm referenced</li> <li>• Isolated facts</li> <li>• Low level content</li> <li>• Generally occurs in “one setting”</li> </ul>

## 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
<b>Knowledge</b> - 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	<ul style="list-style-type: none"> <li>• Prior knowledge inventory, misconception/preconception check</li> <li>• Focused listing, empty outlines</li> <li>• Pre-post test, quiz, quick poll</li> </ul>
<b>Comprehension</b> - 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	<ul style="list-style-type: none"> <li>• Minute paper, muddiest (or clearest) point</li> <li>• Observe and evaluate a student artifact or performance task using a rubric</li> <li>• Directed paraphrasing</li> <li>• Pre-post test, quiz</li> <li>• Interviews</li> </ul>
<b>Application</b> – 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	<ul style="list-style-type: none"> <li>• Observe and evaluate a student artifact, performance, or task using a rubric</li> <li>• Directed paraphrasing, real-world application (apply learning in a new context)</li> <li>• Test, quiz</li> <li>• Job/internship evaluation, skill ratings</li> </ul>
<b>Analysis</b> – 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	<ul style="list-style-type: none"> <li>• Pro and con grid, categorizing grid, compare and contrast, concept maps</li> <li>• Observe and evaluate a student artifact, performance, or task using a rubric</li> <li>• Journaling</li> <li>• Job/internship evaluation, skill ratings</li> </ul>
<b>Evaluation</b> – to judge the value of information based on established criteria	Appraise, argue, assess, attach, defend, judge, predict, rate, support, evaluate, recommend, convince, judge,	<ul style="list-style-type: none"> <li>• Reflection component of a portfolio or experience</li> <li>• Journaling</li> <li>• Peer evaluation</li> </ul>

	conclude, compare, summarize	
<b>Affective Learning</b>	appreciate, accept, attempt, challenge, defend, dispute, join, judge, praise, question, share, support	<ul style="list-style-type: none"><li>• Reflection component of a portfolio or experience</li><li>• Journaling</li><li>• Observe and evaluate group work</li><li>• Surveys, interviews, focus groups</li></ul>

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

<b>Strategy</b>	<b>Description</b>
<b>Analogies</b>	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.
<b>Classroom Presentations</b>	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.
<b>Conferences</b>	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.
<b>Discussions</b>	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.
<b>Essays</b>	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.
<b>Exhibitions/ Demonstrations</b>	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.
<b>Interviews</b>	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.
<b>Learning Logs</b>	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.
<b>Observation</b>	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.
<b>Peer Assessment</b>	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.

<b>Performance Tasks</b>	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.
<b>Portfolios</b>	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.
<b>Questions And Answers (Oral)</b>	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.
<b>Quizzes, Tests, Examinations</b>	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.
<b>Questionnaires</b>	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.
<b>Response Journals</b>	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.
<b>Selected Responses</b>	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.
<b>Student Self-Assessments</b>	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.
<b>Case study</b>	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.
<b>Debate</b>	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.

<b>Games and simulations</b>	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 prizes. Students go into groups and organise. Follow the instructions and play to win.
<b>Peer Teaching and Learning</b> <i>(power point presentations, pair learning)</i>	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.
<b>Project</b> <i>(individual/group)</i>	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.
<b>Use media and technology</b>	<p>Teacher is encouraged to use media &amp; 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.</p> <p>Viewing can provoke questions, debates, critical thinking, emotion and reaction.</p> <p>Students after viewing, students engage in critical thinking and debate.</p>

## 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	Rating Scale			
	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

Diagram annotations: A blue box labeled "Qualifier" points to the word "all" in the Proficient column of both rows. A blue box labeled "Descriptor" points to the words "Identify" and "Explain" in the first and second rows of the Proficient column, respectively. Red circles highlight the words "all", "only", and "one" in the Proficient, Progressing, and Not Yet columns of both rows.

## 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
<b>Description</b>	Demonstrate <b><u>complete</u></b> understanding of the problem. <b><u>All</u></b> requirements of task are <b><u>included in response.</u></b>	Demonstrate <b><u>considerate</u></b> understanding of the problem. <b><u>All</u></b> requirements of task are <b><u>included.</u></b>	Demonstrate <b><u>partial</u></b> understanding of the problem. <b><u>Most</u></b> requirements of task are <b><u>included.</u></b>	Demonstrate <b><u>little</u></b> understanding of the problem. <b><u>Many</u></b> requirements of task are <b><u>missing.</u></b>	Demonstrate <b><u>no</u></b> understanding of the problem.	<b><u>No</u></b> response/ <b><u>not</u></b> 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)
<b>Beyond</b>	<b>Beyond Standard (s) - Advanced in Performance and Understanding</b>
	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
<b>Consistent</b>	<b>Meet Standard (s) - Proficient in Performance and Understanding</b>
	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
<b>Inconsistent</b>	<b>Progressing - Not Yet Proficient in Performance and Understanding</b>
	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
<b>Seldom</b>	<b>Not Yet - Limited Performance and Understanding</b>
	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:

<b>Criteria</b>	<b>Consistent</b>	<b>Inconsistent</b>	<b>Seldom</b>
<b>1</b>	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.

<b>Performance Standards/ Criteria</b>	<b>A 90 - 100</b>	<b>B 70 - 89</b>	<b>C 50 - 69</b>	<b>D 0 - 49</b>
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

<b>Score Range/Percentage Rating (%)</b>	<b>Grade</b>
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".

<b>Number scales</b>	1	2	3	4	5
<b>Rating</b>	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*.

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

#### 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.

<b>Excellent</b>	<b>Proficient</b>	<b>Adequate</b>	<b>Limited</b>
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.

<b>Excellent</b>	<b>Proficient</b>	<b>Adequate</b>	<b>Limited</b>
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		
<b>Total Theory Score</b>	____/40	<b>Total Practical Score</b>	____/60
<b>Total Scores of TAC + PAC = Total Scores out of 100</b>	_____/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
<b>Marks</b>	<b>100 %</b>	<b>A combination of design folios, practical applications, moderations and tests.</b>	

## 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
<b>Topic Tests x 2</b>	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
<b>Portfolio</b>	Individual Students will be assessed	10 marks
<b>Moderation</b>	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
<b>Project (Application)</b>	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
<b>Participation</b>	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	<b>K:</b> Physical and chemical properties of Food, pH Value of Food <b>S:</b> Investigate <b>A/V:</b> Being responsible
2. Character Social Development (CSD)	9.2.2.3 , 9.2.2.4, 9.1.5.2	<b>K:</b> Nutrition, Eating Disorders, Quality of Life <b>S:</b> Decision Making skills, <b>A/V:</b> 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	<b>K:</b> Descriptive writing, Ideas of writing, Clear and coherent ideas of writing, Information sources <b>S:</b> Research skills Interrogation skills, Comprehension skills, Presentation skills Report writing skills <b>A/V:</b> Being critical and considerate
4. Social Science (Geography)	9.1.3.4	<b>K:</b> Impact of migrations on places, resources, services, environments and cultures <b>S:</b> Analyze situations <b>A/V:</b> Being tolerant
5. Technology Industrial Arts (Communication Technology)	9.4.1.5	<b>K:</b> Range of communication and media products or services <b>S:</b> Problem solving <b>A/V:</b> 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,	<b>K:</b> Types of journals used in accounting process, Customer service strategies, Importance of marketing mix, Marketing on social media, 5 P's of Marketing Mix <b>S:</b> Financial skills, ICT Skills,

		<b>A/V:</b> Transparent and accountable, making business decisions,
7. Agriculture	9.1.5.4, 9.1.3.1, 9.2.2.1	<b>K:</b> Food Crops, Animal Food products, Consumption needs of people, Food Demand and Supply, Food Security <b>S:</b> Research and Analyze data <b>A/V:</b> Making informed decisions, show respect and consideration
8. Maths	9.1.1.4	<b>K:</b> Calculation methods, Money is measured using numbers <b>S:</b> Estimate a reasonable solution to a problem using rounding and estimation, mathematical Thinking Skills, Problem Solving <b>A/V:</b> Being trustworthy
9. Arts	9.3.3.2, 9.3.3.5	<b>K:</b> Food presentation <b>S:</b> Creativity, artistic thinking <b>A/V:</b> 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 widely 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 whatsapp 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 whatsapp 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	<ul style="list-style-type: none"> <li>Ethical issues</li> <li>Nutritional value of food</li> <li>Dietary needs for different groups</li> </ul>	<ul style="list-style-type: none"> <li>Public relation,</li> <li>Questioning techniques,</li> <li>Entering information</li> <li>Organize content logically</li> </ul>	<ul style="list-style-type: none"> <li>Appreciation</li> <li>Being responsible</li> <li>Respect views of others</li> </ul>
Survey Results and Recommendation	Compile a survey report, list recommendations and finalize for further action	<ul style="list-style-type: none"> <li>Food Nutritional values</li> <li>Health issues</li> </ul>	<ul style="list-style-type: none"> <li>Analyze survey information</li> <li>Compiling findings</li> </ul>	<ul style="list-style-type: none"> <li>Making informed decisions</li> </ul>
Food Product Development Planning	Plan and design nutritious food menus and recipes	<ul style="list-style-type: none"> <li>Food properties</li> <li>Nutritious value of food</li> <li>Dietary guidelines</li> <li>Cooking methods</li> <li>Food safety and handling</li> </ul>	<ul style="list-style-type: none"> <li>Design process – Investigating , analyzing,</li> <li>Problem solving,</li> <li>Classifying,</li> <li>Communicating ideas</li> </ul>	<ul style="list-style-type: none"> <li>Taking responsible actions,</li> <li>Making informed decisions,</li> <li>Being creative and innovative</li> </ul>
Technology Application	Create a food application, utilize Whatsapp or Facebook platforms (social media) to advertise and market food products	<ul style="list-style-type: none"> <li>Use of technology,</li> <li>Online platforms for sales and marketing,</li> <li>e-commerce</li> </ul>	<ul style="list-style-type: none"> <li>Operate technology devices,</li> <li>Create market venues on electronic devices,</li> <li>Create food app</li> </ul>	<ul style="list-style-type: none"> <li>Making informed decisions,</li> <li>Online citizenship</li> </ul>
Costing and Budget	Planning Budget and food costing	<ul style="list-style-type: none"> <li>Budget,</li> <li>Food costing</li> </ul>	<ul style="list-style-type: none"> <li>Accuracy,</li> <li>Mathematical calculations,</li> <li>Accounting skills</li> </ul>	<ul style="list-style-type: none"> <li>Consumer knowledge of food and purchasing food</li> </ul>
Food Product development	Prepare, process and package foods as per order	<ul style="list-style-type: none"> <li>Cooking methods</li> <li>Food ingredients</li> <li>Packaging</li> </ul>	<ul style="list-style-type: none"> <li>Safety and care</li> <li>Design process</li> </ul>	<ul style="list-style-type: none"> <li>Making informed decisions</li> <li>Problem solving</li> </ul>

Outdoor Presentations	Outdoor awareness presentation and food sale	<ul style="list-style-type: none"> <li>• Food and nutrition</li> <li>• Health and wellbeing</li> </ul>	<ul style="list-style-type: none"> <li>• Communication,</li> <li>• Advocacy and awareness,</li> <li>• Sales and marketing skills</li> </ul>	<ul style="list-style-type: none"> <li>• Commitment &amp; perseverance</li> </ul>
Cash Book Entry	Record revenue and expenditure	<ul style="list-style-type: none"> <li>• Money transactions</li> <li>• Profit</li> <li>• Revenue</li> <li>• Expenses</li> </ul>	<ul style="list-style-type: none"> <li>• Keep records of money</li> <li>• Math calculations (addition &amp; subtraction)</li> </ul>	<ul style="list-style-type: none"> <li>• Wise consumer</li> <li>• Transparency and accountability</li> </ul>
Project Evaluation	Identify: Evaluate successes and failures of the project. Make recommendations	<ul style="list-style-type: none"> <li>• Report Writing</li> </ul>	<ul style="list-style-type: none"> <li>• Judgmental skills</li> </ul>	<ul style="list-style-type: none"> <li>• Making informed recommendations,</li> <li>• Mental, physical and social preparedness</li> </ul>
Product: Folio completion and submission	Compile a folio attach project details, submit for assessment	<ul style="list-style-type: none"> <li>• Report Writing</li> </ul>	<ul style="list-style-type: none"> <li>• Folio &amp; write up</li> <li>• Research skills</li> </ul>	<ul style="list-style-type: none"> <li>• Transparency and accountability</li> </ul>

## 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 <b>accurate</b> results on time	Participants were knowledgeable and provided <b>satisfactory</b> results on time	Participants completed <b>some</b> tasks with care. Others were incomplete and needed help	Participants attempted to complete <b>few</b> tasks, and not all were attempted. Lack of motivation	/4
Survey Results and Recommendations	Questionnaires provided <b>precise</b> answers, <b>well-structured</b> information compiled, analyzed and logically presented	Questionnaires provided answers and information <b>satisfactorily</b> compiled, analyzed and presented	Questionnaires provided <b>partial</b> answers and some were irrelevant to topic and purpose	Questionnaires provided very <b>few</b> answers, information <b>incomplete</b> , not presented in a logical manner	/4
Food Product Development Planning	Menus and recipes are <b>well-structured</b> and contain precise instructions with nutritional considerations	Menus and recipes are of the <b>correct layout</b> with nutritional considerations	Menus and recipes are correctly structured, but <b>some had information gaps</b>	Menus and recipes are poorly structured but noted for <b>incomplete information</b>	/4
Technology Application	Successful uploading of information on social media accommodating <b>smart marketing strategies</b> and attracted many customers. Display good team work	Successful uploading of information on social media. Able to employ <b>some marketing strategies</b> to convince customers to buy food product or place food orders	Successful attempts to connect on social media. <b>Lack marketing skills</b> but attracted customers	Struggled with social media. Encountered problems getting started but convinced <b>only a few</b> customers and shows less team work	/4
Costing and Budget	Have an <b>in-depth</b> understanding on calculating food costs and develop realistic and reliable budget	Have <b>basic</b> understanding on calculating food costs and skills of budgeting	Have <b>partial</b> understanding on calculating food costs per portion, completed a budget plan with figures that seem exaggerated and unreal	Encountered <b>difficulty</b> in calculating food costs per portion and struggled to plan a budget	/4
Food Product Development	Food product/lunch <b>well</b> prepared, processed and package as per order with consideration of	Food product/lunch prepared, processed and package as per order with <b>little</b> consideration of	Food product/lunch was <b>not well</b> prepared, processed and package as per order with little	Food product/lunch <b>lacked</b> 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 <b>well organized</b> and logically presented with tasks delegated well. Awareness messages were delivered with in-depth knowledge, creativity and confidence. <b>Exceptional</b> selling skills/techniques displayed, food sold and sales techniques maturely evident	Awareness was <b>satisfactorily</b> 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 <b>partially</b> 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 <b>difficult to organize</b> . 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 <b>correctly</b> , checked and all balanced well. No outstanding/ uncollected money	Figures entered <b>correctly with minor errors</b> identified, checked and all balanced. No outstanding/ uncollected money	Figures were entered however, <b>food was sold on credit</b> resulting in the delay of recouping all money for the records to be entered, checked and balanced	Figures were entered however, some <b>money was not accounted for</b> , made losses and outstanding money was not accounted for	/4
Evaluation	All aspects of the project was <b>well</b> discussed and evaluated, a thorough report finalized and presented in the correct layout and on time	The overall project was <b>fairly</b> discussed and evaluated, a general report finalized and presented on time	The project report was <b>partially</b> finalized and submitted with information gaps and recommendations that lack the basis of the project	The project report was <b>incomplete</b> and lack information and was not satisfactory compiled	/4
Folio Compilation and Submission	The folio contained <b>all</b> the requirements of the project in a logical order, was <b>well documented</b> and submitted on time	The folio contained <b>most</b> of the requirements of the project, was documented and submitted on time	The folio was <b>adequately</b> complied, some sections lacked details of the project and submitted after the due date	Folio <b>lack sufficient</b> 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 <b>accurate</b> results on time	Participants were knowledgeable and provided <b>satisfactory</b> results on time	Participants completed <b>some</b> tasks with care. Others were incomplete and needed help	Participants attempted to complete <b>few</b> tasks, and not all were attempted. Lack of motivation	3/4
Survey Results and Recommendations	Questionnaires provided <b>precise</b> answers, <b>well-structured</b> information compiled, analyzed and logically presented	Questionnaires provided answers and information <b>satisfactorily</b> compiled, analyzed and presented	Questionnaires provided <b>partial</b> answers and some were irrelevant to topic and purpose	Questionnaires provided very <b>few</b> answers, information <b>incomplete</b> , not presented in a logical manner	4/4
Food Product Development Planning	Menus and recipes are <b>well-structured</b> and contain precise instructions with nutritional considerations	Menus and recipes are of the <b>correct layout</b> with nutritional considerations	Menus and recipes are correctly structured, but <b>some had information gaps</b>	Menus and recipes are poorly structured but noted for <b>incomplete information</b>	2/4
Technology Application	Successful uploading of information on social media accommodating <b>smart marketing strategies</b> and attracted many customers. Display good team work	Successful uploading of information on social media. Able to employ <b>some marketing strategies</b> to convince customers to buy food product or place food orders	Successful attempts to connect on social media. <b>Lack marketing skills</b> but attracted customers	Struggled with social media. Encountered problems getting started but convinced <b>only a few</b> customers and shows less team work	3/4
Costing and Budget	Have an <b>in-depth</b> understanding on calculating food costs and develop realistic and reliable budget	Have <b>basic</b> understanding on calculating food costs and skills of budgeting	Have <b>partial</b> understanding on calculating food costs per portion, completed a budget plan with figures that seem exaggerated and unreal	Encountered <b>difficulty</b> in calculating food costs per portion and struggled to plan a budget	3/4
Food Product Development	Food product/lunch <b>well</b> prepared, processed and package as per order with consideration of	Food product/lunch prepared, processed and package as per order with <b>little</b> consideration of	Food product/lunch was <b>not well</b> prepared, processed and package as per order with little	Food product/lunch <b>lacked</b> 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 <b>well organized</b> and logically presented with tasks delegated well. Awareness messages were delivered with in-depth knowledge, creativity and confidence. <b>Exceptional</b> selling skills/techniques displayed, food sold and sales techniques maturely evident	Awareness was <b>satisfactorily</b> 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 <b>partially</b> 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 <b>difficult to organize</b> . 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 <b>correctly</b> , checked and all balanced well. No outstanding/ uncollected money	Figures entered <b>correctly with minor errors</b> identified, checked and all balanced. No outstanding/ uncollected money	Figures were entered however, <b>food was sold on credit</b> resulting in the delay of recouping all money for the records to be entered, checked and balanced	Figures were entered however, some <b>money was not accounted for</b> , made losses and outstanding money was not accounted for	3/4
Evaluation	All aspects of the project was <b>well</b> discussed and evaluated, a thorough report finalized and presented in the correct layout and on time	The overall project was <b>fairly</b> discussed and evaluated, a general report finalized and presented on time	The project report was <b>partially</b> finalized and submitted with information gaps and recommendations that lack the basis of the project	The project report was <b>incomplete</b> and lack information and was not satisfactory compiled	4/4
Folio Compilation and Submission	The folio contained <b>all</b> the requirements of the project in a logical order, was <b>well documented</b> and submitted on time	The folio contained <b>most</b> of the requirements of the project, was documented and submitted on time	The folio was <b>adequately</b> complied, some sections lacked details of the project and submitted after the due date	Folio <b>lack sufficient</b> information due to lack of teamwork, and, was submitted very late	3/4
<b>Total Mark</b>					<b>30/40</b>

## 2. How to Grade using the rubric

### Grading Rubrics

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

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### 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	<b>Advance</b> 76% - 100% 30 – 40 <b>A</b>	<b>Achieved</b> 46% - 75% 20-29 <b>B</b>	<b>Progressing</b> 26% - 45% 10 – 19 <b>C</b>	<b>Novice</b> 0% - 25% 0 – 9 <b>D</b>	<b>Scoring</b>		
Gathering information	Participants were well versed of the information and provided <b>accurate</b> results on time	Participants were knowledgeable and provided <b>satisfactory</b> results on time	Participants completed <b>some</b> tasks with care. Others were incomplete and needed help	Participants attempted to complete <b>few</b> tasks, and not all were attempted. Lack of motivation	3/4		
Survey Results and Recommendations	Questionnaires provided <b>precise</b> answers, <b>well-structured</b> information compiled, analyzed and logically presented	Questionnaires provided answers and information <b>satisfactorily</b> compiled, analyzed and presented	Questionnaires provided <b>partial</b> answers and some were irrelevant to topic and purpose	Questionnaires provided very <b>few</b> answers, information <b>incomplete</b> , not presented in a logical manner	4/4		
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Food Product Development	Food product/lunch <b>well</b> prepared, processed and package as per order with consideration of food safety	Food product/lunch prepared, processed and package as per order with <b>little</b> consideration of food safety	Food product/lunch was <b>not well</b> prepared, processed and package as per order with little consideration of food safety	Food product/lunch <b>lacked</b> the process of development, poor order done and no consideration of food safety	2/4
Outdoor Presentation – Nutrition Awareness and Lunch sale	Awareness was <b>well organized</b> and logically presented with tasks delegated well. Awareness messages were delivered with in-depth knowledge, creativity and confidence. <b>Exceptional</b> selling skills/techniques displayed, food sold and sales techniques maturely evident	Awareness was <b>satisfactorily</b> 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 <b>partially</b> 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 <b>difficult to organize</b> . Students' roles were not specified correctly. Disorganization was evident, Food sales was slow and showed lacked of coordination and team work	3/4
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	<b>well documented</b> and submitted on time	submitted on time	project and submitted after the due date	was submitted very late	
<b>Total Mark</b>					<b>30/40</b>

**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 on 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 <i>Sphingomonas elodea</i> ; 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

# Reference

Clarke, P., Compton, L., Keller, M., Stamenkovic, S., Valsamis, K., Ware. (2010). *Whole Food 2* Oxford

Clarke, P., Compton, L., Keller, M., Stamenkovic, S., Valsamis, K., Waren. (2010). *Whole Food 1* Oxford

Dengate, B., Ridgewell, T., Mortimer T., Braybon J., Hatch C. (1995) *Focus on Junior Food Technology*. Jacaranda Press.

Department of Education (2009), Design and Technology Lower Secondary Teacher Guides, Waigani: DOE

Grant, E., Fraser, P. (1994) *Food, Nutrition and People*: Jacaranda Press,

Heath, G., McKenzie, H., Tully, L. (2001). *Food Solutions: Food and Technology Units 3 & 4*

Henry, CJK., Chapman C. (2002). *The nutrition handbook for food processors*, 1<sup>st</sup> Edition. Woodhead Publishing Ltd.

International Food Information Council (2009). From farm to fork: Questions and answers about modern food production.

Weihen, L., Aduckiewicz., J, Amys, J. (1995). *Investigating Food Technology*: Rigby Heinemann,

MacEvelly, C., Peltola, K (2003). *The effect of agronomy, storage, processing and cooking on bioactive substances in food*. Blackwell Publishing Ltd.

Mills EN, et al. (2009). *Impact of food processing on the structural and allergenic properties of food allergens. Molecular Nutrition & Food Research* 53(8):963-969.

Norman, P., Vagi, L. (2010) *Text Book Outcomes Edition for PNG Book 2*, Oxford

Sheehan, V., Hill, S. *Food Technology Preliminary Course*, (1997) Longman

Thompson, R., Thompson, B., Paterson, J., *Food Technology* Longmans Cheshire Ltd

Tull, A. (1996). *Food and Nutrition New edition in Colour*. Oxford University Press

Weihen, L., Aduckiewicz., J, Amys, J. (1995). *Investigating Food Technology*: Rigby Heinemann

# Appendices

## Appendix 1: 21<sup>ST</sup> Century Skills

<b>Ways of thinking</b>	<b>Creativity and innovation</b> <ul style="list-style-type: none"> <li>• Think creatively</li> <li>• Work creatively with others</li> <li>• Implement innovations</li> </ul> <b>Critical thinking, problem solving and decision making</b> <ul style="list-style-type: none"> <li>• Reason effectively and evaluate evidence</li> <li>• Solve problems</li> <li>• Articulate findings</li> </ul> <b>Learning to learn and meta-cognition</b> <ul style="list-style-type: none"> <li>• Self-motivation</li> <li>• Positive appreciation of learning</li> <li>• Adaptability and flexibility</li> </ul>
<b>Ways of working</b>	<b>Communication</b> <ul style="list-style-type: none"> <li>• Competency in written and oral language</li> <li>• Open minded and preparedness to listen</li> <li>• Sensitivity to cultural differences</li> </ul> <b>Collaboration and teamwork</b> <ul style="list-style-type: none"> <li>• Interact effectively with others</li> <li>• Work effectively in diverse teams</li> <li>• Prioritise, plan and manage projects</li> </ul>
<b>Tools for working</b>	<b>Information literacy</b> <ul style="list-style-type: none"> <li>• Access and evaluate information</li> <li>• Use and manage information</li> <li>• Apply technology effectively</li> </ul> <b>ICT literacy</b> <ul style="list-style-type: none"> <li>• Open to new ideas, information, tools and ways of thinking</li> <li>• Use ICT accurately, creatively, ethically and legally</li> <li>• Be aware of cultural and social differences</li> <li>• Apply technology appropriately and effectively</li> </ul>
<b>Living in the world</b>	<b>Citizenship – global and local</b> <ul style="list-style-type: none"> <li>• Awareness and understanding of rights and responsibilities as a global citizen</li> <li>• Preparedness to participate in community activities</li> <li>• Respect the values and privacy of others</li> </ul> <b>Personal and social responsibility</b> <ul style="list-style-type: none"> <li>• Communicate constructively in different social situations</li> <li>• Understand different viewpoints and perspectives</li> </ul> <b>Life and career</b> <ul style="list-style-type: none"> <li>• Adapt to change</li> <li>• Manage goals and time</li> <li>• Be a self-directed learner</li> <li>• Interact effectively with others</li> </ul>

## Appendix 2: Teaching and Learning Strategies

Strategy	Teacher	Students
<p><b>Case study</b> Used to extend students' understanding of real life issues</p>	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.
<p><b>Debate</b> A method used to increase students' interest, involvement and participation</p>	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.
<p><b>Discussion</b> The purpose of discussion is to educate students about the process of group thinking and collective decision.</p>	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.
<p><b>Games and simulations</b> Encourages motivation and creates a spirit of competition and challenge to enhance learning</p>	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 prizes.	Go into groups and organize. Follow the instructions and play to win
<p><b>Observation</b> Method used to allow students to work independently to discover why and how things happen as the way they are. It builds curiosity.</p>	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 <ul style="list-style-type: none"> <li>• Observe and ask essential questions</li> <li>• Record</li> </ul>

<p><b>Peer teaching &amp; learning</b> (<i>power point presentations, pair learning</i>) 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.</p>	<p>Distribute topics to groups to research and teach others in the classroom. Go through the basics of how to present their peer teaching.</p>	<p>• Interpret 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.</p>
<p><b>Performance-related tasks</b> (<i>dramatization, song/lyrics, wall magazines</i>) Encourages creativity and take on the overarching ideas of the topic and are able to recall them at a later date</p>	<p>Students are given the opportunity to perform the using the main ideas of a topic. Provide the guidelines, expectations and the set criteria.</p>	<p>Go into their established working groups. Being creative and create dramas, songs/lyrics or wall magazines in line with the topic.</p>
<p><b>Project</b> (individual/group) Helps students complete tasks individually or collectively</p>	<p>Teacher outlines the steps and procedures of how to do and the criteria.</p>	<p>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.</p>
<p><b>Use media &amp; technology to teach and generate engagement <u>depending on the age of the students</u></b></p>	<p>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.</p>	<p>Viewing can provoke questions, debates, critical thinking, emotion and reaction. After viewing, students engage in critical thinking and debate</p>

### 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?

<p>Students draw the <b>FIRST AID</b> SYMBOL here</p>
---

- 2) Explain what is safety?

- 
- 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.

<b>1. Planning Stage</b>	
<i>Item/Equipment/Tool</i>	<i>Injury that may occur</i>
<i>Name: _____</i> <i>(Drawing of the item/equipment/tool)</i>	1.
	2.
	3.
<i>Name: _____</i> <i>(Drawing of the item/equipment/tool)</i>	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.

<b>Injury</b>	<b>Action taken by student</b>
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.

<b>Project Name</b>	
<b>Total Unit (No of Project)</b>	

<b>Material List</b>				
<b>Quantity</b>	<b>Name of Material(s)</b>	<b>Description(s)</b>	<b>Unit Cost</b>	<b>Total Cost</b>

- 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)***

<b>No</b>	<b>Operations</b>	<b>Tools/Equipment Needed</b>
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%:  $(K75 - K50) / K50 = 0.50 \times 100 = 50\%$ .

## 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	<b>Idea Generation</b>										
	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	<b>Research</b>										
	a. Development of a survey questionnaire with a number of essential questions on their project ideas.										
	b. Safety for stages of <b>Planning, Prototyping, Production and Marketing.</b>										
	i. Draw safety precaution sign.										
	ii. Tool/items and injuries that may occur.										
	iii. Injuries and actions taken by students.										
3	<b>Planning</b>										
	a. Identify the various ways to cook them and find out ways to improve the taste for their intended project dish										
4	<b>Prototyping</b>										
	a. Select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards.										
5	<b>Production</b>										
	a. Select the materials according to the descriptions of materials needed for their project.										
6	<b>Costing</b>										
	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.								
<b>7</b>	<p><b>Marketing</b></p> <ul style="list-style-type: none"> <li>a. Review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project.</li> <li>b. Create promotional webpages on social media to market the product.</li> </ul>								

### A Sample Peer Student Assessment

Student Self-Assessment/Teacher Assessment											Date: / /									
Project Name:											Term:									
Student Name:							Grade:				Total									
Peer's Name:							Class:				Score: /									
							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	<b>Idea Generation</b>																			
	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	<b>Research</b>																			
	a. Development of a survey questionnaire with a number of essential questions on their project ideas.																			
	b. Safety for stages of <b>Planning, Prototyping, Production and Marketing.</b>																			
	i. Draw safety precaution sign.																			
ii. Tool/items and injuries that may occur.																				
iii. Injuries and actions taken by students.																				
3	<b>Planning</b>																			
	a. Identify the various ways to cook them and find out ways to improve the taste for their intended project dish.																			
4	<b>Prototyping</b>																			
	a. Select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards.																			
5	<b>Production</b>																			
	a. Select the materials according to the descriptions of materials needed for their project.																			
6	<b>Costing</b>																			
	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.													
<b>7</b>	<b>Marketing</b>													
	<ul style="list-style-type: none"> <li>a. Review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project.</li> <li>b. Create promotional webpages on social media to market the product.</li> </ul>													

## ***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.

<b>Subjects</b> <i>(List of related Subjects)</i>	<b>Benchmarks</b> <i>( List the nominated Benchmarks Codes)</i>	<b>Essential KSAVs</b> <i>(Unpack and list the specific KASVs for each of the Subject Benchmarks )</i>

### **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**

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

### 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**

<b>Category</b> ( <i>Copy and paste Table 1 – Column 1</i> )	<b>Task Description</b> ( <i>Copy and paste Table 1 –Column 2</i> )	<b>Essential KSAVs</b> ( <i>Unpacked Task Description KSAVs</i> )

### 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**

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

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.





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