SECTION SIX: PLANNING AND TEACHING INTEGRATED STEM

Sometimes planning, programming, and teaching integrated STEM approach is challenging.

However, will look at different approaches to planning, programming, and teaching integrated STEM so you have some fair idea on how it can be done in your own context.

To begin with programming, consider the following:

- What are the desired goals or learning standards - content standards and benchmarks are students working towards
- From the anchor subjects with their identified learning standards, identify the curriculum connections
- Identify STEM or subject practices such as inquiry, design process, etc. to be used
- Identify the activities in the unit of work or STEM project that connects to real-life situations.
- Identify the type of 21st century skills required
- What are the types of technologies required to enhance learning
- What is the purpose of the unit of work, STEM Project or topic or learning experience?
- Which learning experiences will assist students to develop their knowledge and understandings, skills, values and attitudes?
- What are the indicators/evidence of student learning that you would expect to observe?
- How can the learning experiences be sequenced?
- How do the learning experiences relate to students' existing knowledge and skills?
- How are individual learning needs to be catered for?
- What are the knowledge demands of the learning experience?
- Do the assessment methods address the learning standards and enhance the learning?
- How can the assessment be part of the learning and teaching program?

We will look at different approaches of how to plan and teach integrated STEM approach using the PNG curriculum and identify all connections. The teaching plan should be sequential and student-centered. Most of the different approaches take into consideration the following common areas:

- Identification of the desired outcomes – learning standards(content standards and benchmarks)
- Identifying and sequencing the different teaching and learning activities involved
- Identifying the different assessment strategies for each activity or group of activities or project

- Consideration of all the connections – connections across disciplines or key learning areas of the curriculum, STEM practices, real-world situations/problem, 21st century skills, Technologies

APPROACH ONE (1): Programming Integrated STEM

An integrated STEM program is a detailed plan developed by teachers to manage teaching and learning activities for their students throughout the year. The main purpose of programming integrated STEM is to help teachers arrange the content of the STEM disciplines by developing a year plan and weekly programs.

A year plan, broken into terms, should show when all of the learning standards for each STEM subject will be taught. Because an integrated STEM approach to programming is recommended, STEM learning standards that link naturally together should be clustered and described through STEM themes that show the linking concept.

The STEM themes for each term are broken down on a week-by-week basis for the four school terms.

Weekly STEM programs detail teaching, learning and assessment activities for each week.

Samples of integrated STEM program appear below or in the integrated STEM Units of Work.

Developing an integrated STEM program

Programs are developed in many different ways around broad and common learning concepts. These concepts are identified in the learning standards from all the subject syllabuses that includes STEM subject syllabuses as well. We will focus on integrated units of work instead of a unit of work for a single subject. In the integrated units of work we will use more than one learning standards to form a unit. Using the integration approach:

- learning is planned by connecting common concepts within or across STEM subjects including other subjects as well
- students' learning needs should relate to real-world problems or projects
- new learning experiences are built on past experiences
- learning is focused around a familiar environmental context
- provides opportunities for a wide variety of student-centred activities
- encourages the use of local resources, technologies and the 21st Century Skills to be used for learning

Planning of the integrated programs is done with the view to encourage teachers to link community activities, subject practices, curriculum learning standards, real-world problems or projects, local resources, technologies and the 21st Century Skills to student's learning and experiences.

Characteristics of a good integrated program

An effective integrated program:

- maintains a focus on learning standards, showing what students must know and do to achieve the learning standards
- uses time flexibly, so that students with different needs can develop understanding and demonstrate specific outcomes over a period of time
- uses a variety of teaching and learning strategies so that teachers act as facilitators of learning and cater for different learning styles and individual needs of students
- emphasizes the development of knowledge, skills and attitudes that promote lifelong learning
- provides opportunities for students to become effective, self-directed learners
- enables students to learn in a range of contexts
- supports learning through the use of a variety of texts, media and real life materials and resources
- shows the links between the learning standards(content standards, benchmarks), teaching and learning activities and assessment tasks.

When programming, teachers should also take into consideration the following:

- providing a balance of activities including projects, practical work and assignments
- students' needs and interests
- the community calendar
- unplanned events
- holidays
- major school activities.

Developing a year integrated plan

Below is a process or a set of steps to help you develop your yearly-integrated plan.

You may modify it according to your needs.

Process for developing yearly-integrated plan

1. Study all syllabuses and teacher guides for each grade or level. Become familiar with the strands, units, topics and learning standards – content standards, benchmarks, performance standards, evidence outcomes.

2. Teachers from the same grade or level can work together to cluster all of the learning standards from all the subjects including the STEM subjects into small clusters of about 4 or more learning standards.
   These clusters can be integrated across 2—3 subjects. Some of those are integrated STEM subjects. The learning standards must link naturally together through a common concept, a connecting idea, or a theme.
3. Record these clusters of learning standards on paper.
   Take note of those clusters of learning standards that integrate mainly across most STEM subjects.
4. Crosscheck which learning standards you have used. You may need to repeat some learning standards more than once so that students develop these skills to a sufficient level. This is particularly true for subjects like English, Science, Arts and Mathematics.
5. Identify a theme or connecting idea for each cluster and record it next to the cluster. For those integrated STEM clusters of learning standards, identify a STEM theme or STEM connecting idea. Identify teaching and learning activities, real-world problems or projects or STEM challenges and assessment tasks that link to the STEM theme and the learning standards in each STEM cluster.
6. Some learning standards will not group into clusters easily and these can be taught on their own.
7. Decide on an appropriate month and week in the year to teach each theme including the STEM themes and separate learning standards. You may decide to teach the separate learning standards in the same week as a unit of work by setting blocks of time aside in that subject.
8. Now fill in the year plan that includes all the themes with the **integrated STEM themes and standalone learning standards.**

Below are some sample clusters of learning standards that have been linked through themes and STEM themes. These clusters have been sequenced into a yearly **integrated** program and appear later in the sample yearly **integrated** program.

Sample cluster of content standards from Grade 3 learning standards across the curriculum

Subject	**Content Standards**
Theme: Interaction and Relationship	
Science	3.1.4 Investigate and describe the interaction between living and non- living things in the environment.
Mathematics	3.2.4 Understand the value of various notes and coins as part of a unit and multiples of unit money and solve various money problem situations.
Arts	3.2.1 Listen to a variety of sounds in the environment. Discuss, imitate and respond to these sounds. 3.2.5 Create a dance routine using various dance genres, styles and techniques to tell a story.

	3.2.7 Create a role-play using different drama genres with animal characters.
Social Science	3.1.1 Understand and recognise changes in groups and the local community 3.1.2 Demonstrate an understanding of the interactions between individuals and groups *3.4.1 Describe the environment of the local area* 3.4.2 Identify the resources in the community
English	3.1.3a Express ideas and opinions clearly and confidently using appropriate grammar, vocabulary, tone and projection in appropriate manner. 3.1.3b Use appropriate descriptive language and body gestures to express personal feelings about familiar topics. 3.2.5a Read a range of texts containing familiar ideas and information and respond appropriately.

Identify teaching and learning activities, real-world problems or projects or challenges and assessment tasks that link to the theme and the learning standards in each cluster. Consider the learning standards in each cluster or theme, and proposed real-world problems or projects or STEM challenges if required. Take into consideration, subject practices, curriculum learning standards, real-world problems or projects, local resources, technologies and the 21st Century Skills to student's learning and experiences.

Sample cluster of content standards and benchmarks from Grade 9 learning standards across the curriculum

Subject	**Content Standards & Benchmarks**
THEME: TECHNOLOGIES	
Science	Benchmark 9.1.1.1 Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data.
Mathematics	9.3.3.4 Solve linear simultaneous equations, using algebraic and graphical techniques including usage of digital technology.
Arts	Content Standard 1: Students will be able to analyse and comprehend different music theories and practices by examining music elements, techniques, genres, instruments, history, and technologies, explain how these influence the creation of compositions and a varied repertoire of music, and designing and interpreting of art, and discuss the importance of promoting safe practices and addressing ethical issues related to music Content Standard 3: Students will be able to explore and reflect on the principles underlying visual arts, examine and explain creative or artistic thinking, investigate the techniques of art and artistic design process used in creating two-dimensional (2D) and three-dimensional (3D) artworks to communicate ideas and solve problems using technologies, and

	reflect on the importance of visual arts safety rules and practices, and ethical issues.
Technology & Industrial Arts	9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work Content Standard 4.1 Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks. Content Standard 4.2 Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society. 9.4.2.3 Identify effects of the widespread use of computers and associated technologies on society Content Standard 5.1 Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues. Content Standard 5.2 Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software. 9.5.2.1 Explore programming software and applications 9.5.2.2 Demonstrate the understanding of Operating Systems/ Software and File Management
English	Content Standard 6: Students will be able to use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. 9.2.6.1: Appreciate technology, including the Internet, to produce, publish, and update individual or shared writing products.
THEME: SUBJECT PRACTICES	
Science	9.1.1.2 Formulate explanations by using logical thinking and evidence. 9.1.1.3 Distinguish between hypothesis and theory as scientific terms. **SUBJECT PRACTICE(S)** • scientific inquiry
Mathematics	9.3.3.3 Apply and interpret linear relation modelling practical situations. 9.4.4.4 Compute probabilities using appropriate methods such as lists and tree diagrams or through experimental or simulation activities.

	SUBJECT PRACTICE(S) • Mathematical thinking, problem-solving processes, and methods • Mathematical Modelling • Statistical inquiry
Arts	9.3.3.6 Design and create an installation art prototype using the creative and critical analysis processes and thinking skills together with available materials to reflect a theme. **SUBJECT PRACTICE(S)** • Creative and critical analysis processes and thinking skills • artistic design process or artistic thinking
Technology & Industrial Arts	9.2.2.6 Apply the design process to create food solutions. Content Standard 3.2 Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs. 9.3.5.6 Outline management and problem solving skills using the engineering design process. **SUBJECT PRACTICE(S)** • Design brief • Engineering design process • Technology design process • Design Thinking
Social Science	9.1.4.1. Investigate different physical systems (and processes), including their inputs, throughputs, and the outputs **SUBJECT PRACTICE(S)** • geographic processes • systems of power, authority and governance
English	9.2.4.2: Analyse the processes of writing, planning, drafting, revising, editing, and rewriting 9.2.8.2: Implement the writing process successfully to plan, revise and edit written work. 9.5.5.3: Write well-organized essays, summaries, and reports on a broad range of topics including those that have been personally researched using authentic texts. **SUBJECT PRACTICE(S)** • Processes of writing, planning, drafting, revising,

	editing, and rewriting • writing process

Yearly-integrated program

The table below shows how to sequence all of the learning standards from all the subject syllabuses in each grade or level into a sample yearly integrated program, broken down into terms. All the clusters of learning standards in each theme and even individual learning standards have been time-tabled into weeks of the year when it is most appropriate to teach them.

Sample yearly-integrated program

Grade : 9 **Year:**

Week	**Term 1**	**Term 2**	**Term 3**	**Term 4**
1	Enrollment			National Education Week
2				
3	**Unit 2** **Subject Practices**			
4			National Book Week	
5			**Unit 11** **Technologies**	
6				
7				
8				
9			Literacy week	
10			Independence Celebrations	
11				
Learning standards not in the clusters				

Note: As an example, a sample of only two themes or units is inserted in the yearly integrated program. However, you could have more units depending on how you have clustered the number of linked learning standards per cluster.

Learning standards that are not clustered must be included in the yearly integrate program. They should be planned and programmed at appropriate times of the year as separate lessons.

The national events included in the program are to be planned as school programs or activities.

Integrated Units of work

An integrated unit of work is a set of sequenced teaching and learning activities with assessment tasks, designed to help students achieve selected learning standards within a specific time frame.

Process for developing integrated units of work

The following ten step process will guide teachers in their planning and developing of integrated units of work. Some teachers may start at different steps in the process. For example, they may reverse the order of Steps 2 and 3, but eventually all steps will be covered. When the unit is completed, you should reflect on the success of the unit and make improvements if you plan to use it with another group of students in a following year.

1. **Study the learning standards**
   Look at the learning standards for all the subjects in a grade if planning an integrated unit of work. Look at the learning standards from one subject only if planning a unit of work for one subject.

2. **Cluster learning standards**
   Cluster a small group of learning outcomes (about four) from across the subjects that link naturally together.

3. **Identify a theme**
   Identify a theme to describe the natural links between the cluster of learning standards.
   Take note of those clusters of learning standards that integrate mainly across most STEM subjects.
   For those integrated STEM clusters of learning standards, identify a STEM theme or STEM connecting idea.
4. **State the purpose of the integrated unit of work**
   Summarise in two or three sentences what students will learn during this integrated unit of work. Refer to the learning standards.
5. **Identify the knowledge, skills, values, attitudes and 21st Century Skills**
   Use the benchmarks and performance standards from the syllabuses and the learning and lesson objectives from the Teacher Guide to identify the knowledge, skills, values and attitudes for the cluster of learning standards. Also, identify the 21st century skills.
6. **Develop teaching and learning activities and assessment tasks**
   Develop relevant teaching and learning activities and assessment tasks that help students to learn and demonstrate the knowledge, skills, values, attitudes and 21st Century Skills.
   Identify subject or STEM practices such as inquiry, design process etc., technologies, problems or challenges, curriculum connections and 21st Century Skills when planning your teaching and learning activities and assessment tasks.

For the STEM themes, identify teaching and learning activities, real-world problems, or projects or STEM challenges and assessment tasks that link to each STEM theme and the learning standards in each STEM cluster.

7. **Estimate the time**
   Identify how many weeks it will take to teach the integrated unit of work.
8. **Develop a weekly teaching program**
   Use your own programming format to develop a weekly program.
9. **Identify relevant resources, technologies and materials**
   List the resources, technologies, and materials needed to teach the integrated unit of work.

Sample integrated unit of work

An integrated unit of work helps the teacher:

- identify subject or STEM practices such as inquiry, design process etc., technologies, problems or challenges, curriculum connections and 21st century skills . The problems or challenges can be real-world problems or projects or STEM challenges that link to the learning standards in each theme or unit.
- identify knowledge, skills,values and attitudes that the students need to develop
- write suitable learning activities and assessment tasks for each theme
- make sure that assessment tasks allow students to demonstrate the knowledge, skills, values and attitudes given in the learning standards
- identify locally relevant resources and technologies for the integrated unit of work
- plan the activities to cater for the duration of the integrated unit.

The following sample integrated unit of work is planned for two weeks – Weeks 3 and 4 of Term 1 (see Year integrated Program). Steps 1 and 2 have been done during the planning of the year program. This sample integrated unit of work starts at step 4 where the purpose is identified for the integrated unit of work.

Grade: 9 **Term: 1** **Weeks: 3 & 4**

Learning Standards

Subject	**Strand**	**Unit**	**Learning standards**
Science	SCIENCE AS INQUIRY	Scientific Tools and Technology	9.1.1.2 Formulate explanations by using logical thinking and evidence. 9.1.1.3 Distinguish between hypothesis and theory as scientific terms.
Mathematics	Patterns and Algebra Statistics and		9.3.3.3 Apply and interpret linear relation modelling practical situations.

	probability		9.4.4.4 Compute probabilities using appropriate methods such as lists and tree diagrams or through experimental or simulation activities.
Arts	Visual Arts		9.3.3.6 Design and create an installation art prototype using the creative and critical analysis processes and thinking skills together with available materials to reflect a theme.
Technology & Industrial Arts	FOOD TECHNOLOGY CONSTRUCTION TECHNOLOGY COMPUTER TECHNOLOGY	Food Science Electrical Technology Engineering Technology Computer Architecture	9.2.2.6 Apply the design process to create food solutions. Content Standard 3.2 Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs. 9.3.5.6 Outline management and problem solving skills using the engineering design process. 9.5.1.3 Investigate and describe the design brief of solving problems.
Social Science	Geography	People and Environment	9.1.4.1. Investigate different physical systems (and processes), including their inputs, throughputs, and the outputs.
English	Writing	Research to Build and Present Knowledge	9.2.8.2: Implement the writing process successfully to plan, revise and edit written work. 9.5.5.3: Write well-organized essays, summaries, and reports on a broad range of topics including those that have been personally researched using authentic texts.

Purpose

Each student should:

- understand and apply the subject or STEM practices or problem solving approaches such as inquiry, engineering design process, Mathematical modelling, writing process, etc during their learning activities
- apply those practices in solving real-world problems and constructing models and processes
- be knowledgeable and fast in finding most appropriate solutions to problems or projects
- relate those practices to everyday challenges

Knowledge, skills, values, attitudes, and 21st century skills

Subject	Learning standards	Knowledge	Skills	Values/Attitudes
Science **Strand:** SCIENCE AS INQUIRY **Unit:** Scientific Tools and Technology	9.1.1.2 Formulate explanations by using logical thinking and evidence. 9.1.1.3 Distinguish between hypothesis and theory as scientific terms.	Skills applied in a scientific research Steps used in a scientific research	Apply the skills involved in carrying out a scientific research Organise ideas and findings using logical thinking and evidence	Build confidence in ways of presenting findings scientifically
Mathematics **Strand:** Patterns and Algebra Statistics and probability	9.3.3.3 Apply and interpret linear relation modelling practical situations. 9.4.4.4 Compute probabilities using appropriate methods such as	Evaluate and understand linear relationship between two quantities as represented e.g. y = 2x + 3 and y = x + 5 and how important they are in practice	Interpret linear relationships between two quantities • Create linear relations between two quantities and graph on table of	Appreciate linear relations in everyday situations and consider the usefulness of linear relations of various quantities

	lists and tree diagrams or through experimental or simulation activities.		values and the line graph	in practice.
Arts **Strand:** Visual Arts	9.3.3.6 Design and create an installation art prototype using the creative and critical analysis processes and thinking skills together with available materials to reflect a theme.	creative and critical analysis processes ability to interpret critiques, decode visual messages	ability to interpret, make judgments, and express opinions on a work, and promotes respect for the work and opinions of others Thinking skills, imagination and exercise personal responsibility for specific tasks	Appreciate artworks, and understand their contexts.
Technology & Industrial Arts **Strand:** FOOD TECHNOLOGY CONSTRUCTION TECHNOLOGY COMPUTER TECHNOLOGY **Unit:** Food Science Electrical Technology	9.2.2.6 Apply the design process to create food solutions. Content Standard 3.2 Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	• Design brief • Engineering design process • Technology design process • Design Thinking • Welding techniques and cutting processes	ability to reason, to think critically and creatively, and to reflect on one's actions, hands-on laboratory activities which verify the scientific concepts ability to think critically about food production and related issues of food security or food shortage problem solving skills using the engineering design process Apply concepts, laws, principles and practices to solve problems in electrical technological environment to improve quality of life. • Apply the use of	empower students to act responsibly toward themselves, their families, their peers, and the larger society

Engineering Technology Computer Architecture	9.3.5.6 Outline management and problem solving skills using the engineering design process. 9.5.1.3 Investigate and describe the design brief of solving problems.		technology to manage electrical activities Freehand drawing and sketching, reading and interpreting graphics, pictorial and orthogonal drawings • Use text types to support the documentation of practical projects and processes including: procedure factual recount • Use a range of computer software applications to sketch ideas for simple structures • Read and interpret simple engineering drawings • Prepare reports to document experiments and processes undertaken in the development and production of practical projects skills and knowledge in setting up computers and software, model and simulate system and troubleshoot hardware and software	
Social Science **Strand:** Geography **Unit:** People and Environment	9.1.4.1. Investigate different physical systems (and processes), including their inputs,			

	throughputs, and the outputs.			
English **Strand:** Writing **Unit:** Research to Build and Present Knowledge	9.2.8.2: Implement the writing process successfully to plan, revise and edit written work. 9.5.5.3: Write well-organized essays, summaries, and reports on a broad range of topics including those that have been personally researched using authentic texts.	Research	Logical reasoning Analysing	Critical thinking

21st century skills

Considering overarching concepts of waste management, sustainability and food protection

The objective of this unit or theme on subject practices is for students to:

- understand and apply the different subject or STEM practices or problem solving approaches during their learning activities
- apply the practices in solving real-world problems and constructing models and processes
- be knowledgeable and fluent with the practices
- apply appropriate practice for each problem or project
- apply those practices in everyday life challenges or problems

The teaching and learning activities for the theme or unit requires students to understand and demonstrate with fluency their understanding in the following subject practices:

- scientific inquiry
- Mathematical thinking, problem-solving processes, and methods
- Mathematical Modelling

- Statistical inquiry
- Creative and critical analysis processes and thinking skills
- artistic design process or artistic thinking
- Design brief
- Engineering design process
- Technology design process
- Design Thinking
- geographic processes
- systems of power, authority and governance
- Processes of writing, planning, drafting, revising, editing, and rewriting
- writing process

Through the theme on subject practices and the teaching and learning activities, students should:

- Understand and describe the different practices
- Identify the differences in the different practices
- Identify the overlaps between the different practices
- Apply the different practices in different real-world problems and projects
    - ✓ A problem or project is given to demonstrate the understanding and application of each practice
    - ✓ For each practice applied in a given problem or project, students will explain and demonstrate their understanding at the different stages of each practice

- Explain the different stages of each practice for a given problem or project
- apply appropriate practice(s) for each given problem or project and identify the overlaps - intersections and connections between the practices within the given problem or project

Teaching and learning activities

- ✓ Apply scientific inquiry by following key science practices that enable students to understand the natural world and answer questions about it. Students become fully engaged in creative scientific thinking.
- ✓ Conduct a research on a topic for students make observations by describing objects and events, ask questions, plan their activities, gather information, test ideas and carry out investigations and deducing their own conclusions, communicate their understanding to others and consider alternative explanations
- ✓ Carry out scientific investigations (scientific inquiry) that involve asking and answering a question and comparing the answer with what scientists already know about the world.
- ✓ Know and understand tools and technology and apply these in different kinds of investigations.

- ✓ Develop explanations based on observations (evidence) and what they already know (scientific knowledge) about the world
- ✓ Know and apply scientific rules and safety in all science activities
- ✓ integrate algebra specifically for problem solving
- ✓ apply Mathematical Modelling and Statistical inquiry in problem solving
- ✓ engages students in the creative and critical analysis processes through problems or projects using traditional and contemporary mediums or technologies to enhance their learning and practices
- ✓ learn the elements of art and the principles of design at different levels of sophistication and meaning
- ✓ understand food processes and improve food products
- ✓ understanding of the physical, biological and chemical makeup of food and the responsibility towards safety, taste, acceptability when developing new food products
- ✓ think critically and creatively to reflect on one's actions and to act responsibly toward themselves, their families, their peers, and the larger society
- ✓ reinforce and enhance the student's knowledge of scientific principles and processes through the study of foods and nutrition
- ✓ The ability to think critically about food production and related issues of food security or food shortage may well lead to modifying recipes and creating nutritious food products and creating a whole new food environment that will still remain authentically Papua New Guinean
- ✓ understanding and application of electrical and electronic principles and the technological processes inherent in the production of products, services and systems in order to improve the quality of life
- ✓ Understand principles and characteristics of circuit functions and operations, the "design, application, installation, manufacturing, operation or maintenance of electrical/electronic(s) systems
- ✓ Safety precautions and dangers of working with electricity
- ✓ develop an understanding and appreciation of the nature and significance of engineering and its impact on society with an emphasis on the application of engineering methodology to become more technologically literate with in-depth experiences geared to career preparation
- ✓ develop deeper problem-solving skills
- ✓ develop critical thinking skills in ways that encourages students to become more discriminating with regard to technology and its impact on society
- ✓ develop knowledge and skills in the use of materials, tools and techniques related to structures and mechanisms through practical projects(small structures, small vehicles, a range of devices and appliances, robotics projects, electronic and mechanical control systems) that should reflect the nature of the Engineering and provide opportunities for students to develop specific knowledge, understanding and skills related to engineering
- ✓ comprehend in computer fundamentals, computer system design, data representation, Artificial Intelligence (AI) and computer electronics and robotics
- ✓ display skills and knowledge in setting up computers and software, model and simulate system and troubleshoot hardware and software

- ✓ understand the evolution of computers, explore and describe computer types, design ideas and solutions
- ✓ solve problems, describe the work and responsibilities of designers and the factors affecting their work, identify innovative, enterprising and creatively design ideas and solutions and understand the management strategies when developing design solutions
- ✓ explore and understand computer fundamentals and system designs which will prepare them for further learning in the next grade
- ✓ Gather information on a given topic from various sources and through writing, evaluate the reliability of each source from which information was collected on the given topic with justification and evidences and use the information collected from the most reliable source(s) to address the given topic
- ✓ Write well-organized essays, summaries, and reports on a broad range of topics including those that have been personally researched using authentic texts.

Process for developing assessment tasks in integrated units of work

1. Identify the assessment tasks from teaching and learning activities for the integrated unit of work.
2. Decide on the best assessment methods to gather information you need about the students' learning for this integrated unit of work.
3. Identify the most appropriate person to conduct the assessment task, that is, the teacher(s), students (self or peers), a community resource person or a combination of these.
4. Decide on the number of assessment tasks necessary to gather all the information you need.
5. Remember to keep it manageable for yourself and be fair to students.
6. Sequence these assessment tasks to line up with your teaching and learning activities. Decide the best time to assess students. Remember, you have to give them time to learn and practice the knowledge, skills and attitudes.
7. Include your assessment activities within your sequence of lesson

Sample assessment plan

Theme: Subject Practices **Term: 1** **Weeks: 3 & 4**

Learning standards (Content standards and benchmarks)	**Assessment methods**	**Assessment tasks**	**Assessment criteria**	**Recording methods**
Science	Conduct a	*Questionnaires*	Students to make	Visual

Strand: SCIENCE AS INQUIRY **Unit:** Scientific Tools and Technology	research on a local ecosystem	*Observation of students* *Talking with students* *Tests* *Student self-assessment* *Keeping records of practical work*	observations by describing plants and animals, ask questions, plan their activities, gather information and data, test ideas, carry out investigations, and deducing their own conclusions, communicate their understanding to others and consider alternative explanations.	representations Oral tasks Writing • Essays • Explanations • Case studies • Completing activity sheets • Concept maps • Assignments • Projects Presentations • Debates • Presentation of work • Presentation of findings • Interviews • Plays and role-plays • Sharing findings
Mathematics Strand: Patterns and Algebra Statistics and probability	apply Mathematical Modelling and Statistical inquiry using data collected in their investigation	Apply and interpret linear relation modelling practical situations	interpret linear relation modelling practical situations	Graphs with their interpretations
Technology & Industrial Arts Unity: Engineering Technology	Show fluency in the use of tools and technology during their investigation Apply problem solving skills using the engineering design process	Outline management and problem solving skills using the engineering design process.	Observation on use of tools and technologies Application and evidence of management and problem solving skills In the research or problem solving	Digital fluency checklist Checklist and journal showing records of the work done at each stage of the engineering design process
English Strand: Writing Unit: Research to Build and Present Knowledge	Use the science journal process to write a journal on their Investigation or research based on a local ecosystem	Gather information from the science Investigation or research and through writing, evaluate the	Written task Work	sample with comments by the teacher

	Write well-organized essays, summaries, and reports based on their research	reliability of each source from which information was collected base on the research with justification and evidences and use the information collected from the investigation to address the given science investigation		

Table shows some ways of assessing and how students can show evidence of learning

Some ways of Assessing are:	***How can students show what they have learned?***
• Student profile • Checklist • Running record sheets • Student folders ***Student records*** • Student profile • Student journal • Working in progress folders • Diaries ***Questionnaires*** • Oral • Written ***Observation of students*** • Informing Observation • Checklist and notes • Running record sheets • Watching working in progress • Systemic observation • Presentation to the class • Assembly ***Talking with students*** • Informal observation • Interview • Questioning individuals and small	**Processes and procedures** • Observing, identifying • Recognizing investigating • Classifying questioning, comparing, predicting, drawing conclusions, taking measures, putting forwards **Practical tasks** • Models • Displaying activities outside • Practical activity • Solving Problems • Applying concepts **Visual representations** • Posters, flow charts drawings • Diagrams, maps, tables • Graphs, paintings, labels *Research* • Small group research • Independent research • Conducting surveys and interviews **Oral tasks** • Answering questions • Explaining • Describing • Relaying information

groups • Asking open-ended questions • Telling stories • Listening to students explanations ***Tests*** • Practical • Written ***Student self-assessment*** • Group discussion • Concept mapping • Peer assessment • Self – assessment ***Keeping records of practical work*** • Models • Work samples • Class and group projects	• Asking questions • Interviewing **Writing** • Essays • Explanations • Case studies • Completing activity sheets • Concept maps • Assignments • Projects • Articles from newspapers **Presentations** • Debates • Presentation of work • Presentation of findings • Interviews • Plays and role-plays • Sharing findings • Observation with other classes

Sample weekly teaching and learning integrated program

Theme: Subject Practices **Term: 1** **Week: 3 (First week of the unit)**

	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
8 – 8: 15	**Assembly**				
8: 15 – 10:00	**Science** Science Journal	**Technology & Industrial Arts** Technological design process	**Technology & Industrial Arts** Design brief	**English** Write well-organized essays, summaries, and reports	**English** Write well-organized essays, summaries, and reports
	English writing process	**Mathematics** Apply and interpret linear relation modelling practical situations.	**Mathematics** Solve linear simultaneous equations, using algebraic and graphical techniques including usage	**Science** Research local ecosystem	**Science** Comparison between scientific inquiry, technological design process, engineering

			of digital technology.		design process, Mathematical modelling and statistical inquiry
Recess					
10:30 – 12:00	**Mathematics** Determine the slope and equation of a line when given the graph of a line, two points on the line, or the equation of the line.	**Mathematics** Apply and interpret linear relation modelling practical situations.	**Mathematics** Solve linear simultaneous equations, using algebraic and graphical techniques including usage of digital technology.	**Science** Research local ecosystem	**Mathematics** apply Mathematical Modelling and Statistical inquiry using data collected in their investigation
	Technology & Industrial Arts Technological design process	**Science** Scientific Research Skills	**Science** Using Mathematical Functions in Science, Importance of Hypothesis and or, Misconceptions in science classes	**Science** Research local ecosystem	**Technology & Industrial Arts** modelling using digital technology
Lunch					
1:00 – 3:00	**Science** Balances, Scales and Pulleys, Microscope	**Science** International System of Units (SI),Telling Locations, Topographic Maps, Controls and variables	**Science** Scientific inquiry process	**Mathematics** apply Mathematical Modelling and Statistical inquiry using data collected in their investigation	**Science** Comparison between scientific inquiry, technological design process, engineering design process, Mathematical modelling and statistical inquiry
	Mathematics Solve and sketch linear	**English** writing process	**Science** Scientific inquiry process	**Technology & Industrial Arts** Design brief and	**Science** Presentation of research report

	equations.			Engineering design process	

Example

Will use the learning standards for arts

Subject	Strand	Content Standard	Benchmark
Arts	Visual Arts	Content Standard 3: Students will be able to explore and reflect on the principles underlying visual arts, examine and explain creative or artistic thinking, investigate the techniques of art and artistic design process used in creating two-dimensional (2D) and three-dimensional (3D) artworks to communicate ideas and solve problems using technologies, and reflect on the importance of visual arts safety rules and practices, and ethical issues	9.3.3.6 Design and create an installation art prototype using the creative and critical analysis processes and thinking skills together with available materials to reflect a theme.

APPROACH TWO(2) : STEM ROAD MAP

Introduction

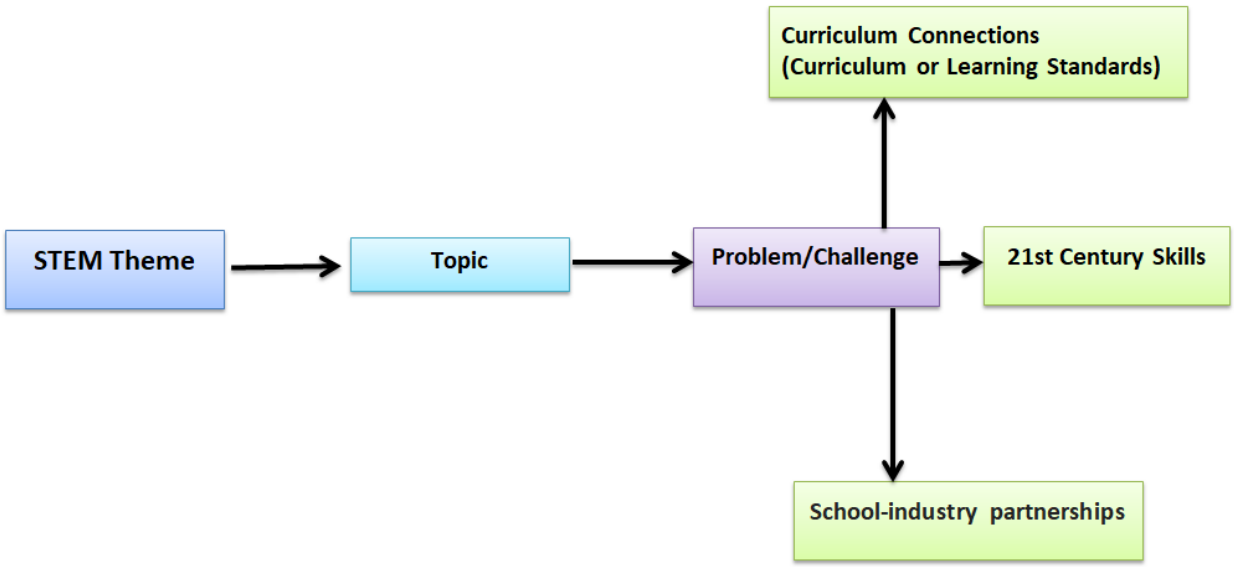
The STEM Road Map is an interdisciplinary approach to SETM education. STEM Road Map indicates that integrative STEM education require content knowledge from some STEM disciplines as well as content knowledge from other curriculum learning areas can be integrated with STEM. We suggest that you use the STEM Road Map for planning, programming, and teaching integrative STEM education if this interdisciplinary resonate with you.

Each STEM Road Map theme is intended for a number of weeks or lessons sequence of integrated instruction where the theme, topic and associated problem or project is enacted through a core

content area for each grade level, including the complete unit with all instructional and assessment materials.

The STEM Road Map for each school level or sector is aligned to Common Core Standards in the STEM disciplines including other disciplines as well and the 21st Century Skills and required technologies that will enhance learning. The enactment of the curriculum should be student-centered, facilitated in an integrated fashion, and taught by making explicit connections across multiple content areas.

The STEM Road Map identifies a STEM theme across a sector or school level. Based on the STEM theme, a topic per grade is identified and a problem or STEM challenge or project based on the topic is developed.



Each STEM challenge or problem is organized around one central topic inspired by one or more of the STEM Road Map themes. These topics not only align with the theme but also with grade level academic content standards (e.g. *Science Standards*).

Topics for each STEM Theme in the different grades are given and each of these topics is organized around a standards-based challenge, problem, or project that student teams are assigned to tackle in the course of learning necessary content and skills in the various disciplines (see Table 5.1) (Brian. L, Moore. T, Johnson. C & Roehrig. G, 2015).

	Grade EP – E2	**Grade 3 - 5**	**Grade 6 - 8**	**Grade 9 - 10**	**Grade 11 - 12**
STEM Theme	One STEM theme across all grades in each sector or school level	One STEM theme across all grades in each sector or school level	One STEM theme across all grades in each sector or school level	One STEM theme across all grades in each sector or school level	One STEM theme across all grades in each sector or school level

Topic	One topic per grade based on STEM theme	One topic per grade based on STEM theme	One topic per grade based on STEM theme	One topic per grade based on STEM theme	One topic per grade based on STEM theme
Problem/STEM Challenge	One Problem/STEM Challenge per grade based on topic	One Problem/STEM Challenge per grade based on topic	One Problem/STEM Challenge per grade based on topic	One Problem/STEM Challenge per grade based on topic	One Problem/STEM Challenge per grade based on topic
Curriculum Connections	Curriculum Connections per topic in each grade	Curriculum Connections per topic in each grade	Curriculum Connections per topic in each grade	Curriculum Connections per topic in each grade	Curriculum Connections per topic in each grade
21st Century Skills	21st Century Skills required per topic in each grade	21st Century Skills required per topic in each grade	21st Century Skills required per topic in each grade	21st Century Skills required per topic in each grade	21st Century Skills required per topic in each grade
Resources/ Technologies	Resources/ Technologies required per topic in each grade	Resources/ Technologies required per topic in each grade	Resources/ Technologies required per topic in each grade	Resources/ Technologies required per topic in each grade	Resources/ Technologies required per topic in each grade
Professionals or experts: School – industry partnership	School – industry partnership: Professionals or experts required per topic in each grade	School – industry partnership: Professionals or experts required per topic in each grade	School – industry partnership: Professionals or experts required per topic in each grade	School – industry partnership: Professionals or experts required per topic in each grade	School – industry partnership: Professionals or experts required per topic in each grade

The STEM Road Map requires teachers in their planning to consider the following:

1. Identify a STEM theme for each sector or school level
   Teachers can use the SDGs, indicators and Goals and Aims, school context, real-world problems or projects to develop STEM themes
2. Identify a topic for each grade relevant to the STEM theme
3. Construct a problem or a STEM Challenge or a STEM project based on each topic
4. Identify curriculum connections or learning standards that link to each topic and the problem/challenge.
5. Develop teaching and learning activities – identify the teaching and learning activities in your teaching plan or program. The teaching plan should consider:
   - Connections to the 21st Century Skills
   - Connections with professionals or experts: School – industry partnership

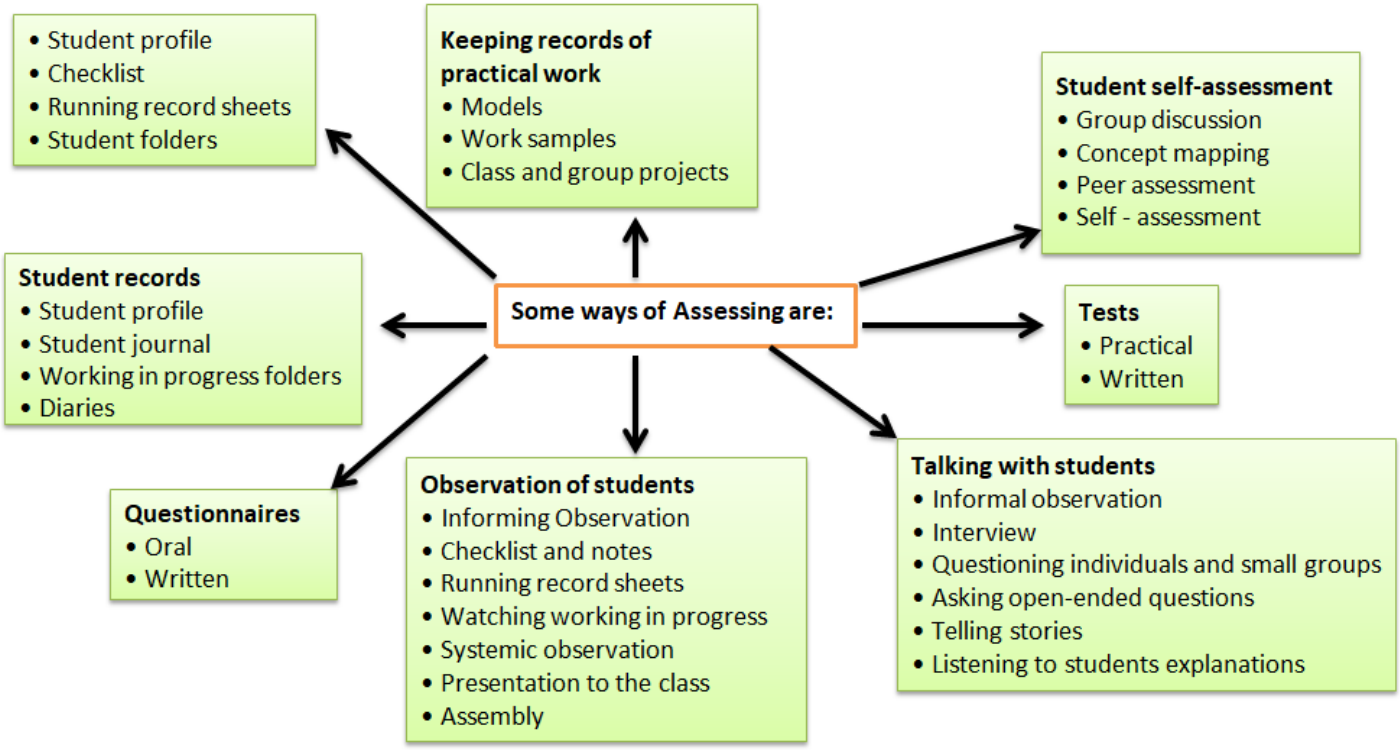
- Connections to resources/ Technologies

6. Identify the types of assessment involved

Methods of Assessment

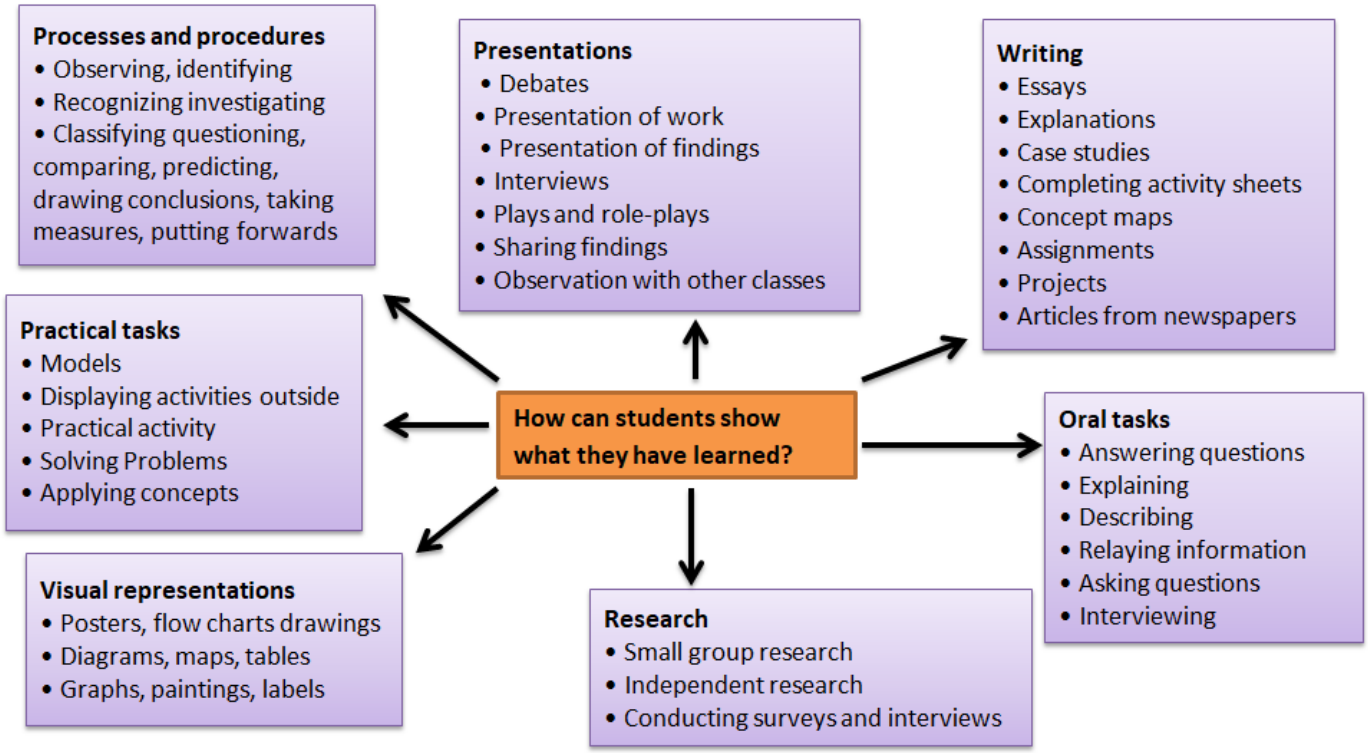
STEM Assessment strategies should take into consideration strategies for assessing both the process of developing a product or finding a solution (Process Assessment Strategies) and strategies for assessing the final product (Product Assessment Strategies).

Assessment is an integral part of students learning. A variety of assessment methods can be used to gather assessment information. Some of these methods are summarized in the diagram below.



Assessment Tasks

Assessment is an integral part of students learning and can be demonstrated in many ways. Teachers should use different ways to collect assessment information. Below are some examples:



Students should show evidence of learning using some of the ways shown in fig 7.

STEM ROAD MAP FOR GRADES 3–5

Brian. L, Moore. T, Johnson. C & Roehrig. G, (2015) proposed the STEM Road Map as a STEM learning approach or integrated STEM approach for elementary and lower primary school level.

Learning and teaching STEM at the elementary school level means providing students with multiple opportunities to develop scientific understandings and related practices necessary to function productively as problem-solvers in a scientific and technological world. Allowing elementary school

students to explore, experiment, or investigate while modeling, reasoning, and communicating affords students the opportunity to build curiosity, increase interest, and, moreover, construct and apply new scientific knowledge to real-world problems (NRC, 2005).

This is critically important at the lower primary school level (defined here as grades 3 through 5) because students' thought processes become more mature and they start solving problems in a more logical fashion as well as incorporating inductive reasoning (Piaget & Inhelder, 1973). From a STEM perspective, this means that teachers must consider innovative ways to engage grade 3–5 students in a more student-centered, collaborative, hands-on, problem based approach to learning while integrating disciplinary core ideas, scientific and engineering practices, and critical thinking across multiple subject areas.

According to Brian. L, Moore. T, Johnson. C & Roehrig. G, (2015), the STEM Road Map for grades 3–5 is anchored in the five STEM themes:

1. Cause and Effect
2. Innovation and Progress
3. The Represented World
4. Sustainable Systems
5. Optimizing the Human Experience

Each STEM Road Map theme is intended for a five-week sequence of integrated instruction where the theme and associated problem or project is enacted through a core content area providing an example of a five-week module for each grade level, including the complete unit with all instructional and assessment materials. The STEM Road Map for grades 3–5 is aligned to Common Core Standards in Mathematics, Common Core Standards in English, Arts, Science Standards and the 21st century skills. The enactment of the curriculum should be student-centered, facilitated in an integrated fashion, and taught by making explicit connections across multiple content areas.

SAMPLE STEM THEMES FOR GRADES 3–5

Before mapping out an integrated approach to learning STEM, it is important to consider what students have learned and experienced prior to entering each grade. For example, in the second grade, students are expected to develop a more informed understanding of plants, different habitats, properties of materials, Earth events, and factors that contribute to Earth events. In addition, students in second grade develop and use models, plan and carry out investigations, analyze and interpret data, construct explanations, and design solutions.

Using this newly acquired knowledge, students in third grade extend their existing ideas and conceptions in life, physical and earth and space sciences by engaging in one or more problem based

challenges. Each challenge is organized around one central topic inspired by one or more of the STEM Road Map themes. These topics not only align with the theme but also with grade level academic content standards (e.g. *Science Standards*). Topics for each STEM Theme in the different grades are given and each of these topics is organized around a standards-based challenge, problem, or project that student teams are assigned to tackle in the course of learning necessary content and skills in the various disciplines (see Table 5.1) (Brian. L, Moore. T, Johnson. C & Roehrig. G, 2015).

The five overarching STEM themes continue to be reinforced and spiraled from the early, elementary grades. For example, the STEM theme *Sustainable Systems* challenges students to investigate the interaction of different components of a larger system and explore ways the system can be sustained over time. Students in grades 3–5 can do so by examining the interactions among living and non-living things in an aquarium/terrarium, the study of renewable energy, and the process of making compost as shown in **TABLE 5.1** (Brian. L, Moore. T, Johnson. C & Roehrig. G, 2015).

Grades 3 -5 STEM Road Map Themes, Topics, and Problems/Challenges

STEM Theme	Grade	Topic	Problem/Challenge
Cause and Effect	3	Predicting the Weather LEAD Mathematics	Student teams will create a local weather forecast in either a video or a blog by making predictions based on collected data and observations.
	4	Field Station Mapping LEAD Social Studies	Student teams will create a plan for the construction of a safe and accessible station to conduct research on predicted volcano activity.
	5	Schoolyard Engineering LEAD Mathematics	Student teams will design a movable awning for a picnic table located on the schoolyard that provides enough shade throughout recess for students and adults.
Innovation and Progress	3	Transportation in the Future LEAD Social Studies	Student teams will design a model of a high-speed train that will safely transport passengers.
	4	Harnessing Solar Energy LEAD Science	Student teams will design, construct, and test a system that removes salt from saltwater using solar energy that could be used for their selected region of the world.
	5	Interactions LEAD Social Studies	Student teams will develop a proposal (using multimedia visual display) for the location of a wind turbine in their assigned region.
The Represented World	3	Recreational STEM LEAD Science	Student teams will conduct a survey of their school playground or a nearby park or playground and develop a proposal for

			design of a new swing set that is both more entertaining, yet a safer environment for play.
	4	Erosion Modeling LEAD Mathematics	Student teams will create a model to demonstrate the impact of soil erosion around their school and communicate the problems associated with soil erosion in a blog.
	5	Rainwater Analysis LEAD Mathematics	Student teams will design a rainwater harvesting system for their school.
Sustainable Systems	3	Ecosystem Preservation LEAD Science	Student teams will develop a plan to preserve the local ecosystem.
	4	Hydropower Efficiency LEAD Science	Student teams will develop a three-dimensional model or a computer-assisted image that demonstrates how an engineer may optimize the efficiency of a dam.
	5	Composting LEAD Science	Student teams will design a compost system for their school's cafeteria that makes use of excess food and food waste that is disposed of each day.
Optimizing the Human Experience	3	Reducing our Footprint LEAD Language Arts	Student teams will develop a plan for more environmentally friendly transportation methods at their local school.
	4	Water Conservation LEAD Language Arts	Student teams will develop informational materials for their school and community focused on water conservation generally and decreasing the use of bottled water specifically by use of filtration methods for tap water.
	5	Mitigating Climate Change LEAD Social Studies	Student teams will design a solution that will mitigate the effects of global climate change in their selected region of the world.

EXAMPLE ON SUSTAINABLE SYSTEMS STEM THEME

Will use the PNG curriculum to look at the STEM Road Map for grades 3–5 based on *Sustainable Systems* STEM theme.

With this example, will select the STEM Theme on *Sustainable Systems* for grades 3–5 and look at all the topics from grades 3 – 5 align with the theme and the grade level academic content standards

from the PNG curriculum. Topics for each STEM Theme in the different grades are given. Will look at each of these topics for the different grades that are organized around a standards-based challenge, problem, or project that student teams are assigned to tackle in each grade during the course of learning that requires application of content and skills from various disciplines.

TABLE 5.1 Grades 3 -5 Topics, and Problems/Challenges for Sustainable Systems STEM Theme

STEM Theme	**Grade**	**Topic**	**Problem/Challenge**
Sustainable Systems	3	Ecosystem Preservation LEAD Science	Student teams will develop a plan to preserve the local ecosystem.
	4	Hydropower Efficiency LEAD Science	Student teams will develop a three-dimensional model or a computer-assisted image that demonstrates how an engineer may optimize the efficiency of a dam.
	5	Composting LEAD Science	Student teams will design a compost system for their school's cafeteria that makes use of excess food and food waste that is disposed of each day.

Grade 3 suggested topic on ***Ecosystem Preservation*** based on the STEM theme(***Sustainable Systems***), involve students in devising, building, and maintaining models of terrestrial and aquatic ecosystems that will provide third grade students with the opportunity to explore factors necessary to sustain an ecosystem as well as observe the diverse and unique life cycles of living organisms.

Third Grade Sustainable Systems Theme: Ecosystem Preservation

STEM Theme	**Grade**	**Topic**	**Problem/Challenge**
Sustainable Systems	3	Ecosystem Preservation LEAD Science	Student teams will develop a plan to preserve the local ecosystem.

Sustainable Systems: **Ecosystem Preservation**

For the Grade 3 suggested topic on **Ecosystem Preservation** based on ***Sustainable Systems*** STEM theme, student teams will develop a plan to preserve the local ecosystem.

CURRICULUM CONNECTIONS

Grade 3 student teams will develop a plan to preserve the local ecosystem. In order to solve the Problem/Challenge, students need to understand concepts, processes and skills from various disciplines shown in TABLE 5.5

Curriculum Connections for Third Grade Sustainable Systems Theme: Ecosystem Preservation

Subject	**Learning Standards & Assessment**	
Science	**Content Standard**	3.1.4 Investigate and describe the interaction between living things in the environment
	Performance Standards	a) Identify and describe components of different environments. b) Differentiate between natural and man-made environment. c) Classify things in the environment into living and non-living . d) Describe the relationship between living and non-living things in the environment. e) Identify places where plants and animals live. f) Explain how living things depend on the environment
Mathematics	**Content Standard**	**3.4.3** Develop understanding of ways to collect, arrange and represent data on tables and bar graphs.
	Performance Standards	a. Explain ways of collecting and representing data with drawing tables and bar graphs. b. Investigate and collect data of things in and around the environment. c. Produce, read and interpret 2 dimensional tables and graphs.
Arts	**Content Standard**	**3.1.1** Apply line characteristics such as straight/curve, thick/thin, long/ short, vertical/horizontal to draw shapes, patterns and familiar objects. **3.1.2** Apply organic and modern colors to paint familiar pictures. **3.1.2** Apply organic and modern colors to paint familiar pictures. **3.2.7** Create a role-play using different drama genres with animal characters.
	Performance Standards	**3.1.1b** Use lines to draw shapes and patterns. **3.1.2a** Use organic materials such as flowers, leaves, clay and charcoal to paint on white paper to appreciate different types of organic colours in the environment. **3.1.2a** Use organic materials such as flowers, leaves, clay and charcoal to paint on white paper to appreciate different types of organic colours in the environment. **3.2.7a** Perform a comedy play or skit using animal characters.
Social Science	**Content Standard**	**3.4.1** Describe the environment of the local area **3.4.2** Identify the resources in the community

	Performance Standards	(a) Identify and describe the main features of the local area (b) Identify and describe local landmarks (c) Describe the seasons (a) Describe what a resource is (b) Identify natural and man-made resources in their community and explain how these are used (c) Identify natural resources and how these are useful
English	**Content Standard**	**3.1.1a** Listen for information from a range of oral text types for different purposes and audiences on familiar topics and respond appropriately **3.1.1b** Listen to a range of simple structured classroom instructions and directions and respond Appropriately **3.1.2a** Give directions, instructions and messages in structured classroom situations **3.1.3a** Express ideas and opinions clearly and confidently using correct grammar, vocabulary, tone and projection in appropriate manner **3.1.3b** Use appropriate descriptive language and body gestures to express personal feelings about familiar topics. **3.2.5a** Read a range of texts containing familiar ideas and information and respond appropriately **3.3.1a** Write neatly and clearly in print script **3.3.2a** Apply appropriate writing process in writing **3.2b** Create and communicate a range of familiar and unfamiliar ideas and information for various purposes and audiences
	Performance Standards	a) Listen to stories for meaning and pleasure, and respond appropriately. b) Listen attentively to interpret implied information. c) Listen to and organise ideas chronologically. d) Listen to teacher-read stories and poems and make inferences. a) Listen and follow simple instructions such as 'Simon says' and 'Chinese whispers'. b) Listen to and relay messages correctly. c) Listen to and identify parts of speech such as nouns, pronouns, verbs and adverbs in spoken texts. d) Listen to and identify similarities and differences in letter sounds and words. e) Listen and respond to stimulus such as rhymes, riddles, poems, sounds, music,songs and jokes. a) Give instructions for directions and games. b) Give a three step instructions or directions to peers. c) Create messages using visual or audio-aids for presentations. a) Give a short talk on a given topic expressing main ideas clearly using appropriate grammar. b) Present an oral report or news on a local topic or personal experience using visual aids. c) Using a logical structure, provide a clear beginning, middle; and end when retelling a familiar story or making oral presentations. d) Retell a simple story using a role play.

		a) Express their likes and dislikes about regular community events or activities using body gestures. b) Display good manners in verbal and non-verbal communication while communicating messages, ideas and opinions such as listening attentively, displaying positive manner and being polite such as 'Pardon me', 'Excuse me' or 'Can you repeat, please..' when interacting with others. c) Role play an event that occurs in the community using appropriate descriptive dialogue and body gestures. d) Listen to a guest speaker or a story and ask relevant questions. e) Identify and use colloquial speech (for example, boss for manager) and demonstrate how oral language changes in different familiar situations with different audiences using songs, poems or plays. a) Use pre-reading strategies to preview, activate prior knowledge, make predictions, use picture clues to establish the purpose of the text. b) Ask and respond to questions designed to develop comprehension. c) Make inferences and interpretations about events, characters and ideas in fictional texts by connecting prior knowledge and experiences with information from the text. d) Produce oral or written summaries by discussing the 'Wh-H' questions by identifying the main ideas and significant supporting details of a text. e) Identify simple cause and effect relationships in a text, make comparisons, and draw conclusions on what is read. f) Distinguish between fact and opinion in non-fiction text. g) Participate in a reading conference with the teacher or peers. h) Apply skimming and scanning skills when reading quickly to identify main idea or locate specific information. a) Use prewriting activities such as brain storming, clustering of ideas and illustrations in the process of writing. b) Apply appropriate strategy to organize and develop the main idea in the process of writing. c) Develop logically the first draft by clearly stating the beginning, middle, and end. d) Revise the draft by making necessary changes to improve it. e) Proof read and edit own writing with the teacher and the peers. f) Publish own writing and share with others in the class.
21st Century Skills		Environmental Literacy Learning and Innovation Skills: • Creativity and Innovation • Critical Thinking and • Problem Solving • Communication and • Collaboration Information, Media and Technology Skills: • Information Literacy

	• Media Literacy • ICT Literacy Life and Career Skills: • Flexibility and Adaptability • Initiative and Self-Direction • Social and Cross-Cultural Skills • Productivity and Accountability Leadership and Responsibility

TEACHING & LEARNING ACTIVITIES AND ASSESSMENT

Activity One

School – industry Partnership

School may invite professionals or experts in the required field of study to provide information, facts, data and motivational advice to the students based on the given problem or challenge.

Career development and exploration in the lower primary or even elementary grades is critically important in facilitating students' interest, attitude, and persistence in STEM. There are many online resources that teachers and parents can utilize to begin supporting children's exploration of STEM careers.

Careers that complement the third grade STEM Road Map and related activities include a variety of professions that reinforce opportunities for students to pursue their interests in fields such as field biology and environmental science provide students with the opportunity to plan and carry out investigations in the field, analyze and interpret data from the field, and communicate results from their field studies to a larger audience. Environmental scientists and specialists use their knowledge of the natural sciences to protect the environment and human health. Environmental scientists monitor the quality of the environment (air, water, and soil), interpret the impact of human activities on terrestrial and aquatic ecosystems, and develop strategies for restoring ecosystems.

Methods of Assessment

Some ways of Assessing are:

Questionnaires

- Oral
- Written

Observation of students

- Informing Observation
- Checklist and notes
- Running record sheets
- Watching working in progress
- Systemic observation
- Presentation to the class

Assessment Tasks

How can students show what they have learned?

Writing

- Essays
- Explanations
- Case studies
- Completing activity sheets
- Concept maps
- Assignments
- Projects
- Articles from newspapers

Students should show evidence of learning in the following areas:

- How to plan and carry out investigations in the field, analyze and interpret data from the field, and communicate results from their field studies to a larger audience.
- How to protect the environment and human health
- Monitoring the quality of the environment (air, water, and soil)
- Interpret the impact of human activities on terrestrial and aquatic ecosystems
- Develop strategies for restoring ecosystems.

Activity Two

In small teams, students investigate a local ecosystem, such as a nearby stream or park, to better understand the interaction between living creatures, energy, and the non-living.

Students will investigate and describe the interaction between living things in the environment.

From their research or investigation, they should be able to:

a) Identify and describe components of different environments.

b) Differentiate between natural and man-made environment.

c) Classify things in the environment into living and non-living .

d) Describe the relationship between living and non-living things in the environment.

e) Identify places where plants and animals live.

f) Explain how living things depend on the environment

Assessment Tasks

Assessment Task One - Science

Research and name two types of natural environments in Papua New Guinea, and name plants and animals that live in these two types of natural environment.

Assessment Task Two - Science

Students investigate the local ecosystem and provided with research questions or questionnaires based on

- Description of the environment
- Differentiation between natural and man-made environment
- Classification of living and non-living things
- Description of the relationships between living and non-living things in the environment
- Identification of places where plants and animals live.
- Explanation of how living things depend on the environment

Assessment Task Three - Mathematics

From their investigation and collection of data of things in the local ecosystem, students:

- Explain how they collected their data
- Represent their data in a table and bar graphs
- Draw a bar graph of the data collected
- Read and interpret the tables and graphs

Activity Three

Problem/Challenge : Student teams will develop a plan to preserve the local ecosystem.

Next, students work together to build a model of an aquatic ecosystem and observe the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails.

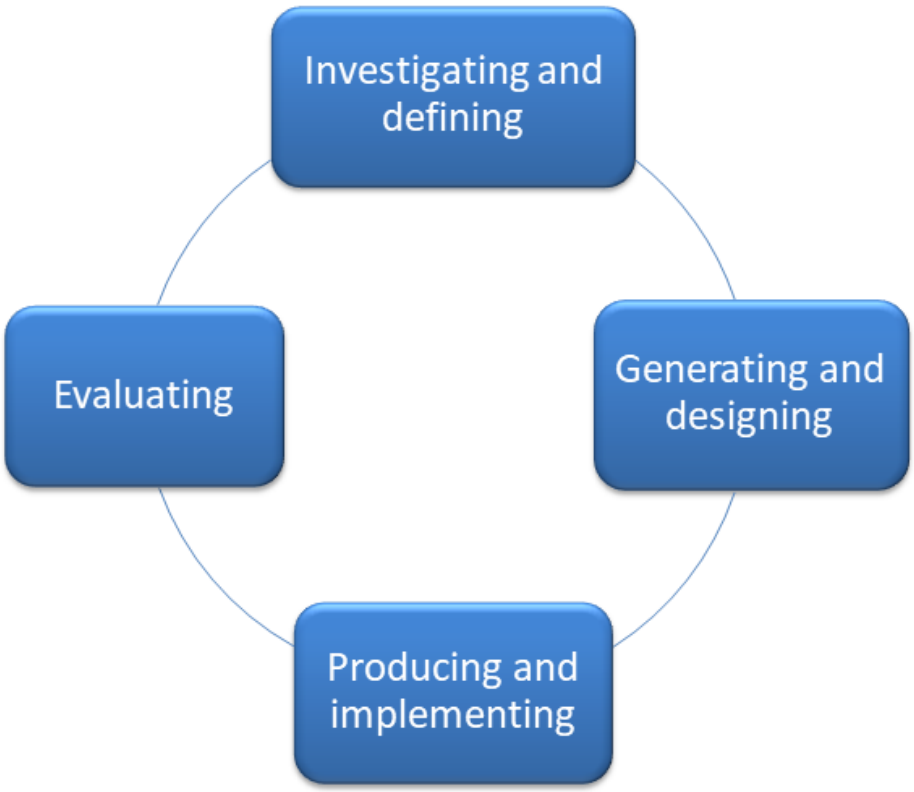
Students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals.

As students observe events in the aquatic ecosystems, the students review the concepts introduced earlier in the life science sequence (Strand 1: Life, Unit 4: Interaction and Relationship in the Environment). The term ‘ecosystem’ is then introduced to refer to the system composed of a community of organisms interacting with its environment. The concept of ‘sustainable’ is further explored by instructing students to find out different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive.

To build a model of an aquatic ecosystem and develop a plan to preserve the local ecosystem, students can apply any STEM practice such as the Technology Design process. With the assistance and guidance from teachers, students construct their model of the aquatic ecosystem and develop their plan to preserve the local ecosystem.

Will apply the Technology Design process **to** construct the model and based on the model and students' observation; they develop a plan to preserve the local ecosystem**.**

Show in figure 22 is the Technology Design process.



Technology design process(ACARA, n.d.a)	
Stages of the Technology design process	**Teacher/Student activities**
Investigating and defining	The science teacher pose relevant questions based on the real –world problem specifically on the connecting idea on Sustainable Systems for Ecosystem Preservation. Teacher can also provide information based on photos or videos of different ecosystems. Students begin to investigate and define the given problem. Investigations can be done by inviting professionals or experts to discuss with students on • how to plan and carry out investigations in the field, analyze and interpret data from the field, and communicate results from their field studies to a larger audience • knowledge of the natural sciences to protect the environment and human health, the quality of the environment (air, water, and soil) • interpret the impact of human activities on terrestrial and aquatic ecosystems • develop strategies for restoring ecosystems. For further investigations, students research or investigate a local ecosystem, such as a nearby stream or park, to better understand the interaction between living creatures, energy, and the non-living. Students will investigate and describe the interaction between living things in the environment. From their research or investigation, they should be able to: a) Identify and describe components of different environments. b) Differentiate between natural and man-made environment. c) Classify things in the environment into living and non-living . d) Describe the relationship between living and non-living things in the environment. e) Identify places where plants and animals live. f) Explain how living things depend on the environment
Generating and designing	As they begin to research or gather more information from their surrounding community or family members, professionals or teachers on ecosystem and how to build and sustain an ecosystem, students begin to generate ideas and brainstorm possible designs. Students developed different solutions/designs for their model. Using the research information, students sketch different possible deigns

	with different measurements for their model ecosystem taking into consideration the researched information that they have collected. They develop possible solutions on the different types of materials and the measurements to use. They will also discussed possible solutions on the type of organisms they will consider for their aquatic ecosystem. *Students developed possible approaches/solutions to each relevant question and using those ideas and information they develop possible solutions and actions/procedures or plan to be taken to solve the problem.*
Producing and implementing	Students select the best design based on constraints and criteria such as cost and time, they build their prototype or model of the aquatic ecosystem. Their work will be evaluated by a rubric to assess their performance and output. Students work together to build a model of an aquatic ecosystem and observe the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails. From their observations and data collections, students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals. Select most appropriate solution in terms of the correct materials and their measurements, they construct the first model of the aquatic ecosystem. Observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements. Explain or justify the results identified in the process of the aquatic ecosystem design. Formulate new approaches/solutions to the construction of the aquatic ecosystem . Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed. At this stage students are testing their design and designing a new course of action. Students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals. The concept of 'sustainable' is further explored by instructing students to find out different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive.
Evaluating	Students test their model. They also do a group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model. *Students reflect on those steps, procedures, actions, and decisions made in the construction of the* aquatic ecosystem *Students reflect and explain their choices/actions and thinking involved or taken in the* aquatic ecosystem *design.* *They improve their* aquatic ecosystem *design or redesign the model of the* aquatic ecosystem *to meet the criteria and constraints and solve the given problem.*

Methods of Assessment

Some ways of Assessing are:

Questionnaires

• Oral

• Written

Tests

• Practical

• Written

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Keeping records of practical work

• Models

• Work samples

• Class and group projects

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

• Systemic observation

• Presentation to the class

Student records

• Student profile

• Student journal

• Working in progress folders

• Diaries

Student self-assessment

• Group discussion

• Concept mapping

• Peer assessment

• Self – assessment

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Completing activity sheets

• Concept maps

• Assignments

• Projects

Practical tasks

• Models

• Displaying activities outside

• Practical activity

• Solving Problems

• Applying concepts

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Processes and procedures

• Observing, identifying

• Recognizing investigating

• Classifying questioning, comparing, predicting, drawing conclusions, taking measures, putting forwards

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- Plan to preserve the local ecosystem.
- Process of constructing the model of the aquatic ecosystem

Activity Four

Students will develop a plan to preserve the local ecosystem.

After students have build a model of an aquatic ecosystem, they will develop a plan to preserve the local ecosystem. Before they develop the plan on how to preserve the local ecosystem, students observe the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails.

Students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals.

Methods of Assessment

Some ways of Assessing are:

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Keeping records of practical work

• Models

• Work samples

• Class and group projects

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

• Systemic observation

• Presentation to the class

Student records

• Student profile

• Student journal

• Working in progress folders

• Diaries

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Case studies

• Completing activity sheets

• Concept maps

• Assignments

• Projects

• Articles from newspapers

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- Observation of the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails
- Roles of organisms in the ecosystem
- Interaction and Relationship in the Environment
- Different ways to maintain their ecosystems over time
- Conditions necessary for the living organisms to survive

Activity Five

Finally, students apply what they have learned when they constructed their own ecosystems and apply their knowledge to their community's ecosystem, do awareness and presentations to the local community.

For the English component, students will write an essay or blog on how to protect, appreciate, and take care of a local natural pond, creek, or park.

In social science, students will describe the environment of the local area and identify the resources in the community. Students will identify and describe the main features of the local area, identify and describe local landmarks and describe the seasons, describe what a resource is, identify natural and man-made resources in their community and explain how these are used, identify natural resources and how these are useful.

For arts, students will use lines to draw shapes and patterns, use organic materials such as flowers, leaves, clay and charcoal to paint on white paper to appreciate different types of organic colors in the environment, perform a comedy play or skit using animal characters during awareness.

Methods of Assessment

Some ways of Assessing are:

Questionnaires

• Oral

• Written

Tests

• Practical

• Written

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Keeping records of practical work

• Models

• Work samples

• Class and group projects

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

• Systemic observation

• Presentation to the class

Student records

• Student profile

• Student journal

• Working in progress folders

• Diaries

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Case studies

• Completing activity sheets

• Concept maps

• Assignments

• Projects

Practical tasks

• Models

• Displaying activities outside

• Practical activity

• Solving Problems

• Applying concepts

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Processes and procedures

• Observing, identifying

• Recognizing investigating

• Classifying questioning, comparing, predicting, drawing conclusions, taking measures, putting forwards

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- Plan for the awareness and presentations to the local community
- write an essay or blog on how to protect, appreciate, and take care of a local natural pond, creek, or park
- describe the environment of the local area and identify the resources in the community
- Students will identify and describe the main features of the local area
- identify and describe local landmarks and describe the seasons

- describe what a resource is, identify natural and man-made resources in their community and explain how these are used
- identify natural resources and how these are useful
- use lines to draw shapes and patterns, use organic materials such as flowers, leaves, clay and charcoal to paint on white paper to appreciate different types of organic colors in the environment
- perform a comedy play or skit using animal characters during awareness

STEM ROAD MAP FOR GRADE 4

As students progress from third to fourth grade, they become more informed problem-solvers. Using what they learned in third grade about changes within an ecosystem, fourth grade students now apply their newly acquired knowledge to explore the role of renewable energy within sustainable systems.

Fourth Grade Sustainable Systems Theme: Hydropower Efficiency

STEM Theme	**Grade**	**Topic**	**Problem/Challenge**
Sustainable Systems	4	Hydropower Efficiency LEAD Science	Student teams will develop a three-dimensional model or a computer-assisted image that demonstrates how an engineer may optimize the efficiency of a dam.

Sustainable Systems: Hydropower Efficiency

The Grade 4 suggested topic on **Hydropower Efficiency** based on ***Sustainable Systems*** STEM theme, requires student teams to develop a three-dimensional model or a computer-assisted image that demonstrates how an engineer may optimize the efficiency of a dam.

In this science-led project, students will learn about the natural resources that provide our energy and fuels for everyday life, specifically hydroelectric power. The challenge for this topic is focused on the development of a three-dimensional model or computer-assisted image that will demonstrate how to optimize the efficiency of a dam.

CURRICULUM CONNECTIONS

Grade 4 student teams will develop a three-dimensional model or a computer-assisted image that demonstrates how an engineer may optimize the efficiency of a dam. In order to solve the Problem/Challenge; students need to understand concepts, processes, and skills from various disciplines shown in **TABLE 5.11**

Curriculum connections for Fourth Grade Sustainable Systems Theme: Hydropower Efficiency

Subject	**Learning Standards & Assessment**	
Science	**Content Standard**	**4.2.2** Investigate the flow of electric currents using simple circuits.
	Performance Standards	a) Define electricity and identify sources and uses of electricity. b) Demonstrate how to make a simple circuit and explain the flow of current in an open and closed circuit. c) Explain through demonstration the flow of an electric current using a light bulb. d) Demonstrate and explain the use of conductors and insulators.
Mathematics	**Content Standard**	**4.3.1** Investigate and understand properties of various types of quadrilaterals using vertex, angles, sides, parallel lines, perpendicular lines and diagonals. **4.3.2** Investigate and understand characteristics of rectangular prism and cube in terms faces and edges and make models of them. **4.4.1** Explore quantities changing together and explain the patterns by sum, difference, product, and quotient. **4.4.2** Extend learned knowledge on tables and graphs to represent data and read line graphs. **4.4.3** Explore how to draw and read multi variable data by two dimensional tables.
	Performance Standards	a. Draw four lines by connecting 2 selected dots on the square dotted grid paper, and find various quadrilaterals. b. Define perpendicular lines and parallel lines, and use the properties to draw them. c. Name various quadrilaterals such as trapezoid, parallelogram, rhombus, rectangle and square based on their properties. d. Identify beautiful patterns in tessellation of quadrilaterals and appreciate the properties of quadrilateral. a. Using common objects to group solid shapes define rectangular prism and cube with vertex, sides and face. b. Produce net from rectangular prism and cube. c. Explore the rectangular prism and cube by relationship amongst faces, segment and edges. d. Represent positions on plane and space. a. Investigate the various situations where quantities change together and find patterns to develop a table of values. b. Represent the given pattern which involve s sum, difference, product,

		quotient of two given changing quantities on a table values and graphs. c. Use mathematical sentence with □ and ○ for representing relationship on the table for a given situation. a. Represent data on a bar graph. b. To compare with bar graph know the usefulness of line graph for knowing basis such as increase, decrease and no change. c. Explore better ways to draw line graphs. a. Gathering, record and arrange data on a table showing two information at once. b. Make and read a table from the qualitative data. c. Identify and present two variable data from the two dimensional tables on graphs and posters and explain their findings.
Arts	**Content Standard**	**4.1.1** Demonstrate understanding of the different characteristics of lines and their uses. **4.1.3** Demonstrate the art of carving and its processes.
	Performance Standards	a) Use different types of lines and their characteristics to create designs. b) Use lines in creating geometrical patterns. c) Draw and apply shading to create 3D effects on images. d) Develop creative drawings combining line and tone using geometrical or natural shapes and forms. a) Discuss the safety rules when handling equipment and identify the materials that can be appropriate. b) Create simple carvings. c) Create models using clay, wood, sticks, shells, grass and chunks found around the environment.
Social Science	**Content Standard**	***4.4.1*** *Identify the natural and man-made features of the district.* **4.4.2** Describe renewable and non-renewable resources of the district
	Performance Standards	(a) *Describe the environment of the district* (b) *Describe natural and man-made features* (c) *identify and describe the natural and man-made features of the district* (d) *Identify and describe landmarks of the district* (a) Explain 'renewable' and 'non-renewable' resources (b) identify renewable resources (c) identify non-renewable resources (d) describe how people use resources
English	**Content Standard**	4.3.1 Write legibly in cursive allowing margins and correct spacing between letters in words and words in sentences 4.3.2a Apply appropriate writing processes in writing 4.3.2b Create and communicate a range of familiar and unfamiliar ideas and information for various purposes and audiences.

	Performance Standards	a) Write clearly using letters of uniform shape, slope, size and spacing. b) Use modified cursive or joined italics to write with speed, legibility and consistency. a) Use a variety of prewriting activities such as brainstorming, clustering of ideas and illustrations, in the process of writing. b) Apply appropriate strategy to organize and develop the main idea in the process of writing. c) Develop logically the first draft by clearly stating the beginning, middle and end. d) Revise the draft by making necessary changes to improve it. e) Proofread and edit own writing with the teacher and peers. f) Publish own writing and share with others in the class. a) Write narrative texts of 200-300 words using appropriate text structure and vocabulary. b) Create poems using different poetic styles (rhymes, and alliteration, etc.). c) Use the elements of setting, character, plot, conflict and ending to write an expository essay. d) Create narratives and poems using varied word choice, dialogue, figurative language, alliteration, personification, simile and metaphor. e) Write formal and informal letters, thank you notes and invitations (including date, greeting, body, closing and signature).
21st Century Skills		Environmental Literacy Global Awareness Learning and Innovation Skills: • Creativity and Innovation • Critical Thinking and Problem Solving • Communication and Collaboration Information, Media and Technology Skills: • Information Literacy • Media Literacy • ICT Literacy Life Career Skills: • Flexibility and Adaptability • Initiative and Self-Direction • Social and Cross-Cultural Skills • Productivity and Accountability • Leadership and Responsibility

TEACHING & LEARNING ACTIVITIES AND ASSESSMENT

In this science-led project, students will learn about the natural resources that provide our energy and fuels for everyday life, specifically hydroelectric power. The challenge for this topic is focused on the development of a three-dimensional model or computer-assisted image that will demonstrate how to optimize the efficiency of a dam.

In English, student teams will research how water has historically been used to produce energy, with an emphasis on sustainability and write a report or essay based on their research. In social science, using sources such as internet or websites on History of Hydropower, students explore the historical development and use of hydroelectric dams, wave power, and tidal power. In science, student teams explore how a hydroelectric dam operates through online simulations.

Activity One

In small teams, students investigate/research the natural resources that provide our energy and fuels for everyday life, specifically hydroelectric power

Methods of Assessment

Some ways of Assessing are:

Talking with students

- Informal observation
- Interview
- Questioning individuals and small groups
- Asking open-ended questions
- Telling stories
- Listening to students explanations

Observation of students

- Informing Observation
- Checklist and notes
- Running record sheets
- Watching working in progress
- Systemic observation
- Presentation to the class

Student records

- Student profile
- Student journal
- Working in progress folders
- Diaries

Assessment Tasks

How can students show what they have learned?

Writing

- Essays
- Explanations
- Case studies
- Completing activity sheets
- Concept maps
- Assignments
- Projects
- Articles from newspapers

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- natural resources
- energy and fuels
- electricity
- hydroelectric power
- production of hydroelectric power

Activity Two

Student teams will research how water has historically been used to produce energy, with an emphasis on sustainability and write a report or essay based on their research.

Methods of Assessment

Some ways of Assessing are:

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

• Systemic observation

• Presentation to the class

Student records

• Student profile

• Student journal

• Working in progress folders

• Diaries

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- History of energy production
- Natural resources
- Energy
- Natural sources of energy
- Water cycle
- how water has historically been used to produce energy
- Sustainable energy sources
- Writing Fluency and comprehension in essay
- Apply appropriate writing processes in writing
- Create and communicate a range of familiar and unfamiliar ideas and information for various purposes and audiences.
- Logical sequence in essay write- up

Activity Three

Research using internet or using sources such as websites on *History of Hydropower*, students explore the historical development and use of hydroelectric dams, wave power, and tidal power

Methods of Assessment

Some ways of Assessing are:

Talking with students

- Informal observation
- Interview
- Questioning individuals and small groups
- Asking open-ended questions
- Telling stories
- Listening to students explanations

Observation of students

- Informing Observation
- Checklist and notes
- Running record sheets
- Watching working in progress
- Systemic observation
- Presentation to the class

Student records

- Student profile
- Student journal
- Working in progress folders
- Diaries

Assessment Tasks

How can students show what they have learned?

Writing

- Essays
- Explanations
- Case studies
- Completing activity sheets
- Concept maps
- Assignments

Visual representations

- Posters, flow charts drawings
- Diagrams, maps, tables
- Graphs, paintings, labels

Oral tasks

- Answering questions
- Explaining
- Describing
- Relaying information
- Asking questions
- Interviewing

Students should show evidence of learning in the following areas:

- Use of digital technologies that supports learning - digital fluency
- *Describe the environment of the district*
- *Describe natural and man-made features*
- *identify and describe the natural and man-made features of the district*
- *Identify and describe landmarks of the district*
- Explain 'renewable' and 'non-renewable' resources
- identify renewable resources
- identify non-renewable resources
- describe how people use resources
- historical development of hydroelectric dams, wave power, and tidal power
- use of hydroelectric dams, wave power, and tidal power

Activity Four

Student teams explore **how a hydroelectric dam operates** through **online simulations**.

Methods of Assessment

Some ways of Assessing are:

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Observation of students

- Informing Observation
- Checklist and notes
- Running record sheets
- Watching working in progress
- Systemic observation
- Presentation to the class

Student records

- Student profile
- Student journal
- Working in progress folders
- Diaries

Assessment Tasks

How can students show what they have learned?

Writing

- Essays
- Explanations
- Case studies
- Completing activity sheets
- Concept maps
- Assignments

Visual representations

- Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- Use of digital technologies that supports learning - digital fluency
- hydroelectric dam
- how a hydroelectric dam operates

Activity Five

School – industry Partnership

As students' curiosity and enthusiasm for STEM builds, it is equally important to make fourth grade students aware of different related careers. Invite professions such as civil engineer, seismologist, urban planner, journalist, and topographer align well with the fourth grade STEM Road Map and related activities.

Professionals may provide information, advice, and interests in the following areas:

- construction and maintenance of buildings and infrastructure such as water supply
- analysis (especially in the planning stage), studying survey reports and maps, breaking down construction costs, and considering government regulations and potential environmental hazards
- testing soils and building materials, provide cost estimates for equipment and labor, and use software to plan and design systems and structures
- monitoring, maintaining, testing, and operating seismological equipment; documenting data; supervising preparation of test sites; managing inventory on equipment; and maintaining safety standards
- understanding of many other fields, including the environment, transportation, and psychology
- Investigate, collect, and present information in the form of a news story.
- writes in an objective manner, stating the facts and getting multiple perspectives of the story
- Survey lands and create highly accurate representations through models and maps
- use computer equipment to take precise measurements of the elevation, location, shape, and contours of a particular area

Methods of Assessment

Some ways of Assessing are:

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

• Systemic observation

• Presentation to the class

Student records

• Student profile

• Student journal

• Working in progress folders

• Diaries

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Case studies

• Completing activity sheets

• Concept maps

• Assignments

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- construction and maintenance of buildings and infrastructure such as water supply
- analysis (especially in the planning stage), studying survey reports and maps, breaking down construction costs, and considering government regulations and potential environmental hazards
- testing soils and building materials, provide cost estimates for equipment and labor, and use software to plan and design systems and structures
- monitoring, maintaining, testing, and operating seismological equipment; documenting data; supervising preparation of test sites; managing inventory on equipment; and maintaining safety standards
- understanding of many other fields, including the environment, transportation, and psychology
- Investigate, collect, and present information in the form of a news story.
- writes in an objective manner, stating the facts and getting multiple perspectives of the story
- Survey lands and create highly accurate representations through models and maps
- use computer equipment to take precise measurements of the elevation, location, shape, and contours of a particular area

Activity Six

Problem/Challenge

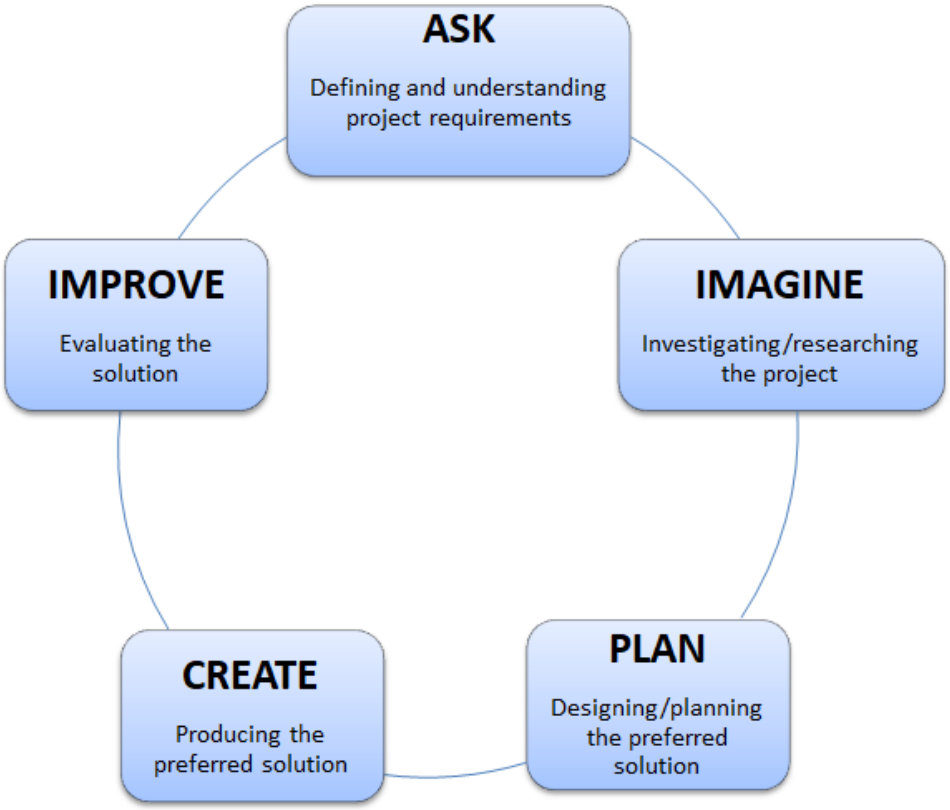
Students develop a three-dimensional model or computer-assisted image that will demonstrate how to optimize/improve the efficiency of a dam.

https://www.ijee.ie/articles/Vol22-3/02_ijee1751.pdf

Which practice will be used??? Apply engineering design process

To construct the three-dimensional model that will demonstrate how to optimize the efficiency of a dam, with the assistance and guidance from teachers, students can apply any STEM practice such as the Technological Design process to construct their model.

We will apply the **Integrated STEM PBL Model to construct the model. Show in figure 22 is the Integrated STEM PBL Model.**



Integrated STEM PBL Model			
Phase	**Components of Integrated STEM PBL Model**	**Components activities**	**Teacher/Student activities**
Phase 1	ASK	Defining and understanding project	Teacher explains to the students the project requirements in terms of the

		requirements	given problem/challenge with the criteria and constraints. Even teacher can provide pictures/photos or videos of hydroelectric dams, how the dams are build and their purpose. Students begin to define and understand the project requirements through students investigation or research on : • the natural resources that provide our energy and fuels for everyday life, specifically hydroelectric power • how water has historically been used to produce energy, with an emphasis on sustainability.
Phase 2	IMAGINE	Investigating/researching the project	Further investigations or research based on the project should provide more information and give students more ideas. Students begin to brainstorm ideas or possible solutions to their problem as they research more information on • history of Hydropower, students explore the historical development and use of hydroelectric dams, wave power, and tidal power • how a hydroelectric dam operates through online simulations. Even experience, knowledge, and skills shared by professionals or experts will give more information for the students to understand the given problem or challenge in real-life situation and develop appropriate or possible solutions.
Phase 3	PLAN	Designing/planning the preferred solution	From the possible solutions identified, students select the most appropriate solution that meets all the project requirements in terms of the criteria and constraints and design a plan for the preferred solution.
Phase 4	CREATE	Producing the preferred solution	Students construct their three – dimensional model using the plan developed from the preferred solution.
Phase 5	IMPROVE	Evaluating the solution	Students evaluate their model and re-design or improve it.

Methods of Assessment

Some ways of Assessing are:

Questionnaires

• Oral

• Written

Tests

• Practical

• Written

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Keeping records of practical work

• Models

• Work samples

• Class and group projects

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

• Systemic observation

• Presentation to the class

Student records

• Student profile

• Student journal

• Working in progress folders

• Diaries

Student self-assessment

• Group discussion

• Concept mapping

• Peer assessment

• Self – assessment

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Completing activity sheets

• Concept maps

• Assignments

• Projects

Practical tasks

• Models

• Displaying activities outside

• Practical activity

• Solving Problems

• Applying concepts

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Processes and procedures

• Observing, identifying

• Recognizing investigating

• Classifying questioning, comparing, predicting, drawing conclusions, taking measures, putting forwards

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- Plan of constructing the final product of a three-dimensional model or computer-assisted image that will demonstrate how to optimize/improve the efficiency of a dam

- Process of constructing the final product of a three-dimensional model or computer-assisted image of a dam
- Quality of the final product

STEM ROAD MAP FOR GRADE 5

The composting design task affords students the opportunity to devise a protocol for making compost (Dankenbring, Capobianco, & Eichinger, 2014) from the excess of water and food from their school's cafeteria. Underpinning the practices associated with the engineering design process is the production of either an artifact or a process. In this challenge, students innovate and create a process for making good compost and will develop a marketing campaign to encourage students and staff to take part in the program.

Fifth Grade Sustainable Systems Theme: Composting

STEM Theme	Grade	Topic	Problem/Challenge
Sustainable Systems	5	Composting LEAD Science	Student teams will design a compost system for their school's cafeteria that makes use of excess food and food waste that is disposed of each day.

Sustainable Systems: Composting

For the Grade 5 suggested topic on **Composting** based on ***Sustainable Systems*** STEM theme, student teams will design a compost system for their school's cafeteria that makes use of excess food and food waste that is disposed of each day.

CURRICULUM CONNECTIONS

Grade 5 student teams will design a compost system for their school's cafeteria that makes use of excess food and food waste that is disposed of each day.

In order to solve the Problem/Challenge; students need to understand concepts and skills from various disciplines shown in **TABLE 5.17**

TABLE 5.17Curriculum Connections for Fifth Grade Sustainable Systems Theme: Composting

Subject	Learning Standards & Assessment	
Science	**Content Standard**	**5.1.1** Investigate and understand the conditions required for seed germination and plant growth. **5.1.4** Investigate the adaptation of living things in different habitats. **5.1.5** Investigate and explain the energy pathway from the Sun through to the living things. **5.2.1** Investigate and explain the properties of heat energy. **5.3.2** Investigate weather and seasons and the effects they have on living things and the environment.
	Performance Standards	a) Explain what plants need in order to grow. b) Plant, observe and record the growth of a seed from the time of germination. c) Explain how plants make food through the process of photosynthesis. a) Identify and explain the different types of habitats. b) Identify living things in the different habitats. c) Explain why different living things adapt to different environments. a) Explain why living things need food. b) Explain and understand that the Sun is the main source of energy for living things. c) Draw food chains and a food web to explain the use of energy from the sun to all living things. a) Define and explain heat as a form of energy. b) Identify the sources of heat and explain its everyday uses. c) Explore the different uses of heat transfer in daily life. d) Define and measure temperature using standard units. d) Explain the characteristics of each season in relation to living things. e) Discuss how weather and seasons affect living things and human activities.
Mathematics	**Content Standard**	**5.4.1** Explore proportions in two changing quantities patterns and explain the patterns by using the relation of direct proportionality. **5.4.2** Extend their understanding of data and statistics to construct graphs using given scales and quantities. **5.4.3** Use percentage and compare data sets of different sizes.
	Performance Standards	a. Use various situations where two changing quantities are directly proportional and develop tables for knowing patterns. b. Use various situations where two changing quantities are directly proportional and represent it on tables and graphs. c. Use mathematical sentence with and, find a missing number for a given situation. a. Collect, organise and represent data using bar graphs, and simple pie charts. b. Use data as a source for representation, interpretation and setting problems.

		c. Identify ordered pairs of data from a graph and interpret the meaning of the data in terms of the situation depicted by the graph. a. Represent percentage by setting the size of the base quantity at 100. b. Use fractions and percentage to compare data sets of different sizes. c. Calculate and represent percentage in tables and graphs.
English	**Content Standard**	**5.1.2a** Give a wide range of directions, instructions and messages in structured and spontaneous situations. **5.1.2b** Use English grammar correctly in a wide range of familiar and introduced oral situations **5.1.3a** Express ideas and opinions using a wide range of vocabulary on familiar and introduced topics using correct grammar, vocabulary, tone and voice projection **5.1.3b** Use appropriate descriptive language and body gestures to express personal feelings about familiar and unfamiliar situations **5.2.1a** Use a wide range of strategies to comprehend common sight words and vocabulary. **5.2.3a** Read and evaluate ideas and information from a wide range of texts. **5.2.3b** Read a range of literary texts and analyse how they inform and manipulate the responses of the readers. **5.3.1** Write legibly in cursive allowing margins and correct spacing between letters in words and words in sentences. **5.3.2a** Apply appropriate writing processes in writing **5.3.2b** Create and communicate a wide range of familiar and unfamiliar ideas and information for various purposes and audiences. **5.3.3a** Apply correct use of written English grammar in a wide range of structured and spontaneous situations. **5.3.3c** Apply appropriate sentence structure and grammatical features in writing a wide range of sentences **5.3.3d** Use a wide range of strategies to spell, read and write sight words and new vocabulary
	Performance Standards	• communicate confidently and express themselves fluently in English in formal and informal situations • apply appropriate social behaviour when listening, speaking and interacting with different audiences • listen, question, report and interpret a wide range of oral, and audio visual texts used for different purposes on familiar and unfamiliar topics • understand and use appropriate grammar and descriptive language to express opinions • know and use the correct structures of text types such as recounts, narratives, procedures, poems, information reports, explanations and expositions. • read a wide range of text types confidently with understanding • self-select reading materials for independent reading • read aloud with increasing speed, accuracy and expression • apply a range of strategies to comprehend, interpret and evaluate a range of text types • identify themes and issues presented in the texts and respond

		critically to them apply a wide range of strategies to comprehend and expand their knowledge of personal vocabulary and phrases in English. • They should hear, recognise and use common English sounds to read unknown words. • write a wide range of texts on familiar and unfamiliar topics using appropriate grammar • know and use the correct structures of text types such as recounts,narratives, procedures, poems and information reports • apply the writing process in all the writing activities demonstrate understanding and choose vocabulary, phrases and punctuation appropriate for the text type in personal writing, and demonstrate legibility in handwriting.
Social Science	**Content Standard**	5.4.2 Identify ways to use resources wisely
	Performance Standards	(a) Identify the effects of using natural resources. (b) Describe how non-r enewable resources could be used wisely (c) Explain how individuals and groups care for renewable resources (d) describe the effects of mining resources and extracting oil and gas
Arts	**Content Standard**	**5.1.1** Draw and create depths with tonal Variation **5.1.2** Paint images using different effects. **5.2.2** Perform using simple melodic instruments and sing songs for different events **5.2.3** Create dance patterns using rhythm, body control, timing and expression.
	Performance Standards	**5.1.1b** Revise pencil techniques of shading with tonal control and creating depths through space **5.1.1c** Draw using grid for transferring and manipulating characters **5.1.2a** Safety and handling of painting media **5.1.2b** Exploring painting with different painting mediums such as water colour, tempera paint and acrylic **5.1.2c** Practice other painting techniques using flat bristle brush and wash technique with water colour (hair/sable) brushes **5.1.3a** Constructing a model of an image using appropriate material **5.2.1d** Explore ways of making sounds using manufactured and homemade instruments **5.2.3a** Compose and demonstrate movement skills **5.2.3b** Compose and demonstrate dance sequences using rhythm, body control, timing and expression **5.2.4b** Demonstrate team work harmoniously **5.2.5b** Demonstrate team work peacefully **5.2.7b** Explore and Perform the different dance elements in dance
21st Century Skills		Global Awareness Learning and Innovation Skills: • Creativity and Innovation • Critical Thinking and • Problem Solving • Communication and • Collaboration

	Information, Media and Technology Skills: • Information Literacy • Media Literacy • ICT Literacy Life Career Skills: • Flexibility and Adaptability • Initiative and Self-Direction • Social and Cross-Cultural Skills • Productivity and Accountability • Leadership and Responsibility

TEACHING AND LEARNING ACTIVITIES

The composting design task affords students the opportunity to devise a protocol for making compost (Dankenbring, Capobianco, & Eichinger, 2014) from the excess of water and food from their school's cafeteria. Underpinning the practices associated with the engineering design process is the production of either an artifact or a process. In this challenge, students innovate and create a process for making good compost and will develop a marketing campaign to encourage students and staff to take part in the program.

In doing so, students utilize what they learn in science class regarding biotic and abiotic factors, conditions for decomposition to take place, and the role of decomposers to generate a form of compost that is useable and nutrient-rich. Further, in English students will learn how to develop materials from their research and experiences for the purpose of relaying a position. Over several weeks, small teams of students will monitor the progress of their compost by recording measurements such as soil temperature, pH, odor, and level of moisture while also finding ways to aerate, weed, and water. At the end of the first month, students will compile their data into a technical report that will be summarized and shared with the school community.

In social science, students will learn about landfills and other areas in the world that garbage is dumped and the implications for human vitality.

In mathematics, students will calculate the savings in disposal costs, as well as in the repurposing of the compost to fertilize future gardens and replenish the soil.

In the end, students develop an informed understanding of the interdependent relationships in ecosystems and significant role decomposers play within these respective ecosystems (see Table 5.17).

Activity One

Teacher show photos, pictures, videos on decomposition process and how to make compost and pose relevant questions.

Teacher review the following:

- ✓ conditions required for seed germination and plant growth
- ✓ adaptation of living things in different habitats
- ✓ energy pathway from the Sun through to the living things
- ✓ properties of heat energy
- ✓ weather and seasons and the effects they have on living things and the environment

ASSESSMENT

Methods of Assessment

Some ways of Assessing are:

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Student self-assessment

• Group discussion

• Concept mapping

• Peer assessment

• Self – assessment

Assessment Tasks

How can students show what they have learned?

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following content areas:

- Identify what is needed by plants to make their own food.
- Identify and classify animals according to their habitats
- Draw a simple food chain and label the producers and the consumers.
- Explain the different ways in which heat can be transferred.
- Explain the use of a thermometer and how to take measurement of temperature.
- Write a poem to describe weather, climate or season.
- Draw pictures to show different types of plants and animals in different seasons.

Activity Two

Students investigate or research biotic and abiotic factors, conditions for decomposition to take place, and the role of decomposers to generate a form of compost that is useable and nutrient-rich. Students research on how to make a compose from waste **excess of water and food**

Methods of Assessment

Some ways of Assessing are:

Questionnaires

- Oral
- Written

Tests

- Practical
- Written

Student self-assessment

- Group discussion
- Concept mapping
- Peer assessment
- Self – assessment

Assessment Tasks

How can students show what they have learned?

Research

- Small group research
- Independent research
- Conducting surveys and interviews

Writing

- Essays
- Explanations
- Case studies

• Completing activity sheets

• Concept maps

• Assignments

• Projects

• Articles from newspapers

Students should show evidence of learning in the following areas:

- Biotic and abiotic factors
- Conditions for decomposition to take place
- Role of decomposers to generate a form of compost that is useable and nutrient-rich.
- How to make a compose from waste excess of water and food

Activity Three

Professions or experts invited by the school provide speeches or information to the students. Professionals such as a hydrologist may provide information on how to solve water-related problems of quantity, quality, and availability, environmental protection, concerned with problems of flooding or soil erosion.

A geotechnical engineer may provide information on Earth's materials and how he applies the knowledge to fields such as mining and fossil fuel production.

Methods of Assessment

Some ways of Assessing are:

Questionnaires

• Oral

• Written

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

• Systemic observation

• Presentation to the class

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Case studies

• Completing activity sheets

• Concept maps

• Assignments

• Projects

• Articles from newspapers

Students should show evidence of learning in the following areas:

- How to solve water-related problems of quantity, quality, and availability
- Environmental protection, concerned with problems of flooding or soil erosion.
- Earth's materials and how professionals apply the knowledge to fields such as mining and fossil fuel production

Activity Four

Students research and learn about landfills and other areas in the school that garbage is dumped and the implications for human vitality.

Methods of Assessment

Some ways of Assessing are:

Questionnaires

- Oral
- Written

Observation of students

- Informing Observation
- Checklist and notes
- Running record sheets
- Watching working in progress
- Systemic observation
- Presentation to the class

Assessment Tasks

How can students show what they have learned?

Writing

- Essays
- Explanations
- Case studies
- Completing activity sheets
- Concept maps

• Assignments

• Projects

• Articles from newspapers

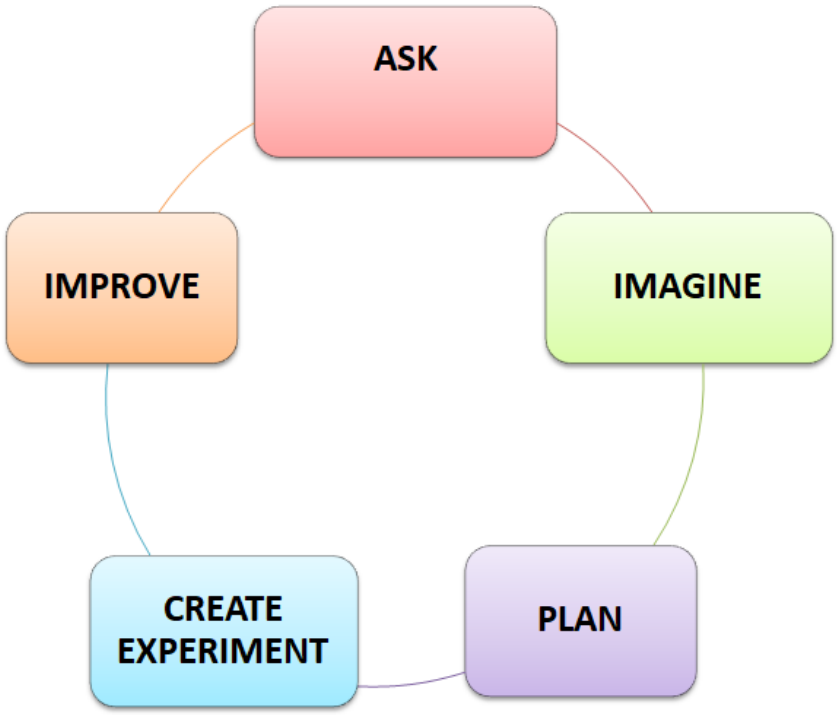
Students should show evidence of learning in the following areas:

- Landfills and other areas in the school that garbage is dumped
- Implications for human vitality

Activity Five

Small teams of **students make compost from the excess of water and food from their school's cafeteria**.

Over several weeks, small teams of students will monitor the progress of their compost by recording measurements such as soil temperature, pH, odor, and level of moisture while also finding ways to aerate, weed, and water.



Engineering design process(NASA, 2020)	
Components of Engineering design process	**Teacher/Student activities**
ASK	Teacher explains to the students the project requirements in terms of the given problem/challenge with the criteria and constraints. Even teacher can provide pictures/photos or videos of decomposition process and how to make compost and pose relevant questions. • Teacher review the following: ✓ conditions required for seed germination and plant growth ✓ adaptation of living things in different habitats ✓ energy pathway from the Sun through to the living things ✓ properties of heat energy ✓ weather and seasons and the effects they have on living things and the environment Students begin to define and understand the project requirements through students investigation or research on. Students investigate or research biotic and abiotic factors, conditions for decomposition to take place, and the role of decomposers to generate a form of compost that is useable and nutrient-rich. Students research on how to make a compose from waste **excess of water and food**
IMAGINE	Further investigations or research based on the project should provide more information and give students more ideas. Students begin to brainstorm ideas or possible solutions to their problem as they are given more information by professionals or experts. Information on how to solve water-related problems of quantity, quality, and availability, environmental protection, concerned with problems of flooding or soil erosion, earth's materials and how professionals apply the knowledge to fields such as mining and fossil fuel production. Experience, knowledge, and skills shared by professionals or experts will give more information for the students to understand the given problem or challenge in real-life situation and develop appropriate or possible solutions. Students research and learn about landfills and other areas in the world that garbage is dumped and the implications for human vitality.
PLAN	From the possible solutions identified, students select the most appropriate solution that meets all the project requirements in terms of the criteria and constraints and design a plan for the preferred solution.
CREATE	Students construct their model using the plan developed from the preferred solution.
IMPROVE	Students evaluate their model and re-design or improve it.

Methods of Assessment

Some ways of Assessing are:

Questionnaires

• Oral

• Written

Tests

• Practical

• Written

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• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Keeping records of practical work

• Models

• Work samples

• Class and group projects

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

• Systemic observation

• Presentation to the class

Student records

• Student profile

• Student journal

• Working in progress folders

• Diaries

Student self-assessment

• Group discussion

• Concept mapping

• Peer assessment

• Self – assessment

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Case studies

• Completing activity sheets

• Concept maps

• Assignments

• Projects

• Articles from newspapers

Practical tasks

• Models

• Displaying activities outside

• Practical activity

• Solving Problems

• Applying concepts

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Processes and procedures

• Observing, identifying

• Recognizing investigating

• Classifying questioning, comparing, predicting, drawing conclusions, taking measures, putting forwards

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- Final Product - compost from the excess of water and food from their school's cafeteria
- Monitoring, observation, recording progress of their compost: record measurements such as soil temperature, pH, odor, and level of moisture while also
- Ways to aerate, weed, and water.

Activity six

Students devise a protocol/procedure for making compost/fertilizer/manure from the excess of water and food from their school's cafeteria. Students innovate and create a process for making good compost and will develop a marketing campaign to encourage students and staff to take part in the program.

Methods of Assessment

Some ways of Assessing are:

Questionnaires

- Oral
- Written

Tests

- Practical
- Written

Talking with students

- Informal observation
- Interview
- Questioning individuals and small groups
- Asking open-ended questions
- Telling stories
- Listening to students explanations

Keeping records of practical work

- Models
- Work samples

• Class and group projects

Observation of students

• Informing Observation

• Checklist and notes

• Running record sheets

• Watching working in progress

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• Student journal

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• Diaries

Student self-assessment

• Group discussion

• Concept mapping

• Peer assessment

• Self – assessment

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Case studies

• Completing activity sheets

• Concept maps

• Assignments

• Projects

• Articles from newspapers

Practical tasks

• Models

• Displaying activities outside

• Practical activity

• Solving Problems

• Applying concepts

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Processes and procedures

• Observing, identifying

• Recognizing investigating

• Classifying questioning, comparing, predicting, drawing conclusions, taking measures, putting forwards

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

- Devise of a protocol/procedure for making compost/fertilizer/manure from the excess of water and food from their school's cafeteria.
- Innovation and creation of a process for making good compost
- Development of a marketing campaign strategy or program
- Development of posters, brochures, drawings, charts, roleplay, drama, presentations, speeches

Activity seven

At the end of the first month, students will compile their data into a technical report that will be summarized and shared with the school community.

Students will calculate the savings in disposal costs, as well as in the repurposing of the compost to fertilize future gardens and replenish the soil.

In the end, students develop an informed understanding of the interdependent relationships in ecosystems and significant role decomposers play within these respective ecosystems (see Table 5.17).

Methods of Assessment

Some ways of Assessing are:

Questionnaires

• Oral

• Written

Tests

• Practical

• Written

Talking with students

• Informal observation

• Interview

• Questioning individuals and small groups

• Asking open-ended questions

• Telling stories

• Listening to students explanations

Keeping records of practical work

• Models

• Work samples

• Class and group projects

Observation of students

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• Student profile

• Student journal

• Working in progress folders

• Diaries

Student self-assessment

• Group discussion

• Concept mapping

• Peer assessment

• Self – assessment

Assessment Tasks

How can students show what they have learned?

Writing

• Essays

• Explanations

• Case studies

• Completing activity sheets

• Concept maps

• Assignments

• Projects

• Articles from newspapers

Practical tasks

• Models

• Displaying activities outside

• Practical activity

• Solving Problems

• Applying concepts

Visual representations

• Posters, flow charts drawings

• Diagrams, maps, tables

• Graphs, paintings, labels

Processes and procedures

• Observing, identifying

• Recognizing investigating

• Classifying questioning, comparing, predicting, drawing conclusions, taking measures, putting forwards

Oral tasks

• Answering questions

• Explaining

• Describing

• Relaying information

• Asking questions

• Interviewing

Students should show evidence of learning in the following areas:

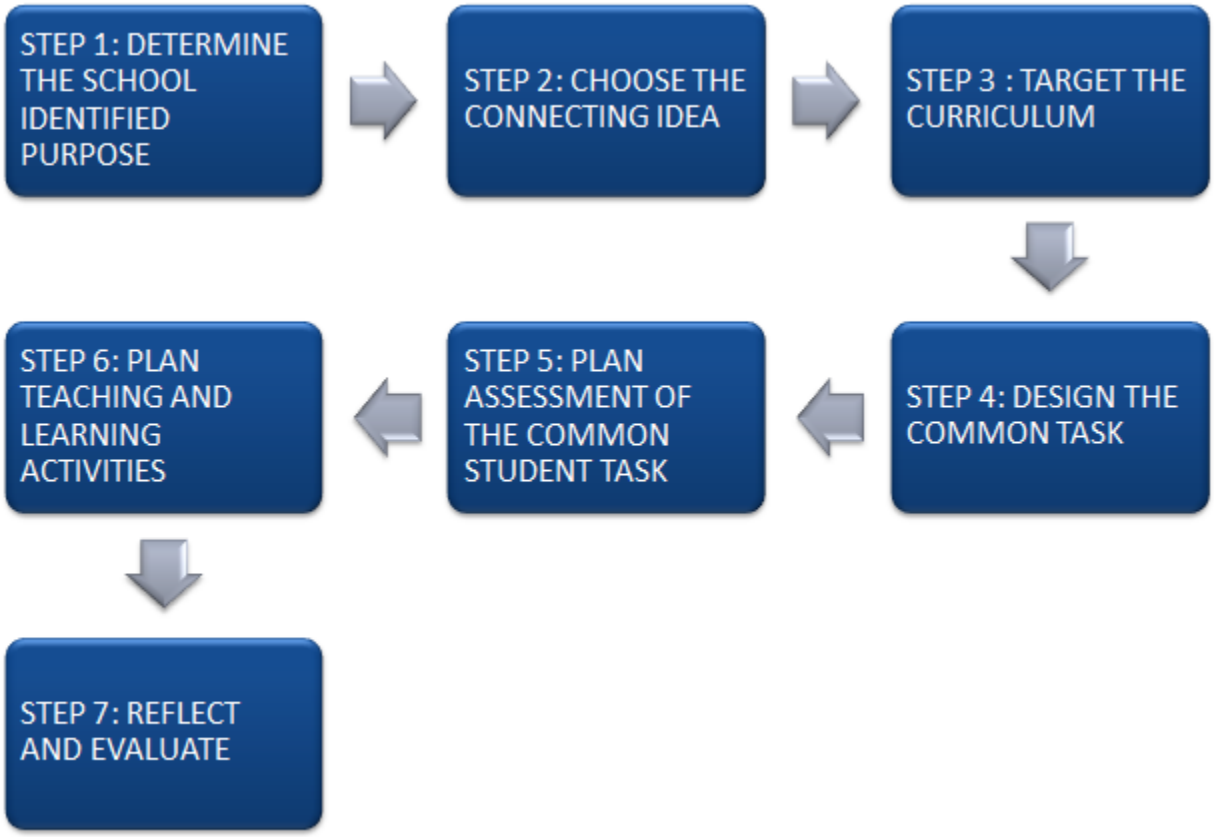
- Ecosystems
- Habitat
- compile data into a technical report that will be summarized and shared with the school community.
- Measurements, calculations
- interdependent relationships in ecosystems
- significant role of decomposers play within respective ecosystems

APPROACH THREE(3): PLANNING WORKBOOK

Teachers can use the Planning Workbook shown below to plan and implement a STEM project or unit of work.

The Planning Workbook has been adopted from the Australian Curriculum and Reporting Authority (ACARA) “STEM Connections workbook”. The “STEM Connections workbook “has been created from the action research project, STEM Connections Project to investigate the effectiveness of using an integral approach to teaching and learning of STEM disciplines.

SUGGESTED PROCESS FOR IMPLEMENTING A STEM CONNECTIONS PROJECT/UNIT OF WORK



CONTENTS	
STEP 1: DETERMINE THE SCHOOL IDENTIFIED PURPOSE	• What do you want students to learn? • What is your school hoping to achieve by undertaking a STEM connections approach? • What does the data tell you about this group of students?
STEP 2: CHOOSE THE CONNECTING IDEA	• Why does this learning matter? • What concept, theme, idea will link the different subjects together? • What knowledge and skills do you want the students to be left with once the unit has been completed? • Does the learning connect to the students world? • Does it form a basis for future learning? • Why teach this connecting idea? • Why does it matter for students to gain a deep understanding of this connecting concept?
STEP 3 : TARGET THE CURRICULUM	• What does this connecting idea look like

	I the PNG curriculum and you current program? • Will the sequencing of the topics for the term need to be adjusted? • What content and outcomes from each learning area are appropriate for the unit of work?
STEP 4: DESIGN THE COMMON TASK	• What are you doing to get the students to do or produce? • What is the common task for the students to complete? • Which activities will develop the deep, integrated knowledge you are looking for? • How will students be supported with this task?
STEP 5: PLAN ASSESSMENT OF THE COMMON STUDENT TASK	• How well do you expect students to perform and have you clarified what you expect in terms of a high quality performance or product? • How will you asses the “common student task”? • How will you asses achievement of the identified purpose? • How will you asses achievement of the chosen content descriptions within individual learning?
STEP 6: PLAN TEACHING AND LEARNING ACTIVITIES	• What learning experiences will most effectively develop the skills and knowledge you want students to have as a result of this project? • How will you ensure that the learning experiences you provide are authentic for the task? • What type of activities best suit a project of this type? • How will you make connections between the STEM disciplines explicit as well as relevant? • What can you use that you already have and what will need to be reprogrammed and resourced? • How will you plan to teach explicit aspects of literacy, numeracy, ICT capability, critical and creative thinking, and the curriculum? • What help will you need?
STEP 7: REFLECT AND EVALUATE	• How will you know whether the project

	is achieving its aims? • Reflect regularly on the progress of the unit of work to address logistical and pedagogical challenges. • Reflect on and evaluate the project at its conclusion, both individually and as a team. • Write a report of the project as a guide for future projects.

TEACHER ACTIVITY

Identify a real-world problem within the school or local community that can be solve using integrated STEM approach.

The STEM Project should relate to real-life situations/problems affecting the school or community and their environment.

As a STEM teacher, make a difference using the STEM project and apply the integrated STEM approach to enable students to understand and develop new knowledge about how they can think more globally.

There are numerous overlaps and interconnections between the content knowledge and skills of each STEM discipline, and in turn discipline-specific curricula. With this project, students should develop the ability to identify content and skill based conceptual connections within and between the STEM disciplines. Students should be able to defining learning goals that are aligned to the content and skills of the disciplines, which will develop their connected STEM understanding and skills.

Problem

The school is currently concern on the polluted river system used by the school and therefore wants to protect, restore and promote sustainable use of terrestrial ecosystems in the river.

Project

Students will plan, build, promote and sustain own school aquatic ecosystem.

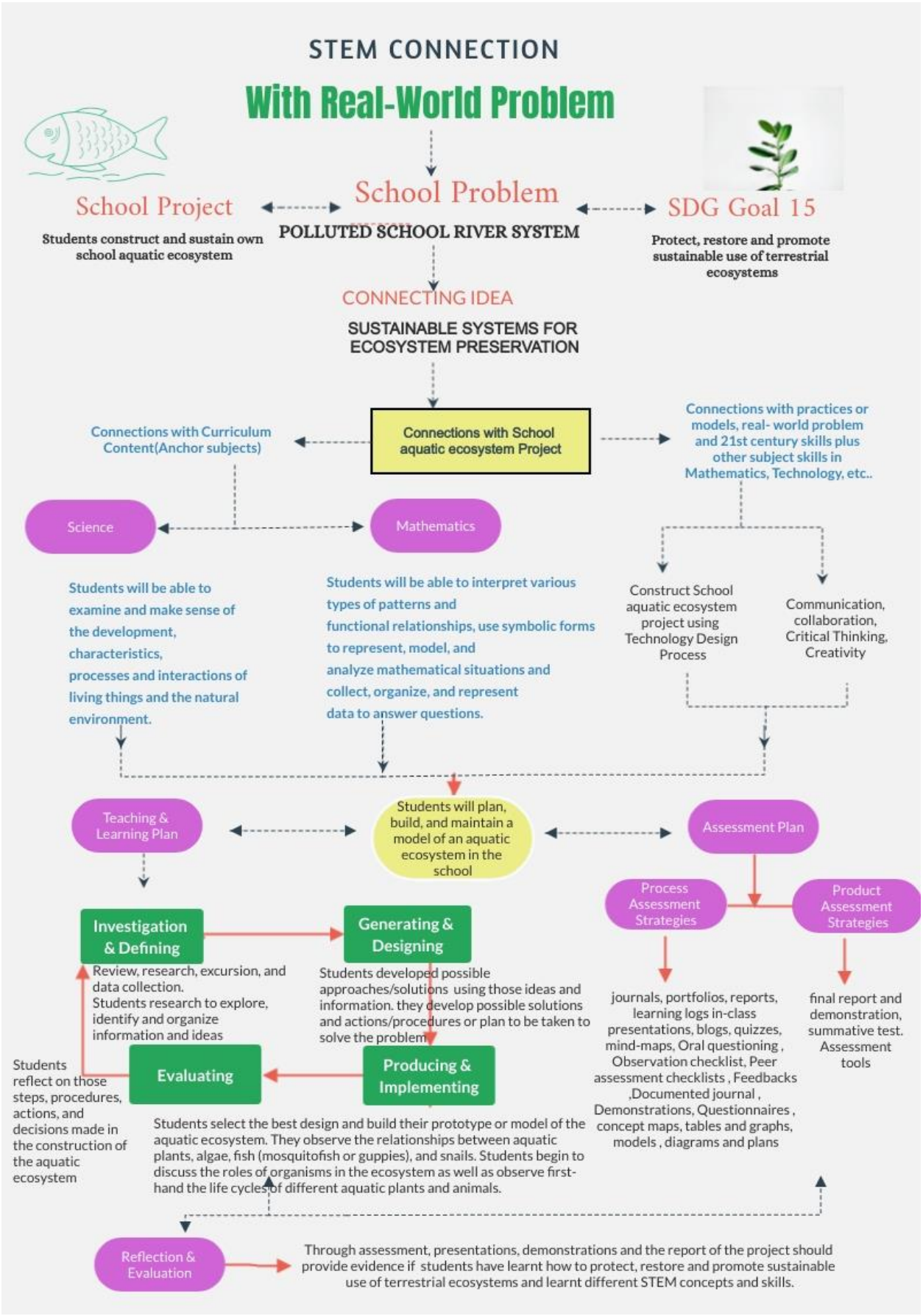
Project Plan/Proposal

The STEM project connects to a real-world problem and it requires materials and funding from the school to implement. In order to secure funding from the school, “sell” your teaching plan to your school principal. As a part of your planning in STEM learning, you will develop an integrative STEM planning workflow that must be captured your project plan that contains evidence of and reflections on your learning.

The project plan should reflect the learning of STEM concepts and the development of 21st century skills aligned to the intentions of the curriculum, identify all other connections in terms of the STEM practices used and technologies required.

To “sell” your teaching plan to your school principal the teacher can apply relevant technologies such as create an infographic that needs to effectively convey information about the workflow within the teaching plan focused on integrated STEM. Your teaching plan within the infographic can target one of the UN’s Sustainable Development Goals and show how integrated STEM teaching can be adopted with your context in terms of the PNG curriculum, availability of technologies, grade, teaching and learning resources required for the STEM project on building, preserving and sustaining aquatic ecosystems.

An example of a teaching plan within the infographic that can be use to “sell” your teaching plan to your school principal is shown below. In order to convince your principle to fund your project, your teaching plan within the infographic must effectively convey information about the workflow within the teaching plan focused on integrated STEM.



STEM Planning Workflow

As a part of your planning in STEM learning, you should develop an integrative STEM planning workflow that contains evidence of and reflections on your learning.

Your teaching and learning plan should capture the following:

- Identifying the connections within and across the STEM disciplines in terms of both discipline concepts and skills, and leveraging these connections to craft authentic transdisciplinary learning experiences which are aligned to the relevant curricula.
- Techniques for planning an instructional sequence and the selection of appropriate teaching resources.
- Teaching strategies that can be employed to guide the development of learners' social, ethical and cultural capability as they work both individually and in groups to solve problems.

Shown below is an integrative STEM planning workflow based on the aquatic ecosystem STEM project. The STEM planning workflow contains evidence of and reflections on learning and was developed through the Planning Workbook.

STEP 1: DETERMINE THE SCHOOL IDENTIFIED PURPOSE

What do you want students to learn about the UN's MDG?

SDG Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Regarding SDG Goal 15, the students will look at Ecosystem Preservation and learn how to protect, restore and promote sustainable use of terrestrial ecosystems in the river that supplies the school. Students will be given the opportunity to explore factors necessary to sustain an ecosystem as well as observe the diverse and unique life cycles of living organisms.

What is your school hoping to achieve by undertaking a STEM Connections project?

- Successful completion of the project
- Construction and sustainability of own school aquatic ecosystem

- Students apply what they have learnt throughout the project during research, data collection, construction and sustaining of the model of the ecosystem to their community ecosystems.
- Students apply what they have learnt in terms of concepts, processes, principles, models, skills, values and attitudes from the different subjects to solve other real-world problems.
- Making awareness to other students and their communities on how to protect, restore and promote sustainable use of terrestrial ecosystems in their communities.
- Students will write an essay or report on how to protect, appreciate, and take care of ecosystems and publish it on the education website as well as presenting it during their awareness on ecosystems preservation.
- Under the School Learning Improvement Plan (SLIP), documentary evidence of the project is required to be presented to the parents and board members of the school during school meetings.
- All forms of data collected before, during and after the project. The data provides useful information about the school, project, funding and analysis of the research findings.

School identified purpose

Project leader: Science HOD	**Class or classes involved: 4 Grade 9 Science classes**
Participating teachers: Four Grade 9 Science Teachers, One Mathematics, English and Technology and Industrial Arts teacher.	**Duration/Timing of unit:** The duration of the project is 10 weeks for the students to complete their project but within the 10 weeks, 9 contact lessons will be used for review of content, activities such as research, excursions, data collection, presentations by professionals or experts. Not forgetting their presentation of the final product during the school expo
What do we know about these students? • These are grade 9 science students who just completed their units on food chain, food web and energy transfer • Plants and animals adaptation • Species, Population and Habitats Which is a build up from primary where they have studied : Grade 8 Science • basic research skills to investigate the environmental changes caused by human activity and natural events, and draw appropriate conclusions • the effects of environmental changes on living things (for example, species extinction). • different types of pollution and evaluate their effects on the ecosystem. • ways of managing and conserving the natural environment, and propose strategies for improvement.	

Grade 6,7,8 Social Science

- Physical and Human Environment
- Effects of Environmental Change
- Human Impacts on Environment
- Environmental Sustainability
- Natural Hazards

Grade 6,7,8 Mathematics

- measure various quantities of measurements using the metric units, and appreciate their usefulness in daily life.
- Determine units of quantities used in everyday life and ways to represent them.
- able to investigate the changes and correspondence of two quantities, examine linear functions using algebraic expressions, tables, and graphs with appreciation.
- able to comprehend the probabilities of uncertain phenomena and find the probability of uncertainty events

Students are excited to take the research and complete their projects. Even they are excited to display and explain their projects to others during the school expo day.

School identified purpose

What are the specific learning needs of this group of students?

Through this project

- Students need to learn how to protect, restore and promote sustainable use of terrestrial ecosystems in the river that supplies the school, which has been polluted.
- Students to be given the opportunity to explore through research and projects factors necessary to sustain an ecosystem as well as observe the diverse and unique life cycles of living organisms in the river system.
- To find solutions to a real-life problem which is captured in the **SDG Goal 15.**
- Students apply what they have learnt throughout the project during research, data collection, construction and sustaining of the model of the ecosystem to their community ecosystems.
- Students apply what they have learnt in terms of concepts, processes, principles, models, skills, values and attitudes from the different subjects to solve other real-world problems.
- Making awareness to other students and their communities on how to protect, restore and promote sustainable use of terrestrial ecosystems in their communities.

STEP 2: CHOOSE THE CONNECTING IDEA

How can we find a meaningful connection?

Complete the following activities to confirm your connecting idea, or to find one.

Activity 1

Write your answers to the following questions below.

Is there a whole-school focus that our school community is currently concerned with? For example: • an issue connected with a MDG • an essential question we want students to investigate more deeply • cross-curriculum content (such as sustainability)	The school is currently concern on the pollution of the river system used by the school and therefore want to protect, restore and promote sustainable use of terrestrial ecosystems in the river.
What engages our students? What are the students' ideas and interests?	To preserve the ecosystems in the river and around the school community, Grade 9 science students are task to devise, build, and maintain models of terrestrial and aquatic ecosystems. Students given the opportunity were interested to explore factors necessary to sustain an ecosystem as well as observe the diverse and unique life cycles of living organisms within the ecosystem.
What have students learned in previous years? What can they do?	**Grade 6 Science** • paths of the water transport system in plants and their functions. • transportation of water to all parts of the plant through the roots, stem, and leaves. • process of transpiration in plants. • basic research skills to investigate the food chains in different environments such as land and ocean, and draw appropriate conclusions. • relationship between the organisms in the food chain such as prey and predator. • food webs in different environments such as land and ocean. • relationship between the organisms in the food web such as producers and consumers. • the impact of population change in a food chain or a food web. • the roles of decomposers and the recycle of energy in a food chain.

	Grade 7 Science • flowering and non-flowering plants, and their characteristics. • groups of animals that are vertebrates and invertebrates, and their characteristics. • different components of an ecosystem. • the relationships of living and non-living organisms in an ecosystem. • the roles of organisms in the ecosystem. • possible causes and effects of population change of organisms in an ecosystem such as competing for resources; water, food and space. • different types of communities in the environment such as ponds, oceans, and soil. **Grade 8 Science** • basic research skills to investigate the environmental changes caused by human activity and natural events, and draw appropriate conclusions • the effects of environmental changes on living things (for example, species extinction). • different types of pollution and evaluate their effects on the ecosystem. • ways of managing and conserving the natural environment, and propose strategies for improvement. **Grade 6,7,8 Social Science** • Physical and Human Environment • Effects of Environmental Change • Human Impacts on Environment • Environmental Sustainability • Natural Hazards **Grade 6,7,8 Mathematics** solve problems involving fraction, decimal and percentages accurately • relationship between fractions, decimals, and percentages, and convert and appreciate their usage in daily life • measure various quantities of measurements using the metric units, and appreciate their usefulness in daily life. • Determine units of quantities used in everyday life and ways to represent them. • Identify how systems of metric units relate to measurements.

	• Use metric units effectively in measuring quantities. • able to investigate the changes and correspondence of two quantities, examine linear functions using algebraic expressions, tables, and graphs with appreciation. • able to comprehend the probabilities of uncertain phenomena and find the • probability of uncertainty events. **What can they do?** • Students having learnt some of the basic concepts mentioned above including what they have learnt in grade 9, they should be able to use those concepts from different subject areas in their project. • They must have an understanding of research design and how data can be generated from a broad range of scientific fields and efficiently analyze those data sets. • Students will even write an essay on how to protect, appreciate and take care of a river system and ecosystems. • Students are being confronted/tasked with a real-world problem which they must value and appreciate finding its solutions • They must also take the challenge of integrating different subject concepts with the project, work in groups, communicate and share ideas, be critical and creative in their decision making. • The school is prepared to fund the project since is part of their learning and assessment.

What resources does our school community have that can be used?	
What ideas, interests, and areas of expertise do we have and how do they link to curriculum?	• There are many online resources that students will utilize to support them with their project • Teacher will provide prepared activities • Other subject teacher specialists will also assist whenever they are required throughout the project.
What funds are available? Are there any pre-existing projects or funds with goals consistent with the aims of this project?	The school is prepared to fund the project since is part of their learning and assessment and also part of the School Learning Improvement Plan(SLIP)
What can we focus on (about the MDG) that would address the school identified purpose outlined above?	SDG Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt

	biodiversity loss Regarding SDG Goal 15, the students will focus on the building and maintaining of the models of terrestrial and aquatic ecosystems that demonstrates/ signifies that the school wants to protect, restore and promote sustainable use of terrestrial ecosystems in the river that supplies the school.

What is your connecting idea?

The school is currently concern on the pollution of the river system used by the school and therefore wants to protect, restore and promote sustainable use of terrestrial ecosystems in the river.

The connecting idea is based on Sustainable Systems for Ecosystem Preservation.

The connecting idea on Sustainable Systems for Ecosystem Preservation will enable students to learn the different concepts, processes, principles, models and skills from different subjects.

- Students will apply different discipline concepts learnt previously
- Develop a lifelong knowledge, skills, values and attitudes to conserve and maintain different types of ecosystems around the school and their communities.
- Value and appreciate the different ecosystems and their interactions with the surrounding environment.
- Explore factors necessary to sustain an ecosystem
- Observe, value and appreciate the diverse and unique life cycles of living organisms

Why does this learning matter?

The learning of the concepts on sustainable systems for ecosystem preservation is important for students to explore different ways to maintain the different types of ecosystems around the school.

They will also apply what they have learnt and construct a model of an acquatic ecosystem. From the model, they will be able to observe the relationship between aquatic plants, algae,

fish and snails. From what they will learnt through the model, they can be able to apply their knowledge on ecosystems to their community's ecosystems.

Activity 2

The connecting idea

In this exercise, you are referring to the connecting idea.

Why does this learning (the connecting idea) matter to our students?

The connecting idea on Sustainable Systems for Ecosystem Preservation will enable students to learn the different concepts, processes, principles, models and skills from different subjects.

- Learnt different concepts from different disciplines
- Students will apply different discipline concepts learnt previously
- Develop a lifelong knowledge, skills, values and attitudes to conserve and maintain different types of ecosystems around the school and their communities.
- Value and appreciate the different ecosystems and their interactions with the surrounding environment.
- Explore factors necessary to sustain an ecosystem
- Observe, value and appreciate the diverse and unique life cycles of living organisms
- Formulate explanations by using logical thinking and evidence.
- Organise their findings and data scientifically
- Apply the correct way of presenting data and findings
- Appreciate the way data and findings are presented scientifically
- Students use the science journal process to write a journal for their investigation on ecosystem preservation
- Select and use appropriate tools such as microscope and technology to perform tests, collect data, analyse relationships, and display data
- Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data.
- Apply the skills used in using topographic maps in other related subjects.
- Use appropriate tools and techniques to make observations and gather data
- Communicate findings on the use of topographic maps
- Apply the skills learnt on how topographic maps are used to communicate findings about the life and nature.
- Identify and examine possible reasons why it is important to utilise controls and variables in the ecosystem preservation investigations.
- Demonstrate how controls and variables are used in science experiments
- Apply the steps and processes involved in carrying out scientific research
- Understand and effectively use the dichotomous key in classifying living things based on their characteristics.
- Create their own dichotomous keys according to their contexts in studying the 6 kingdoms
- Compare internal and external structures of living things
- Observe and record data of organisms

- Infer using the characteristics of organisms and explain these can be used to separate organisms into two.
- Apply the skills involved in carrying out a scientific research
- Appreciate the importance of classifying living things in real world.
- Explain through research that different species of plants can be classified using their characteristics.
- Evaluate and use dichotomous key to classify different species of plants.
- Communicate research findings on different plant species.
- Explain the organization of life on Earth using the modern classification system.
- Describe the diversity of animal kingdom
- Investigate the specimens and characteristics of different animal species and classify these organism into which of the 6 kingdoms.
- Evaluate through research that different species of plants can be classified using their characteristics.Build confidence in ways of presenting findings scientifically.
- Students will be able to examine and make sense of the development, characteristics,processes and interactions of living things and the natural environment.
- Facilitate students' interest, attitudes and determination in terms of career development and exploration
- Students will utilize all kinds of resources including those that they have in the school, online resources and resources from the community or from other stakeholders

Why does this learning (the connecting idea) matter to students in my class/subject?

- Science subject and mathematics will be the anchor for the connecting idea and so my grade 9 science students will contribute immensely and meaningfully.
- Most of the learning goals relating to the connecting idea and the project will be anchored in science and mathematics so my science students will have a greater advantage in terms of their participation and contribution of meaningful ideas.
- Learning goals (what you want students to know) provide coherence between the instructional activities (how students will come to know what you want them to know) and assessments (how you determine whether students have come to know what you want them to know) (Wiggins & McTighe, 2005). Explicit attention is given within the learning goals to the connections between disciplines.
- My students will be heavily engaged with the project and so the connecting idea will develop deeper, transferable understanding.
- They will develop reasoning about interdisciplinary problems and phenomena connected to the connecting idea.
- Students will value and appreciate the ecosystems in and around the school as well as in their own communities
- Students will construct a model of an aquatic ecosystem
- Students will be able to experience and learn from the model of integrating STEM content and practices such as the Bybee's 5E's model.
- From the model used the engineering practices require students to use informed judgment to make decisions and help them develop habits of mind such as troubleshooting, pulling from prior experiences, and learning from failure (Moore, Guzey, & Brown, 2014).

- The real-world problems engage students in issues that are significant in everyday life and have more personal and/or social relevance.
- Furthermore, the teamwork involved in solving real-world problems or tasks provides opportunities to understand the interdisciplinary nature of STEM through rich, engaging, and motivating experiences that require teams of students to solve them. Teams of students need to communicate their processes and results (Carlson & Sullivan, 2004; Dym, et al., 2005; Frykholm & Glasson, 2005; Selingo, 2007; Smith, et al., 2005).

STEP 3: TARGET THE PNG CURRICULUM

How does the connecting idea connect with the PNG curriculum?

The connecting idea in this project connects concepts and skills from different disciplines or subjects within the PNG Curriculum. The connecting idea makes connections within Science subject concepts as the anchor but also across/between other disciplinary knowledge.

The connection of the connecting idea is also determined by the different strategies or practices applied and how each practice is used at various stages of the project. Even the connected idea is connected to a real- world problem and the 21st century skills.

According to PNG Standards-Based Curriculum, the connection of the connecting idea in terms of concepts and skills from different disciplines are captured through the grade 9 learning standards called Benchmarks which are shown in the table below.

Science_____

- Formulate explanations by using logical thinking and evidence.
- Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data.
- Students will be able to explain the nature and the processes of scientific inquiry and use the modes of scientific inquiry and habits of mind to investigate and interpret the world around them.
- Apply the steps and processes involved in carrying out scientific research
- Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
- Understand the types of modern form of metric system, called the International System(SI).
- Apply the (SI) units correctly in classroom activities and in daily life.

- Identify locations on a map or real life locations using scientific equipment such as compass and directions of N/S/E/W.
- Use reference points to describe locations in both physical and natural environments.
- Explain the importance of the reasons for the usage of topographic maps in science.
- identify and examine possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Distinguish between hypothesis and theory as scientific terms.
- Explain the organization of life on Earth using the modern classification system.
- Students will be able to examine and make sense of the development, characteristics,processes, and interactions of living things and the natural environment.
- Explain the organization of life on Earth using the modern classification system.
- Investigate the different cell parts, their functions, and how they are specialized into different tissue and organs.
- Investigate and explain the chemical reactions that occur in photosynthesis and cellular respiration and that results in cycling of energy.
- Explore the differences between the processes of mitosis and meiosis.
- Investigate and explain the chemical reactions that occur in photosynthesis and cellular respiration and that results in cycling of energy.
- Assess dynamic equilibrium in organisms, populations and ecosystems and explain the effect of equilibrium shifts.
- Investigate and describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Examine the dynamic equilibrium in organisms, populations, and ecosystems and explain the effect of equilibrium shifts.

Technology and Industrial Arts

- Describe the functions of tools and equipment and their safe usage
- Select and use appropriate technology to creatively document, communicate and present design and project work
- Apply mathematical skills and scientific concepts in the planning and building of a variety of construction projects
- Outline management and problem solving skills using the engineering design process.
- Explore the use of technical terminology, basic scientific concepts, and mathematical concepts used in communications technology and apply them to the creation of media products.
- Comprehend and explain the Computer System and types of computer.
- Investigate and describe the design brief of solving problems.
- Explore programming software and applications
- Demonstrate the understanding of Operating Systems/ Software and File Management
- Apply typing skills with speed (20wpm) and accuracy (80%)
- Create documents using Microsoft Office
- Explore the Authoring Software or Multimedia associate software

Mathematics

- use appropriate rules and various representations of directed numbers and mixed operations to solve authentic problems
- use ratios, proportions and percent to represent the relationship between two quantities and solve problems.
- Use and represent factors, multiples, primes, composites, in various forms and situations.

- Apply metric systems of measurements to solve problems.
- Solve problems with rates and interpret related graphs.
- Apply and interpret linear relation modelling practical situations.
- Solve linear simultaneous equations, using algebraic and graphical techniques including usage of digital technology.
- Investigate and solve single variable equations and inequalities using rational number line and use nuberline to graph the solutions.
- Represent a variety of patterns, including recursive patterns, with tables, graphs, words and symbolic rules.
- Identify and apply appropriate mathematical formulae to find values of various patterns.
- Solve various problems on number patterns.
- Design a study, collect data, and select the appropriate representation to make conclusions and generalizations.
- Compute probabilities using appropriate methods such as lists and tree diagrams or through experimental or simulation activities.

STEP 4: DESIGN THE COMMON STUDENT TASK

What will your students do or produce?

Students will plan, build, and maintain a model of terrestrial and aquatic ecosystem which is the connecting idea on Sustainable Systems for Ecosystem Preservation

STEP 5: PLAN ASSESSMENT OF THE COMMON STUDENT TASK

What formative and summative assessment strategies can be implemented?

Think about process and product assessment strategies.

Subject level : Science
Assessment Task One Students will use internet, library, class notes, survey, interview people and experts; use other resources to research different types of food webs in different ecosystem and present findings. Students in their groups work on different types of food webs in different ecosystem. They will research a daily life of a selected species and present findings on how it lives in that ecosystem. Their research will focus on concepts regarding food chain, food web, energy transfer. They will document their research using the science journal and write a research report based on their findings to be presented to the class.

The different types of assessment tasks includes:

- Documentation using journal
- Report
- Assignment
- Practical Test
- Questionnaire
- Concept map
- checklists

The different assessment tasks covers concepts on the following:

- different types of food webs in different ecosystem
- identify and explain the main parts of a food web
- food chain, food web and energy transfer
- Students must explain how each species in an ecosystem depends on each other
- Students will investigate the roles each part of the food web plays in an ecosystem.
- Similarities between food chains and food webs
- Parts of a food web
- Role or niche of species in an ecosystem
- Effects of insecticides on food webs
- Classify different species in an ecosystem
- Evaluate which species or organism belongs to a food web
- Appreciate the importance and the roles the decomposers and other parts of the food web in an ecosystem
- Explain how each species in an ecosystem depends on each other
- Investigate the roles each part of the food web plays in an ecosystem

Assessment Task Two

Teacher to plan and organize class/grade excursion to a reserve park to research some causes and effects of organisms' population and adaptation in an ecosystem

Students in their teams will research to explore, identify and organize information and ideas based on plants and animals adaptation
Teacher will design a set of research questions to be used during the excursion to a reserved park for plants or animals and write a report and present findings to the class.
Their research will focus on Plants and animals adaptation

The different types of assessment tasks include:

- guided interview questions
- questionnaires for students to complete
- Report
- Science journal

The different assessment tasks covers concepts on the following:

- causes and effects of organisms' population and adaptation in an ecosystem
- Assess dynamic equilibrium in organisms, populations and ecosystems and explain the effect of equilibrium shifts
- describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Identify the causes and effects of organisms' population and their adaptation in different ecosystems
- Describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Investigate the effects of equilibrium shifts
- Causes and effects of equilibrium shifts
- Plants and animals adaptation
- Population and ecosystems
- Environmental factors or personal choices that may lead to an organism's genetic mutation
- Analyse environmental factors that can result in equilibrium shifts
- Evaluate different ways that a plant or animal can adapt
- Explore examples of genetic mutation

Assessment Task Three

Students will research how people meet their basic needs in a selected community and present findings.

Their research will focus mainly on Species, Population and Habitats and document their research findings in their science journal. They will use the journal to write an essay based on their research findings.

The different types of assessment tasks include:

- research questions or questionnaire
- assignment
- checklists
- concept maps
- science journal
- essay

Teacher will design a set of research questions or questionnaires, checklist; concept map to be used during the research based how people meet their basic needs in the selected community. Students will document their research using the science journal and later write an essay based on the research. The assessment tasks will focus on the following concepts:

- They will record their research findings in their science journal for presentation and report purposes towards the end of the project. Teacher will also assess their science journal and their essay
- explain how the dynamic equilibrium of organisms related to populations and ecosystems
- explain population growth in the community and how are people finding the food, water, and land they need, and explain if these factors limiting population growth
- Research how people meet their basic needs in their community

- Identify and explain causes and effects of equilibrium shifts in different ecosystems within the community
- Research and identify population, species, and habitats in the community
- Explain equilibrium in organisms, populations and ecosystems and how they are linked/relate
- Investigate and explain the dynamic equilibrium in organisms, populations and ecosystems
- Promote sustainability and inter-relationships amongst all life in the communities
- Investigate the equilibrium dynamics in organisms and its relationship to population s of organisms and their ecosystems and the effects of equilibrium shifts.
- Describe equilibrium in organisms, populations and ecosystems and the effects if there is a shift

Assessment Task Four

Teacher or school invite professional or experts to

- explain some concepts relating to their project which are link to the curriculum. They will also reinforce opportunities for students to pursue their interests in fields such field biology, environmental science, law, and other career opportunities that relates to the project they are engaged in
- encourage students to explore different skills, practices, and knowledge associated with the project
- provide students with the opportunity to plan and carry out investigations in the field, analyze and interpret data from the field, and communicate results from their field studies to a larger audience, use their knowledge of the natural sciences to protect the environment and human health, monitor the quality of the environment (air, water, and soil), interpret the impact of human activities on terrestrial and aquatic ecosystems, and provide strategies for restoring ecosystems.
- assist students develop plans on how to protect water resources and reflect efficient and beneficial land use
- introduce different software applications to make their work easier and more efficient

The different types of assessment tasks include:

- guided questionnaires
- checklists
- journal
- report

Assessment Task Five

Students will use their science journal, guided questions, checklist, questionnaires, record sheets for data compilation and presentation, camera when students in small teams investigate the school river ecosystem to better understand the interaction between living creatures, energy, and the non-living in regard to food chain, food web, energy transfer, plants and animals' adaptation, species, population and habitats.

They will document their research in their science journal and write a report based on their

findings and present it to the class.

The different types of assessment tasks include:

- guided interview questions
- questionnaires for students to complete
- Report
- Science journal
- Checklists
- Concept maps
- Assignment
- Test

The different assessment tasks covers concepts on the following:

- food chain, food web, energy transfer
- plants and animals' adaptation
- species, population and habitats
- Identify and explain causes and effects of equilibrium shifts in different ecosystems within the river system
- Research and identify population, species, and habitats in the river
- Explain equilibrium in organisms, populations and ecosystems and how they are linked/relate
- Investigate and explain the dynamic equilibrium in organisms, populations and ecosystems
- Investigate the equilibrium dynamics in organisms and its relationship to population s of organisms and their ecosystems and the effects of equilibrium shifts.
- Describe equilibrium in organisms, populations and ecosystems and the effects if there is a shift
- different types of food webs in different ecosystem
- identify and explain the main parts of a food web
- Students must explain how each species in an ecosystem depends on each other
- Students will investigate the roles each part of the food web plays in an ecosystem.
- Similarities between food chains and food webs
- Parts of a food web
- Role or niche of species in an ecosystem
- Effects of insecticides on food webs
- Classify different species in an ecosystem
- Evaluate which species or organism belongs to a food web
- Appreciate the importance and the roles the decomposers and other parts of the food web in an ecosystem
- Explain how each species in an ecosystem depends on each other
- Investigate the roles each part of the food web plays in an ecosystem
- causes and effects of organisms' population and adaptation in an ecosystem
- Assess dynamic equilibrium in organisms, populations and ecosystems and explain

the effect of equilibrium shifts

- describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Identify the causes and effects of organisms' population and their adaptation in different ecosystems
- Describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Investigate the effects of equilibrium shifts
- Causes and effects of equilibrium shifts
- Plants and animals adaptation
- Population and ecosystems
- Environmental factors or personal choices that may lead to an organism's genetic mutation
- Analyse environmental factors that can result in equilibrium shifts
- Evaluate different ways that a plant or animal can adapt
- Explore examples of genetic mutation

Assessment Task Six

- **Investigation and Defining the problem**
- **Generating and Designing possible solutions, plans, procedures to build the aquatic ecosystem**

Investigation and defining the research information, data collected from the previous researches done earlier

Teacher will pose relevant questions on the possible solutions or plans based on the model of the aquatic ecosystem. Relevant questions and different assessment tasks will be used to identify the most possible solutions or plans to use construct the model of the aquatic ecosystem

The different types of assessment tasks include:

- guided interview questions
- Report
- Science journal
- Checklists
- Concept maps
- Assignment
- Test

The different assessment tasks covers concepts on the following:

- defining and understanding the problem that they have to solve
- brainstorming of ideas based on their findings from the previous activities or research done earlier
- exploring of factors necessary to sustain an ecosystem and how to develop a model of terrestrial and aquatic ecosystem
- development of possible plans on how to plan, build, and maintain a model of ecosystem

- development of plans on how to build and sustain an ecosystem
- generation of ideas and brainstorming of possible designs
- development of different solutions/designs for their model
- sketching of different possible deigns with different measurements for their model ecosystem taking into consideration the researched information that they have collected
- development of possible solutions on the different types of materials and the measurements to use
- Measurements of designs and type of materials required
- Possible designs and number and type of materials required
- Possible designs and cost of materials
- discussion of possible solutions on the type of organisms they will consider for their aquatic ecosystem and how to sustain or maintain the aquatic ecosystem
- relationships between type of organisms they will consider for their aquatic ecosystem

Students will developed possible approaches/solutions to each relevant question and using those ideas and information they develop possible solutions and actions/procedures or plans to be taken to solve the problem

Assessment Task Seven

- **Producing & Implementing aquatic ecosystem using the best design, solution and plan**
- **Evaluating their model, plans, procedures used in building the aquatic ecosystem**

Students select the best solution for their aquatic ecosystem design based on constraints and criteria such as cost and time, they build their prototype or model of the aquatic ecosystem. Their work will be evaluated by a rubric to assess their performance and output.
Students select most appropriate solution in terms of the correct materials and their measurements, they construct the first model of the aquatic ecosystem.
Observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements.
Explain or justify the results identified in the process of the aquatic ecosystem design.
Formulate new approaches/solutions to the construction of the aquatic ecosystem . Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed. Students testing their model and design a new course of action or re-design.
Students test their model. They also do a group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem.

The different types of assessment tasks include:

- Rubric
- guided interview questions
- Report
- Science journal
- Checklists
- Concept maps
- Assignment
- Test

- Peer and group evaluation sheets
- Presentations
- final report and demonstration
- portfolios
- Charts
- questionnaires
- record sheets for data compilation and presentation
- camera
- reports
- learning logs
- in-class presentations
- blogs
- task reflection questionnaire
- Summative Test
- mind-maps
- Oral questioning
- Observation checklist
- Peer assessment checklists
- Feedbacks
- Demonstrations
- Questionnaires
- concept maps
- tables and graphs
- models
- diagrams and plans;
- demonstrations

The different assessment tasks covers concepts on the following:

- criteria used in selecting the best solution for their aquatic ecosystem design
- development and evaluation of a rubric to assess their performance, output and final product
- collaboration, communication, critical thinking and creativity
- selection of most appropriate solution in terms of the correct materials and their measurements
- observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements
- explain or justify the results identified in the process of the aquatic ecosystem design

- formulation of new approaches/solutions to the construction of the aquatic ecosystem
- Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed.
- testing their model and design a new course of action or re-design
- group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem
- reflection on those steps, procedures, actions, and decisions made in the construction of the aquatic ecosystem
- reflect and explain their choices/actions and thinking involved or taken in the aquatic ecosystem design
- improvement of their aquatic ecosystem design or redesign of their model of the aquatic ecosystem that solve the given problem

Assessment Task Eight

Observation of the relationships between plants and animals in the aquatic ecosystem

Students observe the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails. Students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals.

The concept of 'sustainable' is further explored by instructing students to find out different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive.

The different types of assessment tasks include:

- Observation checklists
- Recording and measurement tables and graphs
- guided interview questions
- Report
- Science journal
- Checklists
- Concept maps
- Assignment
- Test
- Peer and group evaluation sheets
- Presentations
- portfolios
- Charts
- record sheets for data compilation and presentation
- in-class presentations
- task reflection questionnaire
- Summative Test
- mind-maps
- Oral questioning

- Observation checklist
- Peer assessment checklists
- Feedbacks
- Questionnaires
- concept maps
- tables and graphs
- models
- diagrams and plans

The different assessment tasks covers concepts on the following:

- observation of the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails
- discussions of the roles of organisms in the aquatic ecosystem
- life cycles of different aquatic plants and animals in the aquatic ecosystem
- different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive

Assessment Task Nine

Application of concept learnt

Finally, students apply what they have learned when they constructed their own ecosystems and apply their knowledge to their community's ecosystem and do awareness to the surrounding communities as well as present their project to the school during the school expo.

The different types of assessment tasks include:

- essay
- blogs
- reports
- posters
- charts
- flyers
- brochures
- pamphlets
- skits (play-lets)
- song and dance
- mime
- puppetry
- Peer and group evaluation sheets
- Presentations
- portfolios
- Charts
- record sheets for data compilation and presentation
- concept maps

- tables and graphs
- models
- diagrams and plans

The different assessment tasks covers concepts on the following:

- write an essay on how to protect, appreciate, and take care of a local natural pond, creek, o park
- write report
- write a blog on how to protect, appreciate, and take care of a local natural pond, creek, or park
- presentation
- development of record sheets for data compilation and presentation, concept maps, tables and graphs, models, diagrams and plans, development of essay , blogs, reports posters, charts, flyers, brochures, pamphlets, skits (play-lets), song and dance, mime, puppetry, presentations and charts

Subject level : Other subjects/disciplines

Mathematics

- Data collection
- Modelling
- Data processing using excel or other tools
- Graphical representations
- Data analysis
- Reporting/explanation/justification of analyzed data

Technology and Industrial Arts

- Fluency in the use of tools such as camera, computer to analyzed data
- Digital technology to model relationships between two quantities
- Understanding of the technology design process
- Modelling and engineering design process
- development of blogs, posters, charts, flyers, brochures, pamphlets

Arts

- development of skits (play-lets), song and dance, mime, puppetry
- sketch/drawings

English

- write an essay
- write a report
- write a blog
- science journal
- presentation
- development of essay , blogs, reports

PRODUCT ASSESSMENT STRATEGIES

- Journals - Documented journal
- final report and demonstration
- portfolios,
- Charts, science folio,
- Science journal,
- questionnaires,
- record sheets for data compilation and presentation,
- camera
- reports
- learning logs
- in-class presentations
- blogs
- concept maps, tables and graphs, models, diagrams, and plans;
- memos; and
- task reflection questionnaire.
- Summative Test

PROCESS ASSESSMENT STRATEGIES

- Tests
- Assignments
- quizzes
- mind-maps
- Oral questioning
- Observation checklist
- Peer assessment checklists

- Feedbacks
- Demonstrations
- Questionnaires

- concept maps
- tables and graphs
- models
- diagrams and plans;
- memos to clients,
- demonstrations

STEP 6: PLAN TEACHING AND LEARNING ACTIVITIES

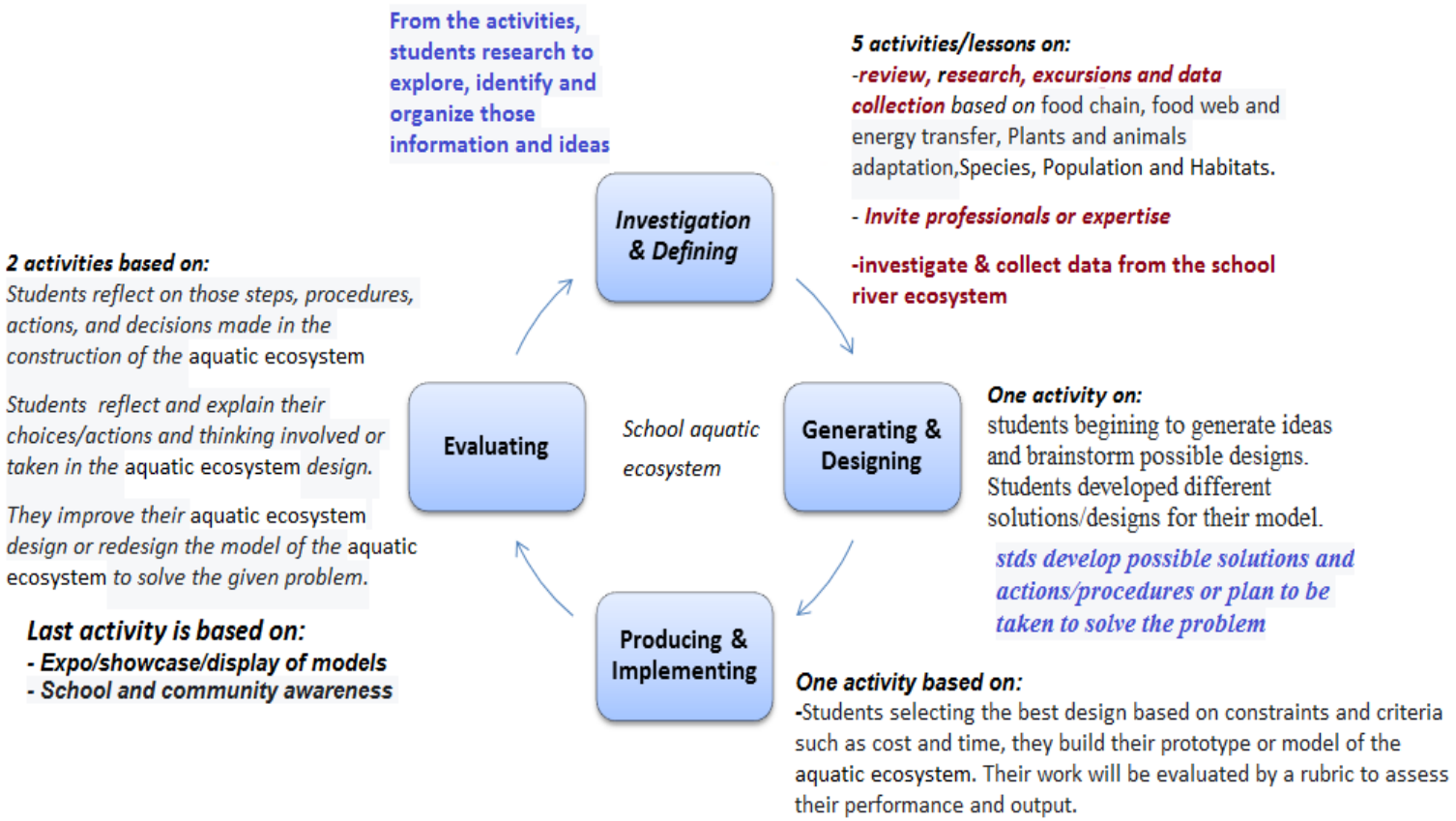
What learning experiences will develop the skills and knowledge you want students to have?

This section should:

- list the activities in which students will engage
- show the sequence of activities you will be getting the students to do in class. Include checkpoints along the way to assess students' progress.

Use the table on the next page to record your plan.

Can you incorporate any frameworks or ideas in your learning sequence? E.g. Bybee's 5E's, Project/Problem/Inquiry based learning etc.



Investigation & Defining	*Activity 1* Students will use internet, library, class notes, survey, interview people and experts; use other resources to research different types of food webs in different ecosystem and present findings. Students in their groups work on different types of food webs in different ecosystem. They will research a daily life of a selected species and present findings on how it lives in that ecosystem. Their research will focus on concepts regarding food chain, food web, energy transfer. They will document their research using the science journal and write a research report based on their findings to be presented to the class. Students will research to explore, identify and organize information and ideas based on: • food chain, food web and energy transfer

	✓ Students must explain how each species in an ecosystem depends on each other. ✓ Students will investigate the roles each part of the food web plays in an ecosystem ✓ Group work on different types of food webs in different ecosystem ✓ Research a daily life of a selected species and present findings on how it lives in that ecosystem. Through this research, students should be able to: • Explain how each species in an ecosystem depends on each other. • Investigate the roles each part of the food web plays in an ecosystem.
Investigation & Defining	*Activity 2* Teacher to plan and organize class/grade excursion to a reserve park to research some causes and effects of organisms' population and adaptation in an ecosystem Students in their teams will research to explore, identify and organize information and ideas based on plants and animals adaptation Teacher will design a set of research questions to be used during the excursion to a reserved park for plants or animals and write a report and present findings to the class. Their research will focus on Plants and animals adaptation. Through this research, students should be able to: • Identify the causes and effects of organisms' population and their adaptation in different ecosystems. • Describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development. • Investigate the effects of equilibrium shifts.
Investigation & Defining	*Activity 3* Students will research how people meet their basic needs in a selected community and present findings. Their research will focus mainly on Species, Population and Habitats and document their research findings in their science journal. They will use the journal to write an essay based on their research findings. Students will research to explore, identify and organize information and ideas based on species, population and habitats. Through this research, students should be able to: ✓ Investigate the equilibrium dynamics in organisms and its relationship to population s of organisms and their ecosystems and the effects of equilibrium shifts ✓ Describe equilibrium in organisms, populations and ecosystems and the effects if there is a shift
Investigation & Defining	*Activity 4*

	Teacher or school invite professional or experts to • explain some concepts relating to their project which are link to the curriculum. They will also reinforce opportunities for students to pursue their interests in fields such field biology, environmental science, law, and other career opportunities that relates to the project they are engaged in • encourage students to explore different skills, practices, and knowledge associated with the project • provide students with the opportunity to plan and carry out investigations in the field, analyze and interpret data from the field, and communicate results from their field studies to a larger audience, use their knowledge of the natural sciences to protect the environment and human health, monitor the quality of the environment (air, water, and soil), interpret the impact of human activities on terrestrial and aquatic ecosystems, and provide strategies for restoring ecosystems. • assist students develop plans on how to protect water resources and reflect efficient and beneficial land use • introduce different software applications to make their work easier and more efficient
Investigation & Defining	*Activity 5* Students will use their science journal, guided questions, checklist, questionnaires, record sheets for data compilation and presentation, camera when students in small teams investigate the school river ecosystem to better understand the interaction between living creatures, energy, and the non-living in regard to food chain, food web, energy transfer, plants and animals' adaptation, species, population and habitats. They will document their research in their science journal and write a report based on their findings and present it to the class.
Investigation & Defining Generating & Designing • **Investigation and Defining the problem** • **Generating and Designing possible solutions, plans, procedures to build the aquatic**	*Activity 6* Investigation and defining the research information, data collected from the previous researches done earlier Teacher will pose relevant questions on the possible solutions or plans based on the model of the aquatic ecosystem. Relevant questions and different assessment tasks will be used to identify the most possible solutions or plans to use construct the model of the aquatic ecosystem The different activities include the following: • defining and understanding the problem that they have to solve • brainstorming of ideas based on their findings from the previous

ecosystem	activities or research done earlier • exploring of factors necessary to sustain an ecosystem and how to develop a model of terrestrial and aquatic ecosystem • development of possible plans on how to plan, build, and maintain a model of ecosystem • development of plans on how to build and sustain an ecosystem • generation of ideas and brainstorming of possible designs • development of different solutions/designs for their model • sketching of different possible deigns with different measurements for their model ecosystem taking into consideration the researched information that they have collected • development of possible solutions on the different types of materials and the measurements to use • Measurements of designs and type of materials required • Possible designs and number and type of materials required • Possible designs and cost of materials • discussion of possible solutions on the type of organisms they will consider for their aquatic ecosystem and how to sustain or maintain the aquatic ecosystem • relationships between type of organisms they will consider for their aquatic ecosystem Students will developed possible approaches/solutions to each relevant question and using those ideas and information they develop possible solutions and actions/procedures or plans to be taken to solve the problem
Producing & Implementing *Evaluating* • **Producing & Implementing aquatic ecosystem using the best design, solution and plan** • **Evaluating their model, plans, procedures used in building the aquatic ecosystem**	*Activity 7* Students select the best solution for their aquatic ecosystem design based on constraints and criteria such as cost and time, they build their prototype or model of the aquatic ecosystem. Their work will be evaluated by a rubric to assess their performance and output. Students select most appropriate solution in terms of the correct materials and their measurements, they construct the first model of the aquatic ecosystem. Observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements. Explain or justify the results identified in the process of the aquatic ecosystem design. Formulate new approaches/solutions to the construction of the aquatic ecosystem . Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed. Students testing their model and design a new course of action or re-design. Students test their model. They also do a group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem. **The different activities include the following:** • criteria used in selecting the best solution for their aquatic

	ecosystem design • development and evaluation of a rubric to assess their performance, output and final product • collaboration, communication, critical thinking and creativity • selection of most appropriate solution in terms of the correct materials and their measurements • observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements • explain or justify the results identified in the process of the aquatic ecosystem design • formulation of new approaches/solutions to the construction of the aquatic ecosystem • Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed. • testing their model and design a new course of action or re-design • group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem • reflection on those steps, procedures, actions, and decisions made in the construction of the aquatic ecosystem • reflect and explain their choices/actions and thinking involved or taken in the aquatic ecosystem design • improvement of their aquatic ecosystem design or redesign of their model of the aquatic ecosystem that solve the given problem
Observation of the relationships between plants and animals in the aquatic ecosystem	*Activity 8* Students observe the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails. Students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals. The concept of 'sustainable' is further explored by instructing students to find out different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive. **The different activities include the following:** • observation of the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails • discussions of the roles of organisms in the aquatic ecosystem • life cycles of different aquatic plants and animals in the aquatic ecosystem • different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive
Expo/ Showcase/display the product	*Activity 9*

Application of concept learnt	Finally, students apply what they have learned when they constructed their own ecosystems and apply their knowledge to their community's ecosystem and do awareness to the surrounding communities as well as present their project to the school during the school expo. **The different activities include the following:** • write an essay on how to protect, appreciate, and take care of a local natural pond, creek, or park • write report • write a blog on how to protect, appreciate, and take care of a local natural pond, creek, or park • presentation • development of record sheets for data compilation and presentation, concept maps, tables and graphs, models, diagrams and plans, development of essay blogs, reports posters, charts, flyers, brochures, pamphlets, skits (play-lets), song and dance, mime, puppetry, presentations and charts

Planning

Detail from achievement standards	**Learning experiences**	**Assessment for learning**
Select and enter these directly from your PNG curriculum. Add extra detail relevant to the connecting idea and common task.	What do you want students to do? List the activities students will engage in. Show the sequence of activities. Include elements required for students to complete the task.	Plan formal and informal ways to evaluate student achievement of outcomes and skills.

Science 9.2.2.11 Investigate and explain the chemical reactions that occur in photosynthesis and cellular respiration and that results in cycling of energy. *Learning Objectives* ***At the end of the research, students can:*** • Explain how each species in an ecosystem depends on each other. • Investigate the roles each par of the food web plays in an ecosystem.	• Students will use internet, library, class notes, survey, interview people and experts; use other resources to research • Students in their groups work on different types of food webs in different ecosystem • They will research a daily life of a selected species and present findings on how it lives in that ecosystem • Document their research in a science journal • Write a research report • present research findings to the class	The different types of assessmen tasks includes: • Documentation using journal • Report • Assignment • Practical Test • Questionnaire • Concept map • Checklists • Peer and group evaluation • Presentation checklist
Science 9.2.2. 19 Assess dynamic equilibrium in organisms, populations and ecosystems an explain the effect of equilibrium shifts. 9.2.2.20 Investigate and describ environmental factors and personal choices that may lead a genetic mutation or changes i an organism's development. *Learning Objectives* At the end of the research, students can: • Identify the causes and effects of organisms' population and their adaptation in different ecosystems. • Describe environmental factors and personal choices	• Teacher plan and organize class/grade excursion to a reserve park to research some causes and effects of organisms' population and adaptation in an ecosystem • Students in their teams will research to explore, identify and organize information and ideas based on plants and animals adaptation • Teacher will design a set of research questions to be used during the excursion to a reserved park for plants or animals • Students in their teams write a report • Students in their teams present findings to the class	**The different types of assessment tasks include:** • guided interview questions • questionnaires for students to complete • Report • Science journal • Report • Assignment • Practical Test • Questionnaire • Concept map • Checklists • Peer and group evaluation • Presentation checklist

that may lead to a genetic mutation or changes in an organism's development. • Investigate the effects of equilibrium shifts.		
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Science	• Invite professional or expertise to: ✓ explain some concepts relating to their project which are link to the curriculum. They will also reinforce opportunities for students to pursue their interests in fields such field biology, environmental science, law, and other career opportunities that relates to the project they are engaged in. ✓ encourage students to explore different skills, practices, and knowledge associated with the project	The different types of assessment tasks include: • guided questionnaires • checklists • journal • report

	✓ provide students with the opportunity to plan and carry out investigations in the field, analyze and interpret data from the field, and communicate results from their field studies to a larger audience, use their knowledge of the natural sciences to protect the environment and human health, monitor the quality of the environment (air, water, and soil), interpret the impact of human activities on terrestrial and aquatic ecosystems, and provide strategies for restoring ecosystems. ✓ assist students develop plans on how to protect water resources and reflect efficient and beneficial land use ✓ introduce different software applications to make their work easier and more efficient • document the open discussions in a journal • write a report	
Science 9.2.2.11 Investigate and explain the chemical reactions that occur in photosynthesis and cellular respiration and that results in cycling of energy. 9.2.2. 19 Assess dynamic equilibrium in organisms, populations and ecosystems an explain the effect of equilibrium shifts. 9.2.2.20 Investigate and describ environmental factors and personal choices that may lead a genetic mutation or changes i an organism's development. **At the end of the research, students can:** • Explain how each species in a ecosystem depends on each other. • Investigate the roles each par of the food web plays in an ecosystem. • Identify the causes and	• In small teams, students investigate the river ecosystem to better understand the interaction between living creatures, energy, and the non-living in regard to food chain, food web, energy transfer, plants and animals' adaptation, species, population and habitats. • They will document their research in their science journal • write a report based on their findings • present report to the class	**The different types of assessment tasks include:** • guided questions • questionnaires for students to complete • Report • Science journal • Checklists • Concept maps • Assignment • Test • record sheets for data compilation and presentation

effects of organisms' population and their adaptation in different ecosystems. • Describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development. • Investigate the effects of equilibrium shifts • Investigate the equilibrium dynamics i organisms and its relationship to population s of organisms and their ecosystems and the effects of equilibrium shifts • Describe equilibrium ir organisms, populations and ecosystems and th effects if there is a shif		
• Investigation and Defining the problem • Generating and Designing possible solutions, plans, procedures to build the aquatic ecosystem **Mathematics** 9.3.3.4 Solve linear simultaneous equations, using algebraic and graphical techniques including usage of digital technology. Modelling the data collected from research Students model research data with the type of design or model required(model or plan of terrestrial and aquatic	• Investigation and defining the research information, data collected from the previous researches done earlier • Teacher will pose relevant questions on the possible solutions or plans based on the model of the aquatic ecosystem. • Relevant questions and different assessment tasks will be used to identify the most possible solutions or plans to use construct the model of the aquatic ecosystem The different activity tasks covers the following: • defining and understanding the problem that they have to solve • brainstorming of ideas based on their findings from the previous activities or research done earlier • exploring of factors necessary to sustain an ecosystem and how to	**The different types of assessment tasks include:** • guided interview questions • Report • Science journal • Checklists • Concept maps • Assignment • Test • Peer and group evaluation sheet

ecosystem) **Arts** Content Standard 3: Students will be able to explore and reflect on the principles underlying visual arts, examine and explain creative or artistic thinking, investigate the techniques of art and artistic design process used in creating two-dimensional (2D) and three-dimensional (3D) artworks to communicate ideas and solve problems using technologies, and reflect on the importance of visual arts safety rules and practices, and ethical issues. **Technology & Industrial Arts** 9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work 9.3.5.6 Outline management and problem solving skills using the engineering design process. 9.5.2.1 Explore programming software and applications • Fluency in the use of tools such as camera, computer to collect and analyzed data • Understanding of the technology design process **English** 9.2.6.1: Appreciate technology, including the Internet, to produce, publish, and update individual or	develop a model of terrestrial and aquatic ecosystem • development of possible plans on how to plan, build, and maintain a model of ecosystem • development of plans on how to build and sustain an ecosystem • generation of ideas and brainstorming of possible designs • development of different solutions/designs for their model • sketching of different possible deigns with different measurements for their model ecosystem taking into consideration the researched information that they have collected • development of possible solutions on the different types of materials and the measurements to use • Measurements of designs and type of materials required • Possible designs and number and type of materials required • Possible designs and cost of materials • discussion of possible solutions on the type of organisms they will consider for their aquatic ecosystem and how to sustain or maintain the aquatic ecosystem • relationships between type of organisms they will consider for their aquatic ecosystem Students will developed possible approaches/solutions to each relevant question and using those ideas and information they develop possible solutions and actions/procedures or plans to be taken to solve the problem	

shared writing products. 9.2.4.2: Analyse the processes of writing, planning, drafting, revising, editing, and rewriting 9.2.8.2: Implement the writing process successfully to plan, revise and edit written work. 9.5.5.3: Write well-organized essays, summaries, and reports on a broad range of topics including those that have been personally researched using authentic texts.		
Producing & Implementing ***Evaluating*** • Producing & Implementing aquatic ecosystem using the best design, solution and plan • Evaluating their model, plans, procedures used in building the aquatic ecosystem	• Students select the best solution for their aquatic ecosystem design based on constraints and criteria such as cost and time • they build their prototype or model of the aquatic ecosystem. • Their work will be evaluated by a rubric to assess their performance and output • Students select most appropriate solution in terms of the correct materials and their measurements, they construct the first model of the aquatic ecosystem • Observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements • Explain or justify the results identified in the process of the aquatic ecosystem design • Formulate new approaches/solutions to the construction of the aquatic ecosystem • Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed • Students testing their model and design a new course of action or re-design. Students test their model • They also do a group presentation	**The different types of assessment tasks include:** • Rubric • guided interview questions • Report • Science journal • Checklists • Concept maps • Assignment • Test • Peer and group evaluation sheets • Presentations • final report and demonstration • portfolios • Charts • questionnaires • record sheets for data compilation and presentation • camera • reports • learning logs • in-class presentations • blogs • task reflection

	and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem. **The different activities include the following:** • criteria used in selecting the best solution for their aquatic ecosystem design • development and evaluation of a rubric to assess their performance, output and final product • collaboration, communication, critical thinking and creativity • selection of most appropriate solution in terms of the correct materials and their measurements • observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements • explain or justify the results identified in the process of the aquatic ecosystem design • formulation of new approaches/solutions to the construction of the aquatic ecosystem • Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed. • testing their model and design a new course of action or re-design • group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem • reflection on those steps, procedures, actions, and decisions made in the construction of the aquatic ecosystem • reflect and explain their choices/actions and thinking involved or taken in the aquatic ecosystem design • improvement of their aquatic ecosystem design or redesign of their model of the aquatic ecosystem that solve the given	questionnaire • Summative Test • mind-maps • Oral questioning • Observation checklist • Peer assessment checklists • Feedbacks • Demonstrations • Questionnaires • concept maps • tables and graphs • models • diagrams and plans; • demonstrations

	problem	
Observation of the relationships between plants and animals in the aquatic ecosystem	• Students observe the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails. • Students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals • The concept of 'sustainable' is further explored by instructing students to find out different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive. **The different activities include the following:** • observation of the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails • discussions of the roles of organisms in the aquatic ecosystem • life cycles of different aquatic plants and animals in the aquatic ecosystem • different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive	**The different types of assessment tasks include:** • Rubric • guided interview questions • Report • Science journal • Checklists • Concept maps • Assignment • Test • Peer and group evaluation sheets • Presentations • final report and demonstration • portfolios • Charts • questionnaires • record sheets for data compilation and presentation • camera • reports • learning logs • in-class presentations • blogs • task reflection questionnaire • Summative Test • mind-maps • Oral questioning • Observation checklist • Peer assessment checklists • Feedbacks • Demonstrations • Questionnaires • concept maps • tables and graphs • models

		• diagrams and plans; • demonstrations
Expo/ Showcase/display the product Application of concept learnt	• Finally, students apply what they hav learned when they constructed their own ecosystems and apply their knowledge to their community's ecosystem • Do awareness to the surrounding communities • present their project to the school during the school expo. **The different activities include the following:** • write an essay on how to protect, appreciate, and take care of a local natural pond, creek, or park • write report • write a blog on how to protect, appreciate, and take care of a local natural pond, creek, or park • presentation • development of record sheets for da compilation and presentation, concept maps, tables and graphs, models, diagrams and plans, development of essay , blogs, reports • develop posters, charts, flyers, brochures, pamphlets, skits (play-let , presentations and charts • produce song and dance, mime, puppetry	• Rubric • guided interview questions • Report • Science journal • Checklists • Concept maps • Assignment • Test • Peer and group evaluation sheets • Presentations • final report and demonstration

Use the table below to plan the whole sequence.

Week	Subject	Subject	Subject	Subject
1	**Science** Students in their groups work on different types of food webs in different ecosystem. They will research a daily life of a selected species and present findings on how it lives in that ecosystem.	**Mathematics** 9.3.3.4 Solve linear simultaneous equations, using algebraic and graphical techniques		

		including usage of digital technology. Modelling the data collected from research Students model research data with the type of design or model required(model or plan of terrestrial and aquatic ecosystem)		
2	**Science** Teacher to plan and organize class/grade excursion to a reserve park to research some causes and effects of organisms' population and adaptation in an ecosystem Teacher will design a set of research questions to be used during the excursion to a reserved park for plants or animals and write a report and present findings to the class.	**English** 9.2.6.1: Appreciate technology, including the Internet, to produce, publish, and update individual or shared writing products. 9.2.4.2: Analyse the processes of writing, planning, drafting, revising, editing, and rewriting		
3	Students will research how people meet their basic needs in a selected community and present findings. Their research will focus mainly on Species, Population and Habitats and document their research findings in their science journal. They will use the journal to write an essay based on their research findings.	**Technology & Industrial Arts** 9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work 9.3.5.6 Outline management and problem solving skills using the engineering design process.		
4	**Science** Teacher or school Invite professional or expertise to the school. Students document the open discussions in a journal. Students write a report.	**English** 9.2.8.2: Implement the writing process successfully to plan, revise and edit written work. 9.5.5.3: Write well-organized essays, summaries, and repor		

		on a broad range of topics including those that have bee personally researched using authentic texts		
5	**Science** In small teams, students investigate the school river ecosystem to better understand the interaction between living creatures, energy, and the non-living in regard to food chain, food web, energy transfer, plants and animals' adaptation, species, population and habitats. They will document their research in their science journal, write a report based on their findings and present report to the class	**Technology & Industrial Arts** 9.5.2.1 Explore programming software and applications • Fluency in the use of tools such as camera, computer to collect and analyzed data • Understanding of the technology design process		
6	**Science** • Investigation and Defining the problem • Generating and Designing possible solutions, plans, procedures to build the aquatic ecosystem • Investigation and defining the research information, data collected from the previous researches done earlier Teacher will pose relevant questions on the possible solutions or plans based on the model of the aquatic ecosystem. Relevant questions and different assessment tasks will be used to identify the most possible solutions or plans to use construct the model of the aquatic ecosystem	**Arts** Content Standard 3: Students will be able to explore and reflect on the principles underlying visual arts, examine and explain creative or artistic thinking, investigate the techniques of art and artistic design process used in creating two-dimensional (2D) and three-dimensional (3D) artworks to communicate ideas and solve problems using technologies, and reflect on the importance of visual arts safety rules and practices, and ethical issues.		
7	**Science** • Students select the best solution for their aquatic ecosystem design based on constraints and criteria such as cost and time			

	• they build their prototype or model of the aquatic ecosystem. • Their work will be evaluated by a rubric to assess their performance and output • Students select most appropriate solution in terms of the correct materials and their measurements, they construct the first model of the aquatic ecosystem • Observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements • Explain or justify the results identified in the process of the aquatic ecosystem design • Formulate new approaches/solutions to the construction of the aquatic ecosystem • Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed • Students testing their model and design a new course of action or re-design. Students test their model • They also do a group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem. **The different activities include the following:** • criteria used in selecting the best solution for their aquatic ecosystem design • development and evaluation of a rubric to assess their performance, output and final product • collaboration, communication, critical thinking and creativity • selection of most appropriate solution in terms of the correct materials and their measurements • observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements			

	• explain or justify the results identified in the process of the aquatic ecosystem design • formulation of new approaches/solutions to the construction of the aquatic ecosystem • Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed. • testing their model and design a new course of action or re-design • group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem • reflection on those steps, procedures, actions, and decisions made in the construction of the aquatic ecosystem • reflect and explain their choices/actions and thinking involved or taken in the aquatic ecosystem design • improvement of their aquatic ecosystem design or redesign of their model of the aquatic ecosystem that solve the given problem			
8	**Science** • Students observe the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails. • Students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals • The concept of 'sustainable' is further explored by instructing students to find out different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive. **The different activities include the following:** • observation of the			

	relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails • discussions of the roles of organisms in the aquatic ecosystem • life cycles of different aquatic plants and animals in the aquatic ecosystem • different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive			
9	**Science** • Finally, students apply what they hav learned when they constructed their own ecosystems and apply their knowledge to their community's ecosystem • Do awareness to the surrounding communities • present their project to the school during the school expo. **The different activities include the following:** • write an essay on how to protect, appreciate, and take care of a local natural pond, creek, or park • write report • write a blog on how to protect, appreciate, and take care of a local natural pond, creek, or park • presentation • development of record sheets for da compilation and presentation, conce maps, tables and graphs, models, diagrams and plans, development of essay , blogs, reports • develop posters, charts, flyers, brochures, pamphlets, skits (play-lets , presentations and charts • produce song and dance, mime,			

	puppetry			
10				
11				

STEP 7: REFLECT AND EVALUATE

How will you know whether the project is achieving its aims?

- Impact of achievement of student learning outcomes
- Construction of own school aquatic ecosystems
- Application of their knowledge to their community's ecosystem.
- Community awareness on sustaining ecosystems
- Expo presentation on how to take care of local ecosystems

Example

This project is based on a real-life situation or problem and is tied to one of the Sustainable Development Goals (SDGs**).**

Project Description

The project connects to SDG Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Regarding SDG Goal 15, the students will look at Ecosystem Preservation and learn how to protect, restore and promote sustainable use of terrestrial ecosystems in the river that supplies the school.

The river that supplies the school is currently polluted and the school is concern of the pollution on the river system and therefore wants to protect, restore and promote sustainable use of terrestrial ecosystems in the river.

Students will be given the opportunity to explore factors necessary to sustain an ecosystem as well as observe the diverse and unique life cycles of living organisms.

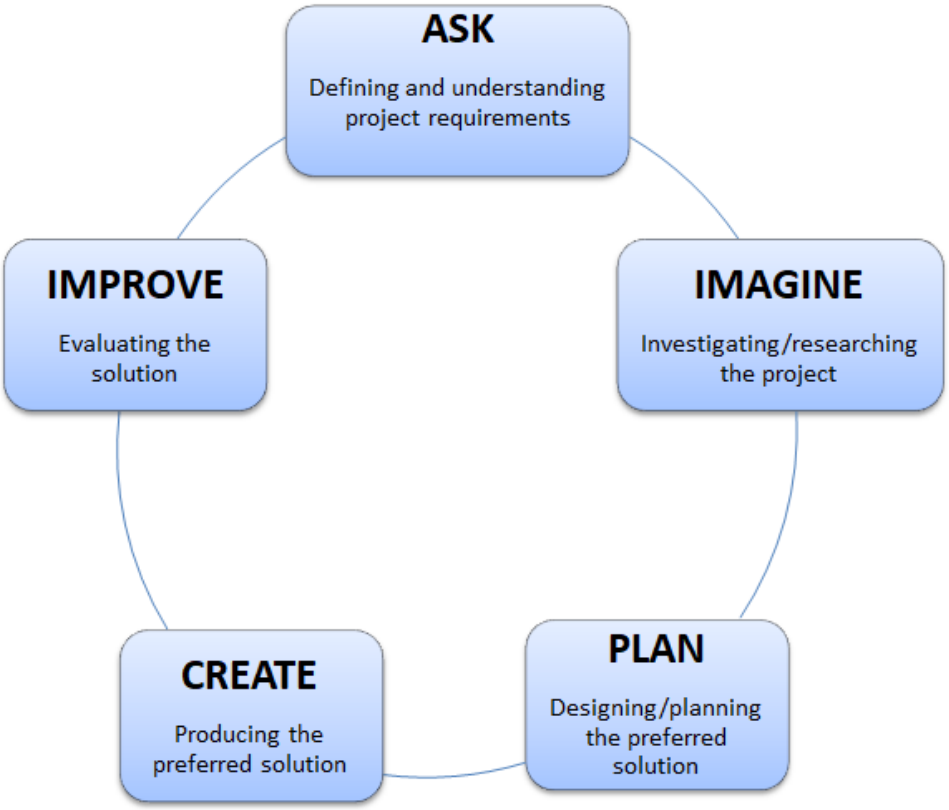
Due to the polluted school river system, the school is hoping to achieve the following by undertaking this STEM Connections project.

- Successful completion of the project
- Construction and sustainability of own school aquatic ecosystem
- Students apply what they have learnt throughout the project during research, data collection, construction and sustaining of the model of the ecosystem to their community ecosystems.
- Students apply what they have learnt in terms of concepts, processes, principles, models, skills, values and attitudes from the different subjects to solve other real-world problems.
- Making awareness to other students and their communities on how to protect, restore and promote sustainable use of terrestrial ecosystems in their communities.
- Students will write an essay or report on how to protect, appreciate, and take care of ecosystems and publish it on the education website as well as presenting it during their awareness on ecosystems preservation.
- Under the School Learning Improvement Plan (SLIP), documentary evidence of the project is required to be presented to the parents and board members of the school during school meetings.
- All forms of data collected before, during and after the project. The data provides useful information about the school, project, funding and analysis of the research findings.

Problem/Challenge

Students will plan, build, and maintain a model of terrestrial and aquatic ecosystem, which is the connecting idea on Sustainable Systems for Ecosystem Preservation

This project will be done using the Integrated STEM PBL Model shown below.



Phase 1: ASK - Defining and understanding project requirements

Teacher explains to the students the project requirements in terms of the given problem/challenge with the criteria and constraints.

Teacher provide some photos of different food webs and pose questions such as:

- What is a food web?
- What is an ecosystem
- Identify species in an ecosystem
- Etc….

For the students to fully understand the given problem, teacher allow students to do some activities mainly involves investigations or research on various research topics.

Phase 2 : IMAGINE – Investigating/Researching the project

Student Activity 1

Driving/Key Questions: What are the main parts of a food web?

Curriculum Connections - Science

Benchmark 9.2.2.11 Investigate and explain the chemical reactions that occur in photosynthesis and cellular respiration and that results in cycling of energy.

Learning Objectives

At the end of the research, students can:
• Explain how each species in an ecosystem depends on each other.
• Investigate the roles each part of the food web plays in an ecosystem.

Knowledge	***Skills***	**Values/attitudes**
• Similarities between food chains and food webs • Parts of a food web • Role or niche of species in an ecosystem • Effects of insecticides on food webs	• Classify different species in an ecosystem. • Evaluate which species or organism belongs to a food web.	Appreciate the importance and the roles the decomposers and other parts of the food web in an ecosystem.

Students will use internet, library, class notes, survey, interview people and experts; use other resources to research different types of food webs in different ecosystem and present findings.

Students in their groups work on different types of food webs in different ecosystem.

They will research a daily life of a selected species and present findings on how it lives in that ecosystem.

Their research will focus on concepts regarding food chain, food web, energy transfer.

They will document their research using the science journal and write a research report based on their findings to be presented to the class.

The different types of assessment tasks includes:

- Documentation using journal
- Report
- Assignment
- Practical Test
- Questionnaire
- Concept map
- checklists

The different assessment tasks covers concepts on the following:

- different types of food webs in different ecosystem
- identify and explain the main parts of a food web
- food chain, food web and energy transfer
- Students must explain how each species in an ecosystem depends on each other
- Students will investigate the roles each part of the food web plays in an ecosystem.
- Similarities between food chains and food webs
- Parts of a food web
- Role or niche of species in an ecosystem
- Effects of insecticides on food webs
- Classify different species in an ecosystem
- Evaluate which species or organism belongs to a food web
- Appreciate the importance and the roles the decomposers and other parts of the food web in an ecosystem
- Explain how each species in an ecosystem depends on each other
- Investigate the roles each part of the food web plays in an ecosystem

Activity 2

Driving/Key Questions: What are some causes and effects of organisms' population and adaptation in an ecosystem?

Curriculum Connections - Science

Benchmark 9.2.2. 19 Assess dynamic equilibrium in organisms, populations and ecosystems and explain the effect of equilibrium shifts.

Benchmark 9.2.2.20 Investigate and describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development.

Learning Objectives

At the end of the research, students can:
• Identify the causes and effects of organisms' population and their adaptation in different ecosystems.

• Describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development.

• Investigate the effects of equilibrium shifts.

Knowledge	***Skills***	**Values/attitudes**
• Causes and effects of equilibrium shifts • Plants and animals adaptation • Population and ecosystems • Environmental factors or personal choices that may lead to an organism's genetic mutation.	• Analyse environmental factors that can result in equilibrium shifts. • Evaluate different ways that a plant or animal can adapt • Explore examples of genetic mutation	✓ Develop and sense of safe and peaceful communities for all organisms in an ecosystem. ✓ show respect for all plant and animal ecosystems, including national parks and wild-life ✓ populations.

Teacher to plan and organize class/grade excursion to a reserve park to research some causes and effects of organisms' population and adaptation in an ecosystem

Students in their teams will research to explore, identify and organize information and ideas based on plants and animals adaptation

Teacher will design a set of research questions to be used during the excursion to a reserved park for plants or animals and write a report and present findings to the class.

Their research will focus on Plants and animals adaptation

The different types of assessment tasks include:

- guided interview questions
- questionnaires for students to complete

- Report
- Science journal

The different assessment tasks covers concepts on the following:

- causes and effects of organisms' population and adaptation in an ecosystem
- Assess dynamic equilibrium in organisms, populations and ecosystems and explain the effect of equilibrium shifts
- describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Identify the causes and effects of organisms' population and their adaptation in different ecosystems
- Describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Investigate the effects of equilibrium shifts
- Causes and effects of equilibrium shifts
- Plants and animals adaptation
- Population and ecosystems
- Environmental factors or personal choices that may lead to an organism's genetic mutation
- Analyse environmental factors that can result in equilibrium shifts
- Evaluate different ways that a plant or animal can adapt
- Explore examples of genetic mutation

Activity 3

Driving/Key Questions: How is the dynamic equilibrium of organisms related to populations and ecosystems?

Curriculum Connections - Science

Benchmark 9.2.2. 19 Assess dynamic equilibrium in organisms, populations and ecosystems and explain the effect of equilibrium shifts.

Benchmark 9.2.2.20 Investigate and describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development.

Learning Objectives

At the end of the research, students can:

- ✓ Investigate the equilibrium dynamics in organisms and its relationship to population s of organisms and their ecosystems and the effects of equilibrium shifts.
- ✓ Describe equilibrium in organisms, populations and ecosystems and the effects if there is a shift

Knowledge	***Skills***	**Values/attitudes**
• Causes and effects of equilibrium shifts in different ecosystems • Population, species, and habitats	• Explain equilibrium in organisms, populations and ecosystems and how they are linked/relate. • Investigate the dynamic equilibrium in organisms, populations and ecosystems.	Promote sustainability and inter-relationships amongst all life in the communities.

Students will research how people meet their basic needs in a selected community and present findings.

Their research will focus mainly on Species, Population and Habitats and document their research findings in their science journal. They will use the journal to write an essay based on their research findings.

The different types of assessment tasks include:

- research questions or questionnaire
- assignment
- checklists
- concept maps
- science journal
- essay

Teacher will design a set of research questions or questionnaires, checklist; concept map to be used during the research based how people meet their basic needs in the selected community. Students will document their research using the science journal and later write an essay based on the research. The assessment tasks will focus on the following concepts:

- They will record their research findings in their science journal for presentation and report purposes towards the end of the project. Teacher will also assess their science journal and their essay
- explain how the dynamic equilibrium of organisms related to populations and ecosystems
- explain population growth in the community and how are people finding the food, water, and land they need, and explain if these factors limiting population growth
- Research how people meet their basic needs in their community
- Identify and explain causes and effects of equilibrium shifts in different ecosystems within the community
- Research and identify population, species, and habitats in the community
- Explain equilibrium in organisms, populations and ecosystems and how they are linked/relate
- Investigate and explain the dynamic equilibrium in organisms, populations and ecosystems
- Promote sustainability and inter-relationships amongst all life in the communities
- Investigate the equilibrium dynamics in organisms and its relationship to population s of organisms and their ecosystems and the effects of equilibrium shifts.
- Describe equilibrium in organisms, populations and ecosystems and the effects if there is a shift

Activity 4

Teacher or school invite professional or experts to

- explain some concepts relating to their project which are link to the curriculum. They will also reinforce opportunities for students to pursue their interests in fields such field biology, environmental science, law, and other career opportunities that relates to the project they are engaged in
- encourage students to explore different skills, practices, and knowledge associated with the project
- provide students with the opportunity to plan and carry out investigations in the field, analyze and interpret data from the field, and communicate results from their field studies to a larger audience, use their knowledge of the natural sciences to protect the environment and human health, monitor the quality of the environment (air, water, and soil), interpret the impact of human activities on terrestrial and aquatic ecosystems, and provide strategies for restoring ecosystems.

- assist students develop plans on how to protect water resources and reflect efficient and beneficial land use
- introduce different software applications to make their work easier and more efficient

The different types of assessment tasks include:

- guided questionnaires
- checklists
- journal
- report

Activity 5

Students will use their science journal, guided questions, checklist, questionnaires, record sheets for data compilation and presentation, camera when students in small teams investigate the school river ecosystem to better understand the interaction between living creatures, energy, and the non-living in regard to food chain, food web, energy transfer, plants and animals' adaptation, species, population and habitats.

They will document their research in their science journal and write a report based on their findings and present it to the class.

The different types of assessment tasks include:

- guided interview questions
- questionnaires for students to complete
- Report
- Science journal
- Checklists
- Concept maps
- Assignment
- Test

The different assessment tasks covers concepts on the following:

- food chain, food web, energy transfer
- plants and animals' adaptation
- species, population and habitats
- Identify and explain causes and effects of equilibrium shifts in different ecosystems within the river system
- Research and identify population, species, and habitats in the river
- Explain equilibrium in organisms, populations and ecosystems and how they are linked/relate
- Investigate and explain the dynamic equilibrium in organisms, populations and ecosystems
- Investigate the equilibrium dynamics in organisms and its relationship to population s of organisms and their ecosystems and the effects of equilibrium shifts.
- Describe equilibrium in organisms, populations and ecosystems and the effects if there is a shift
- different types of food webs in different ecosystem
- identify and explain the main parts of a food web
- Students must explain how each species in an ecosystem depends on each other
- Students will investigate the roles each part of the food web plays in an ecosystem.
- Similarities between food chains and food webs
- Parts of a food web
- Role or niche of species in an ecosystem
- Effects of insecticides on food webs
- Classify different species in an ecosystem
- Evaluate which species or organism belongs to a food web
- Appreciate the importance and the roles the decomposers and other parts of the food web in an ecosystem
- Explain how each species in an ecosystem depends on each other
- Investigate the roles each part of the food web plays in an ecosystem
- causes and effects of organisms' population and adaptation in an ecosystem
- Assess dynamic equilibrium in organisms, populations and ecosystems and explain the effect of equilibrium shifts
- describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Identify the causes and effects of organisms' population and their adaptation in different ecosystems
- Describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development
- Investigate the effects of equilibrium shifts
- Causes and effects of equilibrium shifts

- Plants and animals adaptation
- Population and ecosystems
- Environmental factors or personal choices that may lead to an organism's genetic mutation
- Analyse environmental factors that can result in equilibrium shifts
- Evaluate different ways that a plant or animal can adapt
- Explore examples of genetic mutation

Phase 3: PLAN – Designing/Planning the preferred solution project

Activity 6

Investigation and defining the research information, data collected from the previous researches done earlier

Teacher will pose relevant questions on the possible solutions or plans based on the model of the aquatic ecosystem. Relevant questions and different assessment tasks will be used to identify the most possible solutions or plans to use construct the model of the aquatic ecosystem

The different types of assessment tasks include:

- guided interview questions
- Report
- Science journal
- Checklists
- Concept maps
- Assignment
- Test

The different assessment tasks covers concepts on the following:

- defining and understanding the problem that they have to solve
- brainstorming of ideas based on their findings from the previous activities or research done earlier
- exploring of factors necessary to sustain an ecosystem and how to develop a model of terrestrial and aquatic ecosystem
- development of possible plans on how to plan, build, and maintain a model of ecosystem
- development of plans on how to build and sustain an ecosystem
- generation of ideas and brainstorming of possible designs
- development of different solutions/designs for their model
- sketching of different possible deigns with different measurements for their model ecosystem taking into consideration the researched information that they have collected
- development of possible solutions on the different types of materials and the measurements to use
- Measurements of designs and type of materials required
- Possible designs and number and type of materials required
- Possible designs and cost of materials
- discussion of possible solutions on the type of organisms they will consider for their aquatic ecosystem and how to sustain or maintain the aquatic ecosystem
- relationships between type of organisms they will consider for their aquatic ecosystem

Students will developed possible approaches/solutions to each relevant question and using those ideas and information they develop possible solutions and actions/procedures or plans to be taken to solve the problem

Phase 4: CREATE – Producing the preferred solution

Activity 7a

Students select the best solution for their aquatic ecosystem design based on constraints and criteria such as cost and time, they build their prototype or model of the aquatic ecosystem. Their work will be evaluated by a rubric to assess their performance and output.

Students select most appropriate solution in terms of the correct materials and their measurements, they construct the first model of the aquatic ecosystem.

Observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements.

Explain or justify the results identified in the process of the aquatic ecosystem design.

The different types of assessment tasks include:

- Rubric
- guided interview questions
- Report
- Science journal
- Checklists
- Concept maps
- Assignment
- Test
- Peer and group evaluation sheets
- Presentations
- final report and demonstration
- portfolios
- Charts
- questionnaires
- record sheets for data compilation and presentation
- camera
- reports
- learning logs
- in-class presentations
- blogs
- task reflection questionnaire
- Summative Test
- mind-maps
- Oral questioning
- Observation checklist
- Peer assessment checklists
- Feedbacks
- Demonstrations

- Questionnaires

- concept maps
- tables and graphs
- models
- diagrams and plans;
- demonstrations

The different assessment tasks covers concepts on the following:

- criteria used in selecting the best solution for their aquatic ecosystem design
- development and evaluation of a rubric to assess their performance, output and final product
- collaboration, communication, critical thinking and creativity
- selection of most appropriate solution in terms of the correct materials and their measurements
- observe, record, and evaluate the procedure/steps and results of the aquatic ecosystem design from the selected materials and their measurements
- explain or justify the results identified in the process of the aquatic ecosystem design

Phase 5: IMPROVE – Evaluating the solution

Activity 7b

Students formulate new approaches/solutions to the construction of the aquatic ecosystem . Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed. Students testing their model and design a new course of action or re-design. Students test their model. They also do a group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem.

The different types of assessment tasks include:

- Rubric
- guided interview questions
- Report
- Science journal

- Checklists
- Concept maps
- Assignment
- Test
- Peer and group evaluation sheets
- Presentations
- final report and demonstration
- portfolios
- Charts
- questionnaires
- record sheets for data compilation and presentation
- camera
- reports
- learning logs
- in-class presentations
- blogs
- task reflection questionnaire
- Summative Test
- mind-maps
- Oral questioning
- Observation checklist
- Peer assessment checklists
- Feedbacks
- Demonstrations
- Questionnaires
- concept maps
- tables and graphs
- models
- diagrams and plans;
- demonstrations

The different assessment tasks covers concepts on the following:

- formulation of new approaches/solutions to the construction of the aquatic ecosystem
- Analyse and evaluate the successes and failures of each step and the final product of the aquatic ecosystem being constructed.
- testing their model and design a new course of action or re-design
- group presentation and critics from their report or presentation will be used again to improve/re-design the prototype or model of the aquatic ecosystem
- reflection on those steps, procedures, actions, and decisions made in the construction of the aquatic ecosystem
- reflect and explain their choices/actions and thinking involved or taken in the aquatic ecosystem design
- improvement of their aquatic ecosystem design or redesign of their model of the aquatic ecosystem that solve the given problem

Activity 8

Observation of the relationships between plants and animals in the aquatic ecosystem

Students observe the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails. Students begin to discuss the roles of organisms in the ecosystem as well as observe first-hand the life cycles of different aquatic plants and animals.

The concept of 'sustainable' is further explored by instructing students to find out different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive.

The different types of assessment tasks include:

- Observation checklists
- Recording and measurement tables and graphs
- guided interview questions
- Report
- Science journal
- Checklists
- Concept maps
- Assignment

- Test
- Peer and group evaluation sheets
- Presentations
- portfolios
- Charts
- record sheets for data compilation and presentation
- in-class presentations
- task reflection questionnaire
- Summative Test
- mind-maps
- Oral questioning
- Observation checklist
- Peer assessment checklists
- Feedbacks
- Questionnaires
- concept maps
- tables and graphs
- models
- diagrams and plans

The different assessment tasks covers concepts on the following:

- observation of the relationships between aquatic plants, algae, fish (mosquitofish or guppies), and snails
- discussions of the roles of organisms in the aquatic ecosystem
- life cycles of different aquatic plants and animals in the aquatic ecosystem
- different ways to maintain their ecosystems over time using what they know about the conditions necessary for the living organisms to survive

Activity 9

Application of concept learnt

Finally, students apply what they have learned when they constructed their own ecosystems and apply their knowledge to their community's ecosystem and do awareness to the surrounding communities as well as present their project to the school during the school expo.

The different types of assessment tasks include:

- essay
- blogs
- reports
- posters
- charts
- flyers
- brochures
- pamphlets
- skits (play-lets)
- song and dance
- mime
- puppetry
- Peer and group evaluation sheets
- Presentations
- portfolios
- Charts
- record sheets for data compilation and presentation
- concept maps
- tables and graphs
- models
- diagrams and plans

The different assessment tasks covers concepts on the following:

- write an essay on how to protect, appreciate, and take care of a local natural pond, creek, or park
- write report
- write a blog on how to protect, appreciate, and take care of a local natural pond, creek, or park
- presentation

- development of record sheets for data compilation and presentation, concept maps, tables and graphs, models, diagrams and plans, development of essay , blogs, reports posters, charts, flyers, brochures, pamphlets, skits (play-lets), song and dance, mime, puppetry, presentations and charts

APPROACH FOUR (4): DESIGNING A STEM UNIT

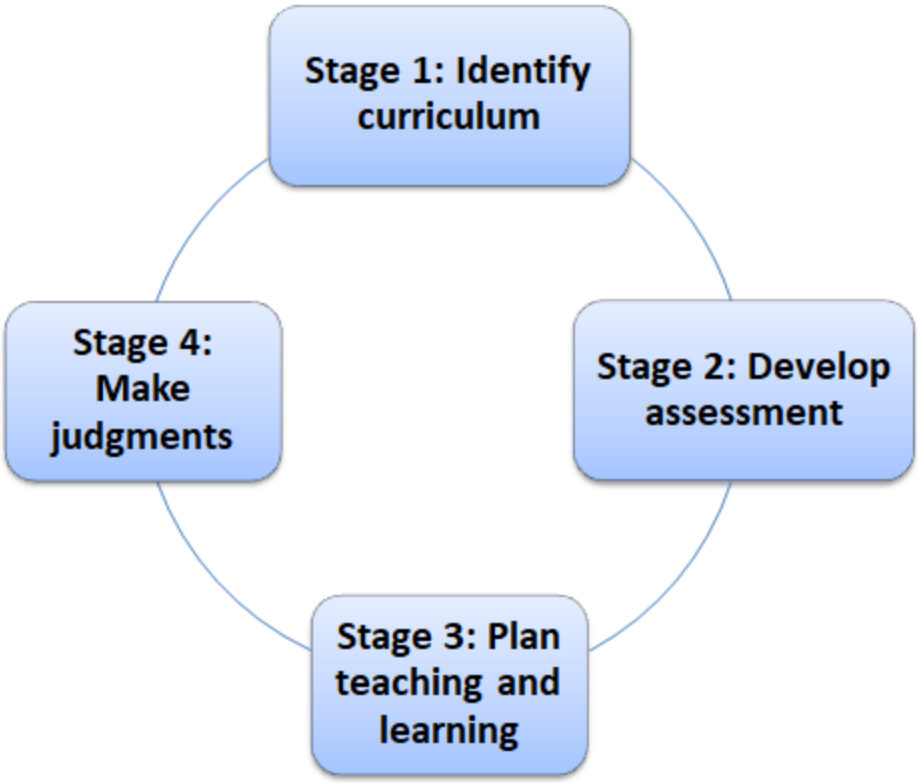
Designing a STEM unit

A STEM approach to teaching and learning provides opportunities for students to develop knowledge, understanding and skills across Science, Technologies, Engineering, Arts and Mathematics.

Planning for teaching, learning and assessment

Teachers can use this approach when planning for the teaching, learning and assessment of a purposefully integrated STEM unit. The approach was adapted from QCAA which contains a sample STEM unit plan and assessment, and standards elaborations to show how teaching, learning and assessment can be integrated.
The sample STEM unit plan is based on the QCAA unit plan template, which supports teachers to plan for an integrated STEM unit and incorporates elements for effective *Planning for teaching, learning and assessment*.

Fig 5 shows QCAA planning process



Example

Problem/Challenge

Children often eat processed snacks that are high in sodium, sugar, fat, and artificial colours and flavours. These snacks are unhealthy and lead to a lack of concentration. To physically and mentally thrive at school, children should eat healthy snacks.

The grade 9 students are given the challenge to grow nutritious food at school to supply to the mess for students to eat as well as sell to the local community for additional income. To grow fresh produce, the students need to investigate suitable plants; soil conditions and sustainable processes to ensure water and nutrients are conserved.

Design Brief

Students need healthy food throughout the school day to maintain their energy levels and stay alert. They would benefit from fresh, healthy snacks available to eat during a school day. How can they design a garden space in in the school environment so that students can grow nutritious food?

Criteria for success

As a class, negotiate a garden design that:

- supports optimal conditions for growing plants
- includes sustainable design ideas
- fulfils the needs of students
- generate additional income

Constraints

The design will need to be:

- located within the school grounds
- enjoyable to visit
- maintained by students

User needs

The grade 9 students will have to consider:

- why students need fresh, healthy food
- how the physical characteristics of students (e.g. height, disability) should influence the design so students of all ages can enjoy and maintain the garden (e.g. safety, access for students with disability)
- what design elements could increase the appeal of the garden space (e.g. colours, layout, seating and how students like to use outdoor spaces)
- how to produce additional crops for income purposes

Sample STEM Unit plan

STEM Unit title	Year level	Timing and duration of unit
Growing Fresh Produce	Grade 9	16 lessons

Unit overview

This unit supports the school's STEM education priority.
Students will conduct an inquiry into the need for fresh food throughout the school day to maintain physical and mental energy levels. They will investigate the optimal conditions for growing plants within the school grounds. This will inform the design of a sustainable garden space that can provide the school community with fresh, healthy snacks.
For this unit, the scientific investigations are an opportunity to develop Science inquiry skills that will be assessed in a future unit. As students design a solution to an identified problem they will enhance the processes and production skills associated with Technology and Industrial Arts.

Stage 1: Identify curriculum

A. Determine the conceptual link

The foundation for a purposefully integrated STEM unit is an authentic conceptual link between learning areas and/or subjects. It encapsulates the rationale of the unit and is often drawn from an engaging real-world context.
The conceptual link in the sample STEM unit addresses the problem of unhealthy eating throughout the school day. The conceptual link is captured in the following subjects:
Science

- students investigate optimal conditions for growing plants
- Describe the similarities and the differences in the appearance and the behaviour of different plants.
- Identify and examine major structures, characteristics, life cycles, processes, behaviours, and reproduction of plants
- Identify and examine how light, gravity, touch, or environment stress can affect the germination, growth, and development of plants.
- Explain the relationship between the living things and the environment.

Agriculture

- students learn about different types of soil and how they are formed
- characteristics of different types of soil and analyze suitable soils for crop production
- A sustainable horticultural production system with an ecosystem approach is necessary to cope with an increasingly degraded environment and uncertainties resulting from climate change, while taking into consideration social, political, economic and environmental impacts

- transition from subsistence farming to income-generating agriculture by adding value to products to achieve greater returns for producers, while catalyzing public-private linkages between producers, processors, supply chain
- Availability of high quality and safe horticultural produce by developing improved crop management practices (e.g. good agricultural practices, integrated production and pest management, integrated soil health management, organic farming) for sustainable and environmentally friendly horticultural crop production systems
- The growing of vegetables, the cultivation, processing, and sale of vegetables, plant conservation, landscape restoration, soil management, landscape, and garden design, construction and maintenance, and arboriculture. In contrast
- Classification of plants according to their species, characteristics, and uses
- importance of plants and investigate how these plants are farmed and commercialized in large scales in different countries and draw appropriate lessons for PNG

Technology & Industrial Arts

- Students will explore food-related issues through a range of practical experiences, allowing them to make informed and appropriate choices
- Change of Food habits as a result of economic, social, cultural, technological and environmental factors
- Making informed food decisions which requires an explicit understanding of nutritional principles in both theory and practice
- Development of sound food habits which contributes significantly to the healthy lifestyles in Papua New Guinea. Lifestyle diseases such as diabetes, obesity and hypertension are increasing while malnutrition is common among children in Papua New Guinea
- broad knowledge and understanding of food properties and processing, preparation and their inter-relationships with the nutritional requirements for people and their consumption patterns
- addressing the importance of hygiene and safe working practices and legislation in the production of food
- Development of food product using specific skills, which can then be applied in a range of contexts enabling students to produce quality food products
- Students develop practical skills in preparing and presenting food that will enable them to select and use appropriate ingredients, methods and equipment
- ability to design, produce and evaluate solutions to situations involving food

Arts

- Students will be able to explore and reflect on the principles underlying visual arts, examine and explain creative or artistic thinking
- investigate the techniques of art and artistic design process used in creating two-dimensional (2D) and three-dimensional (3D) artworks to communicate ideas and solve problems using technologies, and reflect on the importance of visual arts safety rules and practices, and ethical issues

B. Identify the evidence of learning to be collected in the unit

The key elements of the PNG Curriculum **learning standards** for Science, Agriculture and Technology and Industrial Arts and Arts are shown The **cognitive verbs** (thinking required) inform the evidence of learning to be collected in the integrated unit.	**Evidence Outcomes – Achievement Standards** **Science** • Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data. • Identify and communicate sources of unavoidable experimental error. • Identify and examine possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. • Formulate explanations by using logic and evidence. • Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions. • Recognise and assess the issues of statistical variability and the need for controlled tests. • Examine the cumulative nature of scientific evidence. • Analyse situations and solve problems that require combining and applying concepts from more than one area of science. • Investigate a science-based societal issue by researching the literature, utilize data, and communicating the findings • Determine when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent. • Investigate the unity, diversity and the interrelationships between organisms, including their relationships to cycles of matter and energy in the environment. • Investigate and interpret biogeochemical cycles within ecosystems. • Examine the chemical reactions that occur in photosynthesis and cellular respiration and that result in cycling of energy. • Assess dynamic equilibrium in organisms, populations and ecosystems and explain the effect of equilibrium shifts • Investigate different cell parts, their functions and how they are specialized into different tissue and organs • Probe how cells are specialized in different tissues and organs. • Differentiate between the processes of mitosis and meiosis.

	• Examine the components and the functions of a variety of macromolecules active in biological systems.
	Agriculture • analyse and describe the physical properties of soil and its formation to plant, humans, and animal life • compare and categorize the physical properties of soil involved in plant and land use including site analysis, soil sampling, soil structure, and soil texture • examine and categorize farming practices used in different environments and propose ways of improving these practices • compare and classify different types of horticulture plants and assess their functions, purposes, and benefits • explore and categorize fruit trees, vegetable plants, and spice plants according to their species, functions, purposes, and benefits • study and elucidate how fruit trees, vegetables, and spices are cultivated and processed in different environments and places • explore and explain how fruit trees, vegetables and spice products are processed, preserved, and marketed in different contexts and environments • compare and communicate the differences between pomology, Olericulture, Ornamental plants, Arboriculture and Landscaping horticulture • examine and explain how to cultivate, process, preserve, market, regulate and consume pomology, Olericulture, Ornamental plants, Arboriculture and Landscaping • compare and discuss the advantages and disadvantages of technology used for crop cultivation • survey and summarize different types of technology used to manage crops and evaluate their effectiveness
	Technology and Industrial Arts • Explain different functions of tools and equipment and demonstrate how to use them in food preparation and food product development. • Identify and classify characteristics and properties of food. • Apply various cooking methods and preparation techniques in food product development for different needs, occasions and health status. • Discuss social, economic, cultural, environmental and technological factors that influence food and food products • Discuss sensory and nutritional characteristics of food

	and food product development. • Investigate and discuss food habits influenced by economic, social, cultural, technological and environmental factors • Investigate and analyse the chemical, physical and nutritional impacts on food in food processing, preparation and storage. • Describe the function of the digestive system. • Describe the functions of nutrients and significance to the health and wellbeing of individuals. • Make informed consumer choices in food processing and production. • Demonstrate knowledge application in hygiene, safety, ethical values and etiquettes in meal preparation, food handling, product development and meal presentation. • Plan and prepare a menu/recipe for a meal to meet the standards of sensory and biological characteristics in food product development. • Discuss the impact of social, economic, technological, environment and cultural aspects of food and food production, consumption and the dietrelated diseases on individuals. • Use the design process to modify menus and recipes to meet the different needs, occasions and improve health and wellbeing of people. **Arts** • use simply research skills to collect information related to visual arts. • confidently use the creative and critical analysis processes and thinking skills to enhance learning • create and exhibit art and designs or arrange visual stories using appropriate technology to reflect a theme • identify the quality and effectiveness of techniques, styles, and mediums of visual art forms used in various settings • create an installation art prototype using the creative and critical analysis processes together with available materials to reflect a theme • create STEAM related projects.

C. Select the relevant content descriptions

	Content descriptions	
The relevant	**Science knowledge and understanding**	**Science inquiry skills**

PNG Curriculum **content descriptions** describe what is to be taught throughout the integrated unit and what students will learn. Although the Science **inquiry skills** are not highlighted on the achievement standard or evidence outcomes, they will be a part of the teaching and learning in this unit with the expectation that they will be assessed in a future unit.	**Strand 1: Science as Inquiry** **Unit 9.1 and 10.1 Scientific Tools and technology** **Unit 9.2 and 10.2 Measurement and Accuracy** **Strand 2: Life Science** **Unit 9.3 and 10.3 Classifying Organisms** **Unit 9.4 and 10.4 Cell Structure and Function** **Unit 9.5 and 10.5 Interactions and Relationships in the Environment** The core content: • Describe the similarities and the differences in the appearance and the behaviour of plants • Identify and examine major structures, characteristics, life cycles, processes, behaviours, and reproduction of plants. • Identify and examine how light, gravity, touch, or environment stress can affect the germination, growth, and development of plants. • Explain the relationship between the living things and the environment. • Sustainability Systems — All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival	**Strand 1: Science as Inquiry** **Unit 9.1 and 10.1 Scientific Tools and technology** **Content standard 9.1.1** Students will be able to explain the nature and the processes of scientific inquiry and use the modes of scientific inquiry and habits of mind to investigate and interpret the world around them. **Grade 9 Benchmarks** 9.1.1.1 Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data. 9.1.1.2 Formulate explanations by using logical thinking and evidence. 9.1.1.3 Distinguish between hypothesis and theory as scientific terms. 9.1.1.4 Examine the usefulness and limitations of models and theories as scientific representations of reality. 9.1.1.5 Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions **Unit 9.2 and 10.2 Measurement and Accuracy** 9.1.1.6 Identify and communicate sources of unavoidable experimental error. 9.1.1.7 Identify and examine possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. **Strand 2: Life Science** **Unit 9.3 and 10.3 Classifying Organisms** 9.2.2.1 Explain the organization of life on Earth using the modern classification system. 9.2.2.2 Explore the population of organisms and how energy is transferred and distributed in each of the energy levels between organisms in an ecosystem 9.2.2.3 Observe, collect, and analyze class data of single trait inheritance. .9.2.2.5 Compare sexual and asexual reproduction in terms of their advantages and disadvantages for plant species. 9.2.2.6 Examine the dynamic equilibrium in organisms, populations, and ecosystems and explain the effect of equilibrium shifts **Unit 9.4 and 10.4 Cell Structure and Function**

		9.2.2.7 Analyse the growth, division, parts and functions of cells and the process in terms of cellular respiration. 9.2.2.8 Investigate the different cell parts, their functions, and how they are specialized into different tissue and organs 9.2.2.9 Observe and explain the dynamic nature of cell division. 9.2.2.10 Explore the differences between the processes of mitosis and meiosis. 9.2.2.11 Investigate and explain the chemical reactions that occur in photosynthesis and cellular respiration and that results in cycling of energy. 9.2.2.12 Probe how cells are specialized in different tissues and organs. **Unit 9.5 and 10.5 Interactions and Relationships in the Environment** 9.2.2.17 Explain how matter and energy flow through living systems and the physical environment. 9.2.2.18 Explore the population of organisms and how energy is transferred and distributed in each of the energy levels between organisms in an ecosystem 9.2.2. 19 Assess dynamic equilibrium in organisms, populations and ecosystems and explain the effect of equilibrium shifts
	Agriculture knowledge and understanding	**Processes and production skills**
	Agriculture **Strand 1: Crops** **Unit 1: Soil** **Unit 5: Horticulture** **Unit 6: Plant Farming Practices and Management Systems** **Unit 7: Plant Farming and Technology** The challenge is to produce more vegetables, and to do it sustainably. A sustainable horticultural production system with an ecosystem approach is necessary to cope with an increasingly degraded environment and uncertainties resulting from climate change, while taking into consideration social, political, economic and environmental impacts. The aim is to increase the availability of	**Strand 1: Crops** **Unit 1: Soil** **Content Standard 11.2.3** Students will be able to explain the process of soil formation, examine the nutrients, characteristics, uses and functions of different types of soil, and investigate strategies and processes for improving soil fertility to support crop cultivation and maximize crop production returns in different environments. **Grade 9 Benchmarks** 9.1.1.1 Identify different types of soil and explain how they are formed 9.1.1.2 Investigate and evaluate the characteristics of different types of soil.

	high quality and safe horticultural produce by developing improved crop management practices (e.g. good agricultural practices, integrated production and pest management, integrated soil health management, organic farming) for sustainable and environmentally friendly horticultural crop production systems. It is important for students to learn about how plant farming technology evolved over time and the key drivers of technological change and assess the outputs. Farming technology includes implements and knowledge used to grow plants. This knowledge is used to develop new and improved technology and practices over time to improve the cultivation of plants and yields to meet human needs. Plant farming technology evolved and changed from prehistoric gatherers, medieval peasants, and gardeners. An array of technological approaches from primitive tools were developed and used for irrigation, propagation, cultivation, pruning and training, drying, and fermentation. Recent technology trends have seen the development of production technology, particularly in the development of seed products and sowing mechanically to enable them to germinate quickly, plant genetic manipulation using DNA techniques to develop gene transfer and plant regeneration technologies, biotechnology for enhancing the growth of crops through the diagnosis and control of plant diseases and improving productive and the quality of food grains using plant-cell and tissue culture, greenhouse technology used in the production of seedlings for transplanting, and use of robots in the mass cultivation and production of plants	**Unit 5: Horticulture** Horticulture is the growing of flowers, fruits and vegetables, and of plants for ornament and fancy. It also includes plant conservation, landscape restoration, soil management, landscape and garden design, construction and maintenance, and arboriculture. In horticulture, plants are classified according to their species, characteristics, and uses. Students will learn the importance of these plants and investigate how these plants are farmed and commercialized in large scales in different countries and draw appropriate lessons for PNG. **Content Standard 1.4** Students will be able to identify and examine the characteristics and physiology of different types of plants, categorize them according to their characteristics, purposes, and benefits, and explore the different contexts, environments, and places where they are farmed 9.1.5.1 Identify and examine different types of horticulture plants and evaluate their functions, purposes, and benefits. 9.1.5.2 Research and classify fruit trees, vegetable plants, and spice plants according to their species, functions, purposes, and benefits. 9.1.5.3 Investigate and explain how fruit trees, vegetables, and spices are cultivated and processed in different environments and places. 9.1.5.4 Analyse how fruit trees, vegetables and spice products are processed, preserved, and marketed in different contexts and environments. **Unit 6: Plant Farming Practices and Management Systems** **Content Standard 1.6** Students will be able to investigate and analyse the different types of horticulture and management principles, systems, and practices used in different environments, and places to cultivate, process, preserve, market, regulate, and consume different types of plants. 9.1.6.1 Investigate and explain the differences between pomology, Olericulture, Ornamental Plants, Arboriculture and Landscaping horticulture. 9.1.6.2 Analyze how to cultivate, process,

		preserve, market, regulate and use pomology, Olericulture, Ornamental plants, Arboriculture and Landscaping horticulture. **Unit 7: Plant Farming and Technology** **Content Standard 1.7** Students will be able to examine how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environments, and analyse their advantages and disadvantages. 9.1.7.1 Investigate and explain how technological interventions have improved the cultivation, production, marketing, and regulation of different horticulture plants. 9.1.7.2 Identify and explain the impact of technology on traditional and modern cultivation and processing of horticulture plant products. 9.1.7.3 Identify and evaluate the advantages and disadvantages of using technology to propagate horticulture plants in order to improve their products.
	Technology & Industrial Arts knowledge and understanding	**Processes and production skills**
	Technology & Industrial Arts **STRAND 2: FOOD TECHNOLOGY** **Unit 1: Food and Nutrition** **Unit 2: Food Science** The food industry is growing in importance, in providing employment opportunities and increasing the relevance of Food Technology for the individual and society. There are increasing community concerns about food issues; hygiene and safety in food handling and meal preparation, nutritional claims and the nutritional quality of food, genetic engineering, functional food, diets, diseases and the environmental impact of food production processes. Students will explore food-related issues through a range of practical experiences, allowing them to make informed and appropriate choices. Food habits change as a result of economic, social, cultural, technological and environmental factors. People are	**STRAND 2: FOOD TECHNOLOGY** **Unit 1: Food and Nutrition** **Content Standard 2.1** Examine and analyse the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on their production and compliance with ethical principles and standards. **Grade 9 Benchmark** 9.2.1.1; Compare and contrast the nature and properties of food 9.2.1.2; Practice safety and hygiene procedures in tool and equipment, food handling, meal preparation and food development 9.2.1.3; Examine the nutritional components of food and food development and the impact of food consumption on nutrition. 9.2.1.4; Explore nutrition as integral to making food choices 9.2.1.5; Discuss economic, social and technological influences of food, food product and food sciences 9.2.1.6; Explore ways of meeting nutritional requirements to maintain optimum nutrition or manage nutritional issues

	confronted by an increasing array of food products designed to complement our changing lifestyles. Making informed food decisions requires an explicit understanding of nutritional principles in both theory and practice, and this is embedded in the study of Food Technology. This is essential to the development of sound food habits and contributes significantly to the healthy lifestyles in Papua New Guinea. Lifestyle diseases such as diabetes, obesity and hypertension are increasing while malnutrition is common among children in Papua New Guinea This study provides students with a broad knowledge and understanding of food properties and processing, preparation and their inter-relationships with the nutritional requirements for people and their consumption patterns. It addresses the importance of hygiene and safe working practices and legislation in the production of food. This knowledge and understanding is fundamental to the development of food product using specific skills, which can then be applied in a range of contexts enabling students to produce quality food products. Students develop practical skills in preparing and presenting food that will enable them to select and use appropriate ingredients, methods and equipment. Integral to this study is the ability to design, produce and evaluate solutions to situations involving food.	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 **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 (eg, health, occasions, lifestyle, business) **Grade 9 Benchmark** 9.2.2.1 Identify and describe the cultural, physical, biological and nutritional characteristics of food that influence food development 9.2.2.2 Describe the nutritional and sensory characteristics of food to meet the needs, health and occasions. 9.2.2.3 Apply management strategies in food selection, meal preparation, product development, storage and preservation 9.2.2.4 Explore safety and hygiene practices relating to food, and changes that occur in the functional properties of food. 9.2.2.5 Examine the social, economic and environmental impact of food processing technology, and the role packaging plays in the distribution of food from the point of production to consumption. 9.2.2.6 Apply the design process to create food solutions.
	Arts knowledge and understanding	**Processes and production skills**
	Arts Students will be able to explore and reflect on the principles underlying visual arts, examine and explain creative or artistic thinking, investigate the techniques of art and artistic design process used in creating two-dimensional (2D) and three-dimensional (3D) artworks to	**Grade 9 Benchmark** 9.3.3.4 Create and exhibit art and designs or arrange visual stories using appropriate technology to reflect a theme. 9.3.3.5 Investigate and evaluate the quality and effectiveness of techniques, styles, and mediums of visual art forms used in various settings. 9.3.3.6 Design and create an installation art prototype using the creative and critical analysis processes and thinking

	communicate ideas and solve problems using technologies, and reflect on the importance of visual arts safety rules and practices, and ethical issues Applying the Critical and creative thinking process, students organise and process information — analyse, condense and combine relevant information from multiple sources Seek solutions and put ideas into action — assess and test options to identify the most effective solution to put ideas into action Reflect on processes — identify and justify the thinking behind choices they have made	skills together with available materials to reflect a theme.

Stage 2: Develop assessment

Children often eat processed snacks that are high in sodium, sugar, fat, and artificial colours and flavours. These snacks are unhealthy and lead to a lack of concentration. To physically and mentally thrive at school, children should eat healthy snacks.

We could grow nutritious food at school for students to eat. To grow fresh produce, we need to investigate suitable plants, soil conditions and sustainable processes to ensure water and nutrients are conserved.

A. Identify the problem and problem-solving skills

For a STEM assessment, more than one learning area or subject can be incorporated into a task. STEM assessment addresses the real-world problem of children eating processed snacks, which can lead to a lack in concentration throughout the school day.

The problem will be solved using Agriculture - Plant Farming and Technology processes and production skills and Technology and Industrial Arts design process to design a garden space in the school environment where students can grow nutritious food.

In developing assessment, ensure you have defined the task clearly so that students have clear boundaries for responding.

B. Prepare the assessment design brief

<table>
<tr><td rowspan="3">The design brief outlines the context of the problem; the parameters of the task, including constraints; and the desired outcome of the designed solution, i.e. a garden space.
The criteria for success include ‘supports optimal conditions for growing plants’. This gives</td><td colspan="2">Design brief</td></tr>
<tr><td colspan="2">Students need healthy food throughout the school day to maintain their energy levels and stay alert. They would benefit from fresh, healthy snacks available to eat during a school day. How can the students design a garden space in their school environment so that students can grow nutritious food?</td></tr>
<tr><td>Criteria for success
As a class, negotiate a garden design that:</td><td>Constraints
The design will need to be:
• located within the school</td></tr>
</table>

students the opportunity to apply **Science, Arts, Technology and Industrial Arts and Agriculture understanding** to the garden design.	• supports optimal conditions for growing plants • includes sustainable design ideas • fulfils the needs of students • generate additional income	grounds • enjoyable to visit • maintained by students
	User needs The grade 9 students will have to consider: • why students need fresh, healthy food • how the physical characteristics of students (e.g. height, disability) should influence the design so students of all ages can enjoy and maintain the garden (e.g. safety, access for students with disability) • what design elements could increase the appeal of the garden space (e.g. colours, layout, seating and how students like to use outdoor spaces) • how to produce additional crops for income purposes	

C. Develop materials for the assessment technique

Unit assessment			
Title of assessment/s	**Technique/s**	**Conditions**	**Assessment dates**
The different assessment tasks are captured in the assessment booklet	Design task supported by a learning journal	Open Reasonable adjustments: • assistive technology where necessary and/or appropriate • multiple means to create a graphical representation • use checklists	
Description of assessment/s			**Assessment dates**
Design brief: Students need healthy food throughout the school day to maintain their energy levels and stay alert. They would benefit from fresh, healthy snacks available to eat during a school day. How might we design a garden space in our school environment so that students can grow nutritious food? **A supporting learning journal will provide opportunities for ongoing feedback during the design process that includes:** • investigation of the design brief needs and opportunities • negotiated criteria for success that include sustainability considerations			

Unit assessment	
• explanation of the techniques that will help the garden to grow and thrive • explanation of how the identified gardening techniques will inform the designed solution • graphical representations that combine selected design ideas • evaluation of the designed solution using the negotiated 'criteria for success' • suggested changes or additions that could improve the garden space. .	
Create the task-specific standards	
The task-specific standards (marking guide) can be found at the end of the sample assessment.	

The assessment technique used in the STEM assessment is a project. A marking guide for the project has been developed by the teacher and given to the students prior to the project.

The summative task is a learning journal completed by students individually. What other assessment instruments could have been used? Explain your answer, providing reasons for it.

The assessment requires students to apply Science, Agriculture and Technology & Industrial Arts knowledge to designing a solution.

Students record their responses in an Assessment booklet. All the assessments tasks for the project are outlined in the Assessment Booklet. All the assessment tasks involved in the project and captured in the assessment booklet are shown below.

Section 1: Design brief needs and opportunities

1. Why do students need fresh, healthy snacks?

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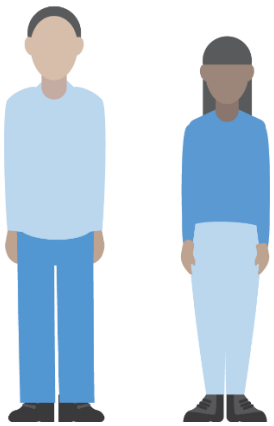
2. Label the physical characteristics of the users that will influence the design, so students of all ages can enjoy and maintain the garden. Think about student height, safety and access for students with disabilities.



3. What design elements could increase the appeal of the garden space for students? Think about colours, layout, seating and how students like to use outdoor spaces.

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Note: In class, negotiate the criteria for success and complete the table in section 4.

Section 2: Scientific knowledge

4. Complete the table below by applying the scientific discoveries you have made throughout this unit to decide which techniques will help plants grow and thrive in your garden.

Based on the scientific discoveries you have made, predict the best techniques to grow and maintain plants at school.	How could you incorporate each of these scientific discoveries into your garden design?
Technique 1	

Technique 2	
Technique 3	

5. Explain why incorporating the above scientific discoveries will provide the best conditions for the plants to grow.

Technique 1: .....

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Technique 2: .....

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Technique 3: .....

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Section 3: Graphical representation

6. Use the design ideas generated in the brainstorming activity in class to draw two views of your designed solution for the garden. Show the view from the front (front view) and the view from above (aerial view). Label and annotate your drawings.

Front view

a.

Aerial view

b.

Section 4: Evaluating the designed solution

7. Complete the following table.

Criteria for success	Evaluation

Record the criteria for success below.	Explain how the design features of your garden fulfil each of the criteria for success.

8. Describe two changes or additions that could improve the garden space.

a. .....

b. .....

9. Why would these changes or additions improve the garden space? Refer to the criteria for success in your answer.

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The summative task is a learning journal completed by students individually. What other assessment instruments could have been used? Explain your answer, providing reasons for it.

According to ACARA framework, assessments can occur in two ways:

1. First, the teacher needs to assess at the 'individual subject level' (e.g., teachers have selected the subject content descriptions appropriate to this unit of work and will use different strategies to assess that content, such as; journals, portfolios, reports, learning logs, in-class presentations, blogs, quizzes, mind-maps, etc.
2. The ACARA framework also proposes that common tasks can be assessed at the non-subject (e.g., teachers from different subjects plan what they are going to assess in the common task, and how to communicate the criteria explicitly to students. The common student task can be assessed on a broader level, with teachers choosing to assess any elements from the identified purpose.

Questions for discussions:

1. Name some formative assessment strategies that can be used to provide students with feedback in order to help them with their project work? Do we need to use formative assessment strategies with technology?
2. When planning summative assessment in a project what do you need to consider?

Stage 3: Plan teaching and learning

Identify and sequence the teaching and learning

In an integrated STEM unit, teachers select and sequence learning experiences and teaching strategies to support students to develop knowledge, understanding and skills in each learning area or subject.

A. Create teaching and learning plan

In the Sequence teaching and learning section of the unit plan, the Learning intentions and success criteria contain each of the identified content descriptions for each subject.

Some lessons focus on one subject while others purposefully combine both Science and Agriculture and Technologies.

Real-world applications are purposefully incorporated in the planning for the sample STEM unit.
Some examples include:

- excursion to a community garden
- experiments
- evaluation of the school's sustainability practices
- student surveys
- guest speakers

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback
Note: Lessons 6–7 rely on the ongoing collection of data from a variety of scientific investigations. It is suggested that these investigations are set up early in the unit, so that data can be collected at regular intervals.	
Lessons 1–2 We are learning to explain how and why food is produced in managed environments and prepared to enable people to grow and be healthy **Technology & Industrial Arts** **STRAND 2: FOOD TECHNOLOGY** **Unit 1: Food and Nutrition** Students will 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 **Unit 2: Food Science** Students will investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (eg, health, occasions, lifestyle, business) What I'm looking for is a flow chart of the sequence involved in converting 'on farm' food to the food we buy at the supermarket. I'm also looking for a comparison of this to the 'garden to plate' supply chain and a list of the benefits of having access to healthy fresh food.	• Present the 'Design brief' to students. • Consider the problem the designed solution will address and explain that the designed garden spaces will be presented to a group for consideration and feedback. (This group could include the school principal, P&C representative, experts etc.) • Compare and contrast the nature and properties of food • Practice safety and hygiene procedures in tool and equipment, food handling, meal preparation and food development • Examine the nutritional components of food and food development and the impact of food consumption on nutrition. • Explore nutrition as integral to making food choices • Explore ways of meeting nutritional requirements to maintain optimum nutrition or manage nutritional issues • Apply the design process to create food items using combinations of basic ingredients with variations using a selection of techniques and food preparation equipment • View a video on food and nutrition • Visit or research a local community garden, with the following in each section – Draw the users of this garden in the centre square. – In each of the squares around the picture of the user answer the following questions. When community members use the community garden ▪ what do they see and hear? ▪ what do they say and do? ▪ what do they think and feel? ▪ what do they want from the space? • Consider the parts of the 'garden and discuss the benefits of having access to healthy fresh produce at school. • Gather evidence of prior knowledge of gardening and sustainable practices through discussion

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback
This is because understanding the processes involved in food production will help us to design a space that fulfils the need for nutritious food.	• Identify and describe the cultural, physical, biological and nutritional characteristics of food that influence food development • Describe the nutritional and sensory characteristics of food to meet the needs, health and occasions. • Apply management strategies in food selection, meal preparation, product development, storage and preservation • Explore safety and hygiene practices relating to food, and changes that occur in the functional properties of food. • Apply the design process to create food solutions.
Lessons 3–4 We are learning to communicate how the conditions of an environment impact the suitability of plant types. **Agriculture** **Strand 1: Crops** **Unit 5: Horticulture** Students will be able to identify and examine the characteristics and physiology of different types of plants, categorize them according to their characteristics, purposes, and benefits, and explore the different contexts, environments, and places where they are farmed What I'm looking for is an awareness of the types of plants you observe being grown in a local garden, the impact of the local environment and the methods being used to ensure that plants thrive. I'm also looking for explanations of garden features through annotated drawings that include an aerial and side view of a garden. This is because our design brief requires you to select fruit and vegetables that will successfully grow in your school environment. The skill of graphically representing ideas is an important communication	• List (as a class) what seeds and plants need to grow and thrive. • Research your local climate zone and record the environmental conditions. List some of the types of fruit and vegetables that the local conditions will support • Present an image of a thriving local vegetable garden. Model drawing an aerial and side view of the garden and label the features that help the plants to grow and thrive. • Practise drawing and labelling an aerial and side view of an area or feature in the school. • Learn about the growing conditions of fungi and, if there is time, conduct a scientific inquiry into how mushrooms grow in a dark, warm cupboard compared to the classroom environment. • Each student provides feedback to a peer on the graphical representation they have drawn. • Identify and examine different types of horticulture plants and evaluate their functions, purposes, and benefits. • Research and classify fruit trees, vegetable plants, and spice plants according to their species, functions, purposes, and benefits. • Investigate and explain how fruit trees, vegetables, and spices are cultivated and processed in different environments and places.

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback
technique as an annotated drawing can convey a lot of information in a clear, ordered way.	
Lessons 5–6 We are learning to investigate and evaluate sustainable techniques for improving soil. **Agriculture** **Strand 1: Crops** **Unit 1: Soil** Students will be able to explain the process of soil formation, examine the nutrients, characteristics, uses and functions of different types of soil, and investigate strategies and processes for improving soil fertility to support crop cultivation and maximize crop production returns in different environments. What I'm looking for is an understanding of the benefits of sustainable fertilising techniques such as composting. I'm also looking for an understanding of the need for sustainable water usage and systems that can enable this to happen in the school environment. This is because we need to be aware of our impact on the environment and include sustainable elements in our garden design.	• View 'a video that explore the benefits of nutrient-rich soil conditions on the growth of plants. • Identify different types of soil and explain how they are formed. • Investigate and evaluate the characteristics of different types of soil. • Research the types of items that can and can't be placed in a compost bin • Develop (as a class) composting 'criteria for success' and evaluate the composting that occurs at the school against the 'criteria for success'. • Consider the importance of water in the growth and maintenance of a plant. Discuss the importance of water conservation and evaluate how water is used throughout the school. As a class, brainstorm ways that water could be conserved. • Exit ticket activity: 1. Describe two benefits of composting. 2. Describe a technique that could be used to save water at home or at school.
Lessons 7–8 We are learning to inquire into the impact of different variables on the growth of plants. **Science** **Strand 1: Science as Inquiry** **Unit 9.1 Scientific Tools and technology** **Unit 9.2 Measurement and Accuracy**	**Note:** It is suggested that these scientific investigations are started at the beginning of the unit. • Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data. • Formulate explanations by using logical thinking and evidence. • Distinguish between hypothesis and theory as scientific terms. • Examine the usefulness and limitations of models and theories as scientific representations of reality. • Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback
Students will be able to explain the nature and the processes of scientific inquiry and use the modes of scientific inquiry and habits of mind to investigate and interpret the world around them. What I'm looking for is a scientific inquiry where one variable is changed to measure the impact of that variable on the growth of a plant. This is because it is important to collect scientific evidence to support the design choices we are making so we can optimise the growing conditions in our designed garden space.	• Identify and communicate sources of unavoidable experimental error. • Identify and examine possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. • Conduct a variety of scientific inquiries using seedlings. These will be monitored regularly over a two-week period and data will be collated and evaluated. – Possible experiments include an inquiry into the same type of plant growing ▪ in shade and in sunlight ▪ in a variety of soil types ▪ with a variety of watering conditions. • Write up an investigation as a science report. • Summarise the findings of the investigations in an infographic. • Opportunity to collect evidence of Science inquiry skills and provide feedback.
Lessons 9–10 We are learning to reflect on the impact of physical conditions on plants and evaluate the best design elements to fulfil the design brief. **Agriculture** **Strand 1: Crops** **Unit 6: Plant Farming Practices and Management Systems** Students will be able to investigate and analyse the different types of horticulture and management principles, systems, and practices used in different environments, and places to cultivate, process, preserve, market, regulate, and consume different types of plants. What I'm looking for is a negotiated 'criteria for success' for a garden design in our school environment that: • supports optimal conditions for growing plants • includes sustainable design	• Review the sustainable gardening techniques and results of the scientific investigations • Investigate and explain the differences between pomology, Olericulture, Ornamental Plants, Arboriculture and Landscaping horticulture. • Analyze how to cultivate, process, preserve, market, regulate and use pomology, Olericulture, Ornamental plants, Arboriculture and Landscaping horticulture. • Show photos of a variety of inspirational vegetable gardens, e.g. vertical gardens, glasshouse structures, hydroponic systems, repurposed garden beds such as an old bathtub. Identify some features of each garden and discuss how they meet user needs. • Watch a video on 'Building a school garden' and list the design elements that appeal to students. • Discuss and clarify understanding of the design brief. • Observe and survey students from a variety of year levels to find out what sort of design features they would like in a garden space. • In the Assessment booklet complete: – Section 1: Design brief needs and opportunities – Section 4: Add jointly developed 'criteria for success' for the designed solution – Section 2: Scientific knowledge. • Model (teacher talk-aloud) using the 'criteria for success' to evaluate an example vegetable garden. • Evaluate an example garden design using the negotiated 'criteria for success'.

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback
ideas • fulfils the needs of students. This is because 'criteria for success' will help you evaluate design ideas and create something that fulfils the design brief to a high standard.	
Lessons 11–12 We are learning to generate design ideas for a garden. These ideas will need to be evaluated. **Agriculture** **Strand 1: Crops** **Unit 5: Horticulture** What I'm looking for are many ideas about possible materials, vegie types, garden placement, structural shape, aesthetics and sustainability. This is because it is important to evaluate design ideas and then improve the designed solution.	• Review the conditions of an environment impact the suitability of plant types • Review the growing of flowers, fruits and vegetables, and of plants for ornament and fancy. • Review the cultivation of vegetables and ornamental plants • Review plant conservation, landscape restoration, soil management, landscape and garden design, construction and maintenance, and arboriculture • Brainstorm design ideas for a garden space under the headings – fruit and vegetables – techniques to help plants grow – appearance/function – materials – sustainability. • Evaluate brainstormed ideas against the negotiated 'criteria for success' and select design ideas. • Draw a quick aerial representation of the garden that includes the selected ideas. • Guide the students to improve the design as they apply the SCAMPER tool through the following questions – Substitute: What materials can you substitute to improve sustainability? – Combine: What garden features could you combine to make something new? e.g. sculptures that collect water for the garden – Adapt: What could you adapt to make it more assessable/appealing to younger students? – Modify: What could you improve to increase the productivity of the garden? – Put to another use: What design features could be put to another use? e.g. seating that includes storage – Eliminate: What could you eliminate to improve the garden? – Reverse: Are there garden features that need to be moved/swapped so when you experience the garden it makes sense?
Lessons 13–14 We are learning to communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques. **Arts** **Strand 3: Visual Arts** Students will be able to explore and reflect on the principles underlying visual arts, examine	• Display and discuss an example (possibly from lesson 3) of a clearly labelled and annotated diagram with an aerial and side view of a designed solution. • In the Assessment booklet complete: – Section 3: Graphical representation. • Students present the graphical representations to an audience for consideration and feedback (this group could include the school principal, P&C representative, experts etc.). • In the Assessment booklet complete: – Section 4: Evaluating the designed solution. • Create and exhibit art and designs or arrange visual stories using

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback
and explain creative or artistic thinking, investigate the techniques of art and artistic design process used in creating two-dimensional (2D) and three-dimensional (3D) artworks to communicate ideas and solve problems using technologies, and reflect on the importance of visual arts safety rules and practices, and ethical issues. What I'm looking for is: • two graphical representations (front view and aerial view) of the designed solution • annotations that justify the inclusion of each design element • an evaluation of the designed solution against the 'criteria for success' • changes or additions that could improve the garden space. This is because communicating design ideas through annotated graphical representations can demonstrate how the garden space fulfils the design brief for an audience.	appropriate technology to reflect a theme. • Investigate and evaluate the quality and effectiveness of techniques, styles, and mediums of visual art forms used in various settings. • Design and create an installation art prototype using the creative and critical analysis processes and thinking skills together with available materials to reflect a theme.
Lessons 15–16 (optional) We are learning to collaboratively plan a designed solution, select appropriate materials, components, tools, equipment and techniques, and apply safe procedures to construct a prototype. **Arts** **Strand 3: Visual Arts** Students will be able to explore and reflect on the principles underlying visual arts, examine and explain creative or artistic thinking, investigate the techniques of art and artistic design process used in creating two-dimensional (2D) and three-dimensional (3D) artworks to communicate ideas	• With a partner, students combine the best of the design ideas, then plan and create a 3D model of a designed garden space that fulfils the design brief. • Demonstrate safe cutting and adhering procedures. • Collect evidence of the processes and production skills related to 'producing and implementing' for Design and Technologies.

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback
and solve problems using technologies, and reflect on the importance of visual arts safety rules and practices,and ethical issues. **Technology & Industrial Arts** **STRAND 2: FOOD** **Unit 2: Food Science** Students apply the design process to create a prototype of a designed solution What I'm looking for is a collaboratively considered, safe, well-constructed, 3D prototype of the designed solution made out of recycled materials. This is because prototyping a 3D model of the garden space will help us to better understand how students will interact with the space.	

Stage 4: Make judgments

A. Create a task-specific marking guide

The marking guide use the PNG Curriculum achievement standards – evidence outcomes to provide teachers with a tool for making consistent and comparable judgments about how well, on a five-point scale, students have demonstrated what they know, understand and can do.
In a STEM assessment, more than one learning area or subject can be incorporated into a task. The task-specific standards (marking guide) reflect this by incorporating multiple learning areas or subjects.

B. Select the aspects of the Learning Standards

The sample STEM assessment draws from the Grade 9 Science, Agriculture, Technology & Industrial Arts and Arts Learning Standards.

The rows of the evidence outcomes corresponding to the identified aspects of Science, Agriculture, Technology & Industrial Arts and Arts are selected and combined in a single document.

Rows that contain aspects of the achievement standard that are not being assessed are deleted.

The collection of evidence will reflect Science understanding as applied in Technology & Industrial Arts, Agriculture, and Arts towards a designed solution.

C. Task-Specific Standards (Marking Guide)

Grade 9 STEM unit task-specific marking guide is shown in the table below.

The summative task is a learning journal completed by students individually. What other assessment instruments could have been used? Explain your answer, providing reasons for it.

			A	B	C	D	E
			The folio of student work has the following characteristics:				
Agriculture	**Strand 1: Crops**	**Unit 1: Soil**	reasonably explain the process of soil formation, carefully examine the nutrients, characteristics, uses and functions of different types of soil, and investigate comprehensive strategies and processes for improving soil fertility to support crop cultivation and maximize crop production returns in different environments.	explain the process of soil formation, examine the nutrients, characteristics, uses and functions of different types of soil, and investigate informed strategies and processes for improving soil fertility to support crop cultivation and maximize crop production returns in different environments.	explain the process of soil formation, examine the nutrients, characteristics, uses and functions of different types of soil, and investigate strategies and processes for improving soil fertility to support crop cultivation and maximize crop production returns in different environments.	partially explain the process of soil formation, examine the nutrients, characteristics, uses and functions of different types of soil, and partially investigate strategies and processes for improving soil fertility to support crop cultivation and maximize crop production returns in different environments.	recall facts about soil
Agriculture	**Strand 1: Crops**	**Unit 5: Horticulture**	identify and fully examine the detailed characteristics and physiology of different types of plants, categorize them according to their reasoned characteristics, purposes, and benefits, and explore the different contexts, environments, and places where they are farmed	identify and fully examine the characteristics and physiology of different types of plants, categorize them according to their reasoned characteristics, purposes, and benefits, and explore the different contexts, environments, and places where they are farmed	identify and examine the characteristics and physiology of different types of plants, categorize them according to their characteristics, purposes, and benefits, and explore the different contexts, environments, and places where they are farmed	Partially identify and examine the characteristics and physiology of different types of plants, partially categorize them according to their characteristics, purposes, and benefits, and partially explore the different contexts, environments, and places where they are farmed	recall facts about Horticulture

			A	B	C	D	E
Agriculture	**Strand 1: Crops**	**Unit 6: Plant Farming Practices and Management Systems**	Explain the investigation and analyses of the different types of horticulture and management principles, systems, and practices used in different environments, and places to cultivate, process, preserve, market, regulate, and consume different types of plants.	Describe the investigation and analyses of the different types of horticulture and management principles, systems, and practices used in different environments, and places to cultivate, process, preserve, market, regulate, and consume different types of plants.	Investigate and analyse the different types of horticulture and management principles, systems, and practices used in different environments, and places to cultivate, process, preserve, market, regulate, and consume different types of plants.	Partially investigate and analyse the different types of horticulture and management principles, systems, and practices used in different environments, and places to cultivate, process, preserve, market, regulate, and consume different types of plants.	recall facts about Plant Farming Practices and Management Systems
Agriculture	**Strand 1: Crops**	**Unit 7: Plant Farming and Technology**	Comprehensive examination of how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environments, and analyse their advantages and disadvantages.	Detailed examination of how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environments, and analyse their advantages and disadvantages.	Examine how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environments, and analyse their advantages and disadvantages.	Examine aspects of how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environments, and analyse their advantages and disadvantages.	recall facts about Plant Farming and Technology

			A	B	C	D	E
Science	Strand 1: Science as Inquiry	Unit 9.1 and 10.1 Scientific Tools and technology	Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data, and formulate compressive explanations by using logical thinking and evidence.	Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data, and formulate detailed explanations by using logical thinking and evidence.	Select and use appropriate tools and technology to perform tests, collect data, analyse relationships, and display data, and formulate explanations by using logical thinking and evidence.	Select and use minimal tools and technology to perform tests, collect data, analyse relationships, and display data, and explanations about using logical thinking and evidence.	Statements about tools and technology and explanations about using logical thinking and evidence
Science	Strand 2: Life Science	Unit 9.3 Classifying Organisms	Comprehensive explanation of the exploration of the population of organisms and how energy is transferred and distributed in each of the energy levels between organisms in an ecosystem, and fully examine and explained the dynamic equilibrium in organisms, populations, and ecosystems and explain the effect of equilibrium shifts	Detailed explanation of exploration of the population of organisms and how energy is transferred and distributed in each of the energy levels between organisms in an ecosystem, and examine and explained the dynamic equilibrium in organisms, populations, and ecosystems and explain the effect of equilibrium shifts	Explore the population of organisms and how energy is transferred and distributed in each of the energy levels between organisms in an ecosystem, examine the dynamic equilibrium in organisms, populations, and ecosystems and explain the effect of equilibrium shifts	Partially explore the population of organisms and how energy is transferred and distributed in each of the energy levels between organisms in an ecosystem, and partly examine the dynamic equilibrium in organisms, populations, and ecosystems and explain the effect of equilibrium shifts	recall of facts about classifying organisms

			A	B	C	D	E
Technology & Industrial Arts	STRAND 2: FOOD TECHNOLOGY	Unit 2: Food Science	Comprehensive investigation and analyses of the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (eg, health, occasions, lifestyle, business)	Detailed investigation and analyses of the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (eg, health, occasions, lifestyle, business)	Investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (eg, health, occasions, lifestyle, business)	Partially investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (eg, health, occasions, lifestyle, business)	statements about food science

D. Evaluate and quality assure

Prior to implementation, quality assure the unit to ensure assessment is valid, accessible and reliable and that curriculum, teaching and learning is aligned with assessment.
Determine the processes for moderation of assessment.

During and at the end of the unit, reflect on the teaching, learning and assessment to make refinements for the future.
Evaluate how the teaching, learning and assessment provided opportunities to develop depth and breadth of student learning. Consider:

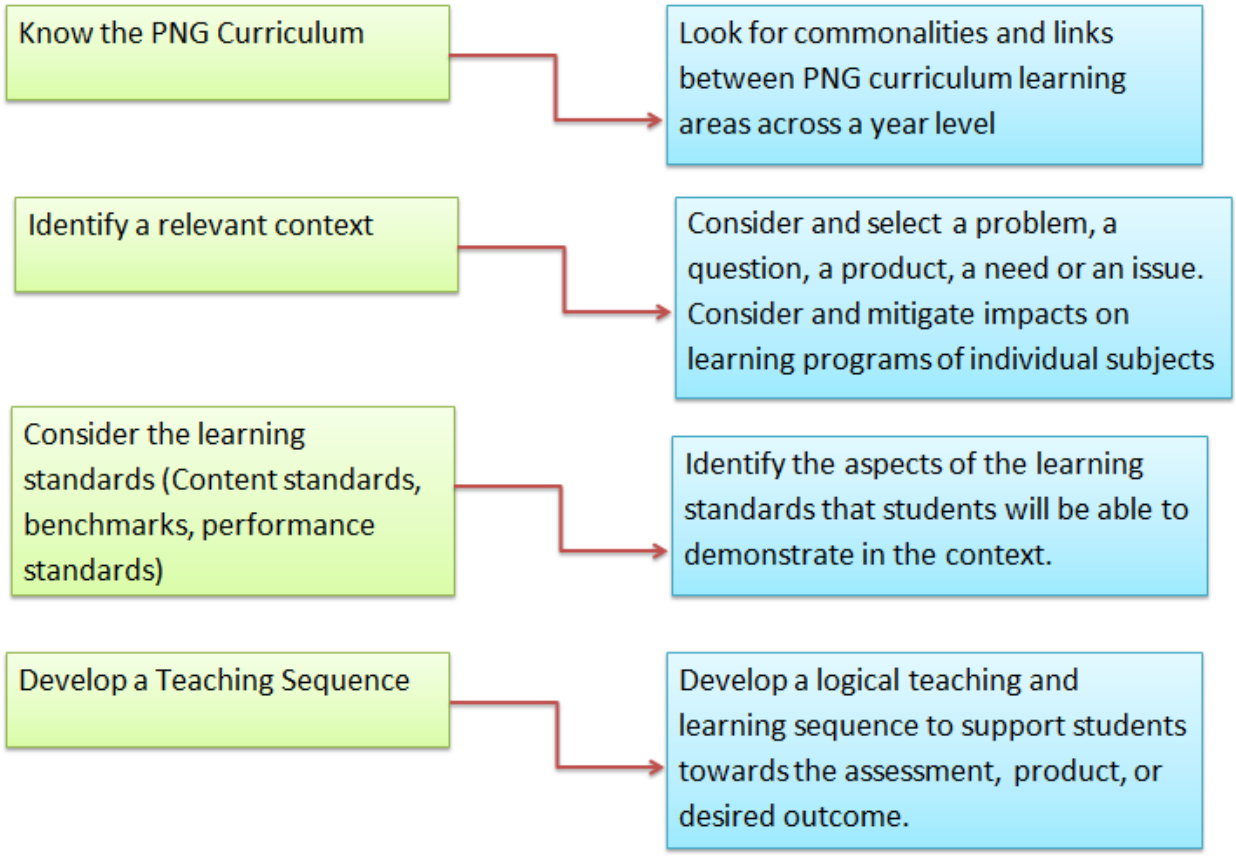
- Was the teaching, learning and assessment effective?
- Are there opportunities to improve the effectiveness of the teaching, learning, and assessment? If so, where and how?
- Were there any common student misconceptions that need, or needed, to be clarified?
- How does student progress and achievement in this unit affect the planning of subsequent units within the year/band of years?

APPROACH FIVE (5): STEM PLANNING WORKFLOW

A SEQUENCE FOR PLANNING CROSS – DISCIPLINARY STEM

If you have determined that a cross –disciplinary approach will best meet your school goals/targets, this sequence of steps will help in planning your STEM program.

You can use this approach using the PNG curriculum and your context.



The teaching and learning activities are captured in the teaching sequence. Assessment tasks are also identified before, during or after the development of the teaching sequence.