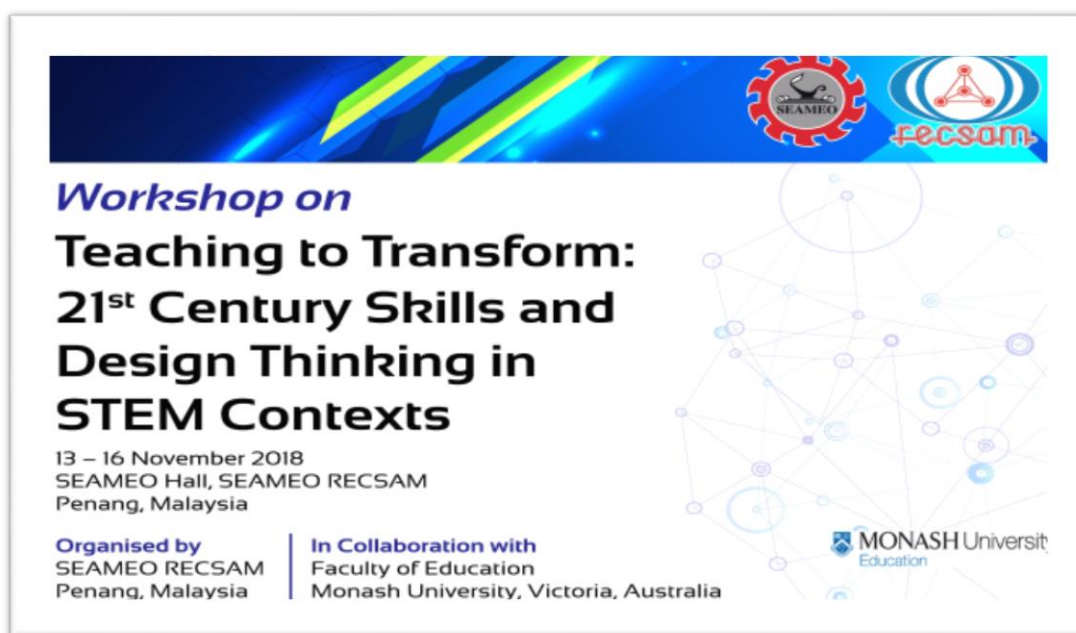DRAFT VERSION

Teaching to Transform: 21st Century Skills and Design Thinking in STEM Contexts

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Let's Go! Create enthusiasm with your class

This stage of the student design process is about starting your class on your learning journey. It is a celebration of what is about to come. For many classrooms, it also marks a point when there is a change in the way that teaching and learning has been done. In addition, it is an opportunity for you, the teacher to connect with your students and to explore their cultural backgrounds, local context and preferred learning styles.

Why create enthusiasm

Planning the introduction and launch of your problem solving project and associated inquiry based learning will enable your students to better understand the goals of the activities, justify the cultural connections and enable them to become more deeply connected with the project mission. If this is not done correctly, the diminished student understanding and project ownership will reduce engagement and ongoing interest will undermine opportunities deep thinking and creativity. A great project demands an inspiring educator.

How to create enthusiasm

You need to explain to students that you are challenging them in new and unfamiliar ways. Do not rely on explicit clues, rote memory or hidden answers. Instead, provide scaffolding and opportunities to help students make sense of where the project will go and what they need to learn. Instil a sense of purpose, build passion and drive. Find how to interest and engage your students. Prepare your students to embrace frustration, mistakes and blunders. Be open to questions from your students.

Connections: Let's Go >> Ethical and Social Awareness

Your class is enthusiastic! The students are excited to learn and to meet the challenge. But you will need to help your students contain their excitement and to work together respecting each other and the research process.
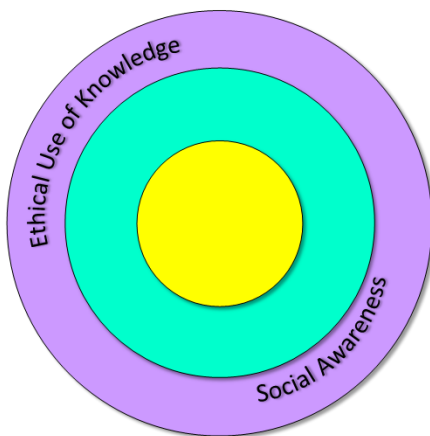
What is Ethical use of knowledge and Social Awareness

In this step you need to consider how to inform students of the moral decisions they will make as they collect and use evidence, and the problems of falsification of data. It is necessary to be sceptical and open to alternative explanations. You need to help students consider and respond to the ethical and social norms of behaviour as they work in groups and share learning ideas.
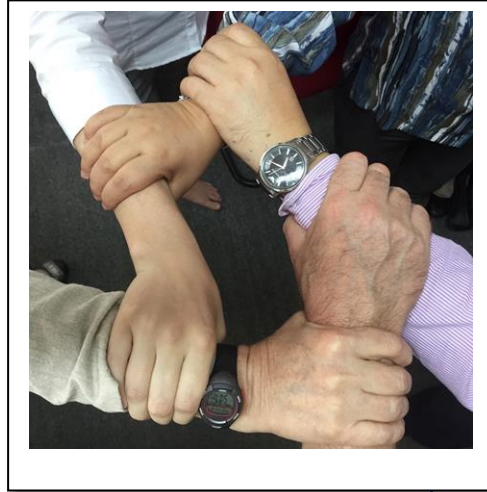
Why have ethical and social awareness

If your students have a social awareness, they can empathize with the ideas of others, and engage in positive classroom behaviours – thus a classroom is created with a focus on learning. Students with strong social awareness are able to communicate with their peers and resolve conflicts when they arise.

# How to behave ethically and with social awareness

Ethical behaviour involves demonstrating respect for moral principles that include honesty, fairness, equality, dignity, and diversity.

Students who carefully consider what their peers want, and then plan to communicate with them in a way that is intended to meet that need as being socially aware. Being socially aware is a natural response to people, taking their situation and needs into account as much as possible.

Connections: Ethical use of knowledge and Social awareness >> Planning for teaching and Design learning process for students

After exploring the ethical and social learnings you want to develop in your students, begin thinking of the content you can teach to develop ethical and social awareness. How will you develop these skills in a mathematics and science focused activity?
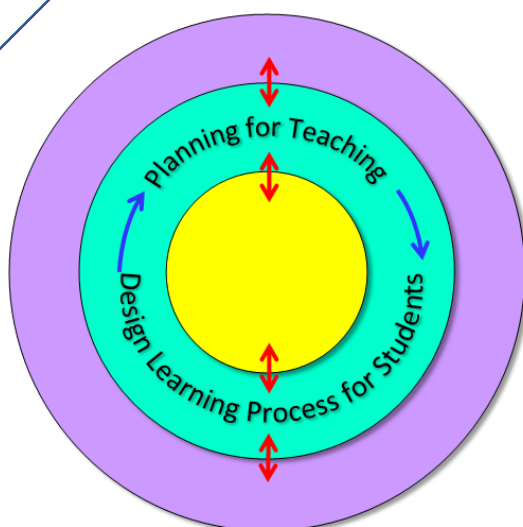
What is Planning for teaching and Design learning process for students

In this step you incorporate your ideas about creating enthusiasm, a real-world problem or issue for students, connection to the curriculum, and plan the sequence of learning activities, scaffolding, resources, and assessment. The sequence of learning activities will lead students through the Design learning process (empathising, …, proposing solution). Get students to consider issues like ethical use of knowledge, implications and consequences of solutions, how to work cooperatively in groups, how to conduct inquiry and develop other 21st Century Skills.

Why students use the Design learning process

This Design learning process model for learning is a particular pedagogical approach which will develop students' collaborative, problem solving, 21st Century skills, while learning and applying their disciplinary knowledge and skills.

How to plan for teaching

Use the unit plan template (see examples) to plan for a 6 weeks unit on a topic. Plan with other subject teachers teaching the same class Incorporate *Common Core Regional Learning Standards* from other subjects. Have fun trying out the prototyping and other activities first before teaching. Incorporate activity ideas from the examples in this booklet.
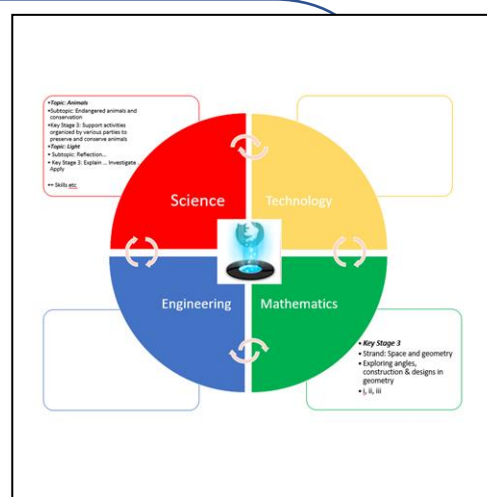
Connections: Planning for teaching & Design learning process for students >> Reflection

After each lesson, reflect on the strengths and areas for improvement of the activities, resources, instructions, scaffolding, and assessment. Also reflect on your own planning process, and the students' design learning process.
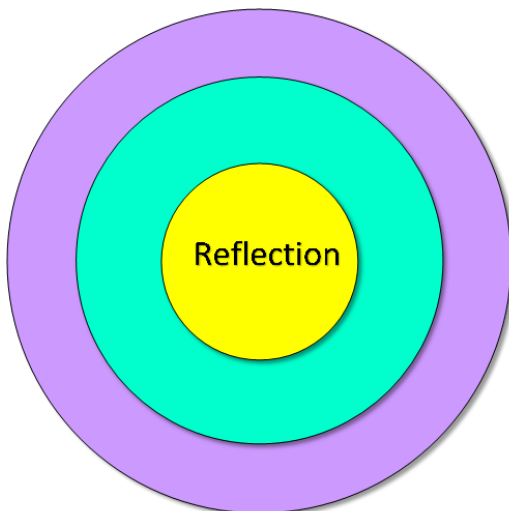
What is Reflection

Through-out all stages of planning, you must consider your overall goal to ensure you meet the *Common Core Regional Learning Standards*.

Questions you can ask yourself during the planning are: Are the students productively engaged and how do I know they are? What additional assistance, support, and/or resources will further enhance this lesson? What can I do differently, and why do I need to have options?

Why reflect

Teachers who explore their own planning and teaching through reflection develop changes in attitudes and awareness which benefits their professional growth as teachers, as well as improve the learning support they provide their students.

By reflecting teachers begin to exercise control and open up the possibility of transforming their everyday classroom life.

How to reflect

How can we help students to learn, create, connect, communicate ideas and concepts better? How can we also help students reflect on their own learning process?

The teacher needs to move beyond "how to" questions and asking "what" and "why" questions. Asking "what and why" questions give teachers power over our teaching.

Iteration and making the process your own

The *Design Planning Model for Teachers* is iterative and requires multiple cycles, where the teacher has to go back to the previous step or even back to the first step, in order to go forward. This process is only a suggestion and, in the end, you have to make the process your own and adapt it to your style and your work. It is about your way of thinking and working.

Design Learning Process for Students

Empathising
- Define the Problem
- Diagnose Issue
- Analyse Needs

Developing Design Ideas
- **STEM Thinking and Knowledge** - Convergent & Divergent Thinking, Maths & Computational Thinking, Scientific Inquiry, Technical Skills
- **Values** - Social Awareness, Ethical Use of Knowledge

Prototyping/ Modelling
- Test & Improve
- Evaluate
- Trial & Error

Proposing Solution
- Present & Communicate
- Examine Consequences
- Reflect on the Process

Every great design begins with a great **DREAM** or a great *PROBLEM*.

DESIGNING is so easy. That's why it is so *HARD*.

Prototyping is a way you **talk** to your *IDEAS*.

If the *PLAN* doesn't work, change the plan but never the **GOAL**.

Empathising

"Empathy is seeing with the eyes of another, listening with the ears of another and feeling with the heart of another." – Alfred Adler

What is Empathising

The empathy stage of the student design process is about you developing a human-centred view of problem solving. Observe other people, examining their context and listening to their needs and requirements. This will help you to become more deeply empathic and understanding. A great project demands a rich empathy experience.

Why include empathy

The empathy stage puts other people at the start and heart of any planning activity or research project. This human-centred approach ensures that your design and proposed solution is anchored in the real-world. It will help you to make the right decisions and avoid design failure when solving problems. Do not guess what other people need without first listening to them. A lack of empathy will contribute to design failure. Without empathy, there is no solution.

How to empathise

There are many different tools and techniques for this stage; from interviewing to empathy maps. They all require you listen and observe people. To do this, you may need to challenge yourself, examine any biases and ask better questions. Explore the heart not just the head. Your teacher can help you to cultivate a sense of curiosity, and help get you out of your usual comfort zone.

Transition: Empathising >> Developing Design Ideas

Only when you have combined all the collected insights can you begin to synthesise them into an outline and define the problem. It ensures that your prototype or model puts people into the centre of the solution and does not contribute to an undesirable outcome.

Developing Design Ideas

What is Developing Design Ideas

In this step, you brainstorm many different ideas, based on the problem, issue and needs found in the previous step. Go wild with different ideas! Write or draw them out. Link different things together to create new ideas. Ideas will push you to the next step of prototyping and modelling. Use your social awareness and ethical use of knowledge.
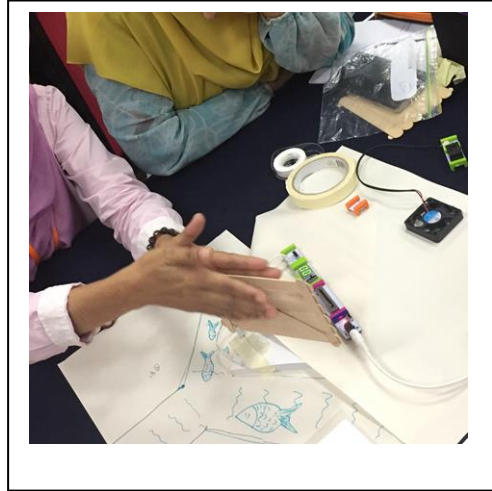
Why develop design ideas

You need to think creatively and generate the widest possible range of ideas from which you can choose from (this is called divergent thinking). You will start to narrow down your options to find the best solution in the next step, through testing your prototypes or models (convergent thinking).

How to develop design ideas

Combine your understanding and knowledge in different subjects (Mathematics, Science, Technology) to new thinking about how to solve the problem or issue.

Use your conscious and unconscious mind, logical thinking, computational thinking, and imagination.

Building things (prototyping) can be a way to help you come up with new ideas. Other ways: Brainstorm, MindMap, Role-Play, Draw.

Transition: Developing Design Ideas >> Prototyping / Modelling

After coming up with all the ideas, you need to carefully choose some ideas to prototype (choose e.g., most logical, most liked by people, most unexpected). Use these **different ideas rather than just one idea** everyone agrees with.

Prototyping/ Modelling
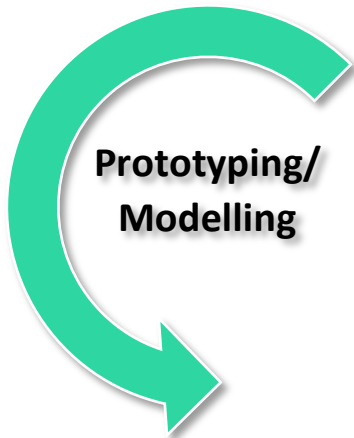
What is Prototyping/ Modelling

The modelling stage of the student design process is about the construction of a unique model that solves a real-world problem. Your final model or prototype is a representation of a proposed solution. It should clearly illustrate what the solution could look like, how it works or how it could be used. A model does not need to be the same size or even made of the same materials as the proposed solution.

There are many different tools and techniques for this stage; from ideation and testing to hands-on construction. They all require you to plan using your mind, look with your eyes, build with your hands and listen to everybody else's ideas and questions. The final model you design and build is a display of your imagination, creativity and playful tinkering.

Why build a prototype model

A great project demands a curious disposition, a compelling modelling experience and an interesting prototype or final model that can be designed, built then shared with others. To do this, you all need to generate and build upon ideas from your imaginations and personal experiences. Your model can represent the behaviour of a solution, or test the solution in different ways. It is something that you can showcase and learn about. It is something to share and build from. The modelling process rapidly moves from an initial paper design towards a working solution, physical 3D model or prototype, with idea checking along the way.

How to create new knowledges

This involves you constructing ideas and models. You need to use the inquiry learning approach, and you must embrace failure and learn from your mistakes. It is important that you allow yourself the chance to fail – so that you can learn. Moving from idea generation to hands-on action and construction, requires mental activity that constructs new knowledge and objects. To do this, you must collaborate in groups and draw your plans, communicate with others to explore alternative ideas and build new knowledge.

Transition: Prototyping/ Modelling >> Proposing Solution

Your teacher can help you by supplying model construction kits, cultural contexts and by cultivating a sense of playful tinkering and innovation with strategic questioning and deep thinking. You must work as a group, find the courage to explore with your hands and with your friends, not just from memory, and certainly not from a textbook.

Proposing Solution

What is Proposing Solution

In this step you get feedback, evaluate your prototype or model, consider the consequences, and come up with your groups' solution to solve the problem. You need to finalise your prototype or model into a model that is realistic and as good as possible given the time frame and resources. You must also decide how to present your solution to your audience, to convince them that your solution is the best possible.

Why propose a solution

To connect your model/ prototype back to the context or problem, and check if it is a good solution.

To communicate your model/ prototype to other stakeholders.

To reflect on the entire design process and make improvements.

How to propose a solution

Think of the **different components** of your prototype/ model – how can you improve them based on the context?

Evaluate - Does your prototype/ model solve the problem? What are the consequences of the model when it is used?

Communicate – How can you use words, diagrams, graphs and other media to present your solution to convince others?

Iteration and making the process your own

This process can go in many cycles and sometimes you have to go back to the previous step or even back to the first step, in order to go forward. This process is only a suggestion and, in the end, you have to make the process your own and adapt it to your style and your work. It is about your way of thinking and working.

END OF THE MODULE

NOTE: Your comments and suggestions on this proposed STEM Planning and Design Learning Framework/Model (for teachers and for students) would be greatly appreciated by SEAMEO RECSAM. We look forward to receiving your Feedback Form or in track changes into this file by June 30, 2020.

THANK YOU VERY FOR YOUR TIME AND EXPERTISE!!

June 3, 2020/ Mr. Dom Mangao