Engineering THAILAND

Appendix 1: Workshop presentations

Stuart Bevins, Tony Daniels, George Forster,
Emily Perry, Gareth Price, Mark Windale.

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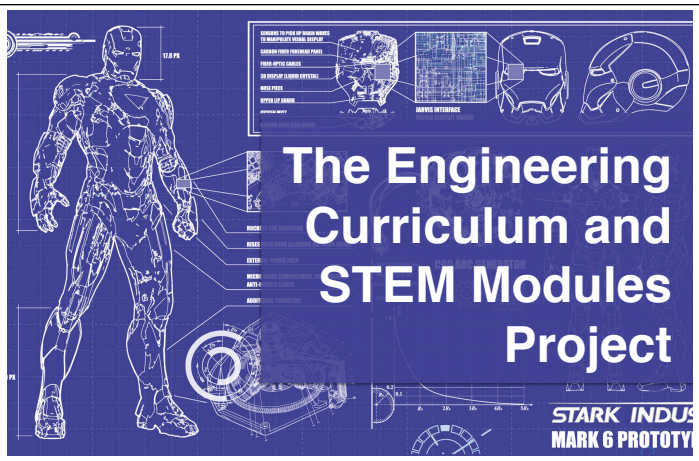
BRITISH COUNCIL

Newton Fund



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Purpose

- To review **STEM courses** and **curricula** in Thailand.
- To design an **Engineering curriculum** for Thailand.
- To design a series of **STEM modules** suitable for use in **G+T schools** across Thailand.
- To plan for **implementation** and **evaluation** of the project.

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Personnel

- Dr. Stuart Bevins. (SHU)
- Dr. George Forster. BoostED
- Mr. Gareth Price. (SHU)
- Mr. Mark Windale. (SHU)
- The OBEC team.
- The British Council (Thailand) Team

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Program

	Morning	Afternoon
Saturday 27 Aug 2016	The project context The Engineering curriculum	The STEM modules An evaluation strategy
Sunday 28 Aug 2016	Describing the engineering curriculum Assessment for learning	Activities and resources Materials review
Monday 29 Aug 2016	Describing the STEM modules STEM resources	Assessment for learning Clinic Plenary
Ongoing	Email support available as required.	

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Product

- A chance to **contribute** to the project.
- An understanding of the **philosophy** and **approach** of the proposed Engineering and STEM initiatives.
- A **network of colleagues** who are on the same journey as yourself.
- A selection of **practical resource ideas** to develop.

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An Engineering Curriculum for Thailand

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Spot the engineer

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Task 1: What is engineering?

- What does engineering mean to **you** and **your students**?
- Create a **definition** of engineering.
- List five words that describe **'good' engineering**.

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So, what is engineering?

- It is a **craft**: building motorbikes, cars, roads, rice fields…
- It is a **strategy**: a collection of skills from recognising a problem to proposing, testing and refining a constructed solution
- It is a **sector** of industry: automotive, electrical, civil, energy …

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The three themes

- Themes are packages of **process-defined**, **knowledge-informed** skills that fit into a **purposeful strategy**.
  - **Engineering for everyone**: the importance and impact of engineering on society and individuals.
  - **The engineering design process**: from initial idea to prototype and on to a finished product.
  - **Manufacturing**: the complexities of shifting from prototypes to mass produced products.

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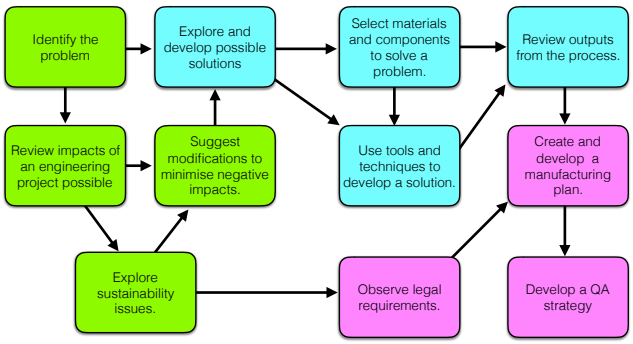
Theme elements



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The sectors

- The **big earners** for Thailand: medical and biotechnology, civil engineering and structures, agriculture, automotive, electronics and energy.
- All sectors **require** the engineering design process.
- Manufacturing is more **significant** in some sectors than others.

The context

- The **context** is the local environment (personal, educational and social), the **sector** is the industry environment (technological and economic).
- **Different** contexts require and develop **different** approaches.
- The course will produce a **wide range** of experiences because every school context is different.

Task 2: How did we do?

- How well does **our** definition match **yours**?
- Is the model strong enough to work across **all sectors** and in a **variety of contexts**?
- What do you **like**? What do you **dislike**?
- What can you **improve**?

Phases and grades

- The engineering course is seen as a **six year** continuum.
- It is divided into **three phases** of **two grades** each.
- The **first year** of the phase provides **basic instruction** with the **second year** developing this in **increasingly demanding** projects.
- **Assessment opportunities** are built into the course structure.

Learning modules

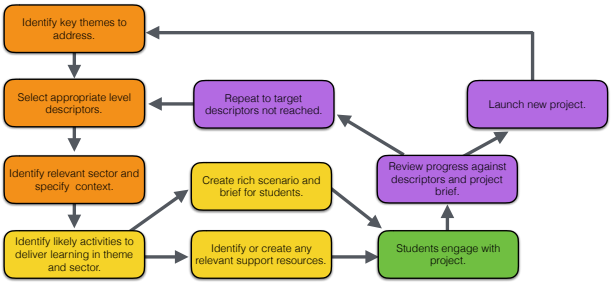
- Modules are **meaningful sequences** of learning activities typically lasting 3,6 or 12 weeks.
- Modules are specified by the **theme elements** they address, the **sector** they work in and the **context** they inhabit.
- Modules can be **shared** between schools but there is no requirement to cover a **particular** module.

Modules per phase

Week	Module
1 - 6	What is engineering?
7- 9	Engineering and problem solving mini project 1
10 - 15	Solving an engineering problem in a sector 1
16 -21	Solving an engineering problem in a sector 2
22-27	Solving an engineering problem in a sector 3
28-30	Engineering and problem solving mini project 2
31-36	Large project

Week	Module
1 - 3	Engineering and problem solving mini project
4- 9	Solving an engineering problem in a sector context 4
10 - 15	Solving an engineering problem in a sector context 5
16 -21	Solving an engineering problem in a sector context 6
22-33	Large project
34-36	Course review and conference

Module management



Teaching that builds engineers

- NOT just a series of **recipes** or **kits to assemble**. We aim to build **engineers** not teach students **about engineering**.
- **Process-driven, open-ended** and **contextually rich** to build competence and creativity.
- **Team-based** - because engineers work in teams.

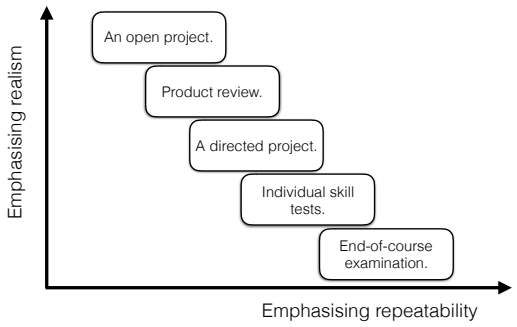
Task 4

- What could you do to develop a **strategy element**, e.g.problem identification or technique selection?
- How could you **embed** this in a given **sector**, e.g. automotive, energy?
- What is your **context** for this element?

Assessment

- Assessments must be **realistic** and **rigorous**.
- Realistic means they **reflect** what you are trying to teach and the students are trying to learn.
- Rigorous means the result is **reliable** and **repeatable**.
- **Validity** is a measure of how an assessment system provides **both** realism and rigour.

Assessment items



Our assessment model

- Criterion-referenced with **Level Descriptors** for each element.
- **Continuous** over six years - but **de-coupled** from rigid grade levels.
- **Extensible** - you can add in any other strategies you currently found useful.
- **Shared** - other schools will use the same descriptors and system.

The level descriptors

Engineering for everyone	Grade 8	Grade 10	Grade 12
Review potential impacts of an engineering project	• List the possible impacts of an engineering project on a number of identified groups.	• Describe the potential impact of an identified engineering project on more than one group showing the advantages and disadvantages for these groups.	• Use evidence to argue the potential impact of an identified engineering project from the perspective of at least three identified groups showing the advantages and disadvantages for each group.
Suggest modifications to minimise impacts	• Suggest simple modifications to reduce negative impacts.	• Make recommendations for the development of an existing project suggesting modifications to reduce negative outcomes for at least two groups.	• Make recommendations for the development of an existing project suggesting modifications to reduce costs and negative outcomes and increase benefits and positive outcomes for a range of groups.
Explore sustainability issues	• List a range of sustainability issues.	• Describe a range of relevant sustainability issues.	• Describe the scale and significance of a range of relevant sustainability issues and recommend ways to minimise future potential impact.

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Unpacking the LDs

Engineering for everyone	Grade 8	Grade 10	Grade 12
Review potential impacts of an engineering project	• **List** the possible impacts of an engineering project on a number of groups.	• **Describe** the potential impact of an **identified** engineering project on more than one **identified** group showing the advantages and disadvantages for these groups.	• **Use evidence to argue** the potential impact of an identified engineering project from the **perspective** of **at least three** identified and **described** groups showing the advantages and disadvantages for each group.

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Task 5: The Level Descriptors

- **Review** the Level Descriptors for a strategy element.
- Are they **clear enough** for you to use? How could they be **improved**?
- Does the **incline in demand** make sense across the levels?

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Resources and teaching techniques

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Resource audit

- Everything that supports our students' learning is a **resource**.
- Resources **include**: textbooks, laboratory space and equipment, websites, public TV and radio, newspapers and magazines, libraries, books, experts (visiting or resident), other teachers, other students … (this list is NOT complete!)
- In this session we will be looking at **resources** that are easily used in the classroom and **teaching techniques** that make the most of them.

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The study

- Looked at published data from **1980 to 2004** covering **160,000 students**.
- Compared **pedagogical strategies** with **traditional teaching**.
- If the strategy produced **no difference** the Effect Size was zero. An improvement gave a positive figure. If things got worse…

Schroeder, Scott, Tolson, Huang, Lee. (2007) A Meta-Analysis of National Research: Effects of Teaching Strategies on Student Achievement in Science in the United States. *Journal Of Research In Science Teaching* Vol. 44, No. 10.

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The strategies

- **Enhanced context** - real life contexts and situating the science in their existing understanding.
- **Collaborative learning** - working in groups.
- **Questioning strategies** - asking better questions.
- **Inquiry-focus** - designing and carrying out investigations.
- **Practical work** - 'hands-on' experiments.
- **Assessment changes** - modifying tests and feedback.
- **Digital enhancements** - computers, iPads, websites.
- **Enhanced materials** - rewriting the textbooks.

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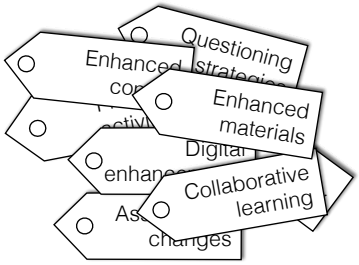
Task 1: Winning strategies

Positive

Zero

Negative



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And the winner is…

Strategy	Effect
Enhanced Context	1.48
Collaborative Learning	0.96
Questioning Strategies	0.74
Inquiry focus	0.65
Practical work	0.57
Assessment changes	0.51
Digital enhancements	0.48
Enhanced Materials	0.29

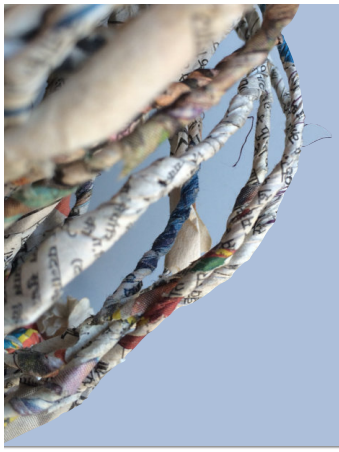
A catalogue

- The catalogue offers a **range of teaching techniques**. There are many others not on the list.
- **Some** will work for you. **Others** will not. **None** are compulsory.
- **Open, collaborative classrooms** are better able to make use of a variety of techniques than classrooms where students are sat in rows and the only person who talks is the teacher.

Resources

- You have seen some great **ideas**.
- Now it's time to start **writing** so that you have something to use in your school.
- A **common format** means it is easier to share resources.

Heading	Purpose
Lesson focus	What is the lesson for? **Why** are you doing this?
Level descriptors	What are the **assessment targets**?
Context	What is the **story**?
Activities	What will the **students** do?
Script and timings	Minute by minute instructions for the teacher. **Do** this… **do** that …
Resources	What will you **need** to teach the lesson?



Strands, themes and contexts

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The three themes

- Themes are process-driven **packages** of skills applied in a **purposeful strategy**.
- **Engineering for everyone**: the importance and impact of engineering on society and individuals.
- **The engineering design process**: from initial idea to prototype and on to a finished product.
- **Manufacturing**: the complexities of shifting from prototypes to mass produced products.

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Engineering for everyone

- What is the **impact** of engineering and new technology on **people** and **society**?
- What are the **advantages** and **disadvantages** of opting for an **engineered solution**?
- How can we ensure the engineered solution is **sustainable** over the long term?
- What problems are addressed by engineers and **who chooses** which developments are funded?

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Engineering design process

- What is the **problem** that **people** are facing?
- What **solutions** to this problem can engineers offer?
- Which solution is the **optimum** one and why?
- How will you **evaluate** the **efficacy** and **impact** of the solution?

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Manufacturing

- What are the **relevant regulations** for this work (e.g. H+S, consumer protection, environmental regulations)?
- What are the **key stages** in the manufacture of your product?
- How will you **manage production efficiently** to respond to supply/quality/workforce issues?
- How will you **minimise** and **manage** risk?
- How will you ensure **quality assurance**?

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A journey

Year	Engineering for everyone	The engineering design process	Manufact -uring
7			
8			
9			
10			
11			
12			

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Themes and sectors

Sectors	Engineering for everyone	The engineering design process	Manufacturing
Medical and biotechnology	✔	✔	✔
Civil engineering and structures	✔	✔	✔
Agriculture	✔	✔	✔
Automotive	✔	✔	✔
Electronics	✔	✔	✔
Energy	✔	✔	✔

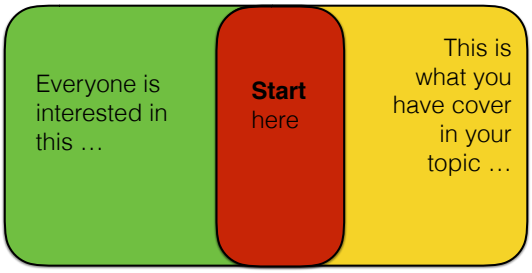
Task 1: Sector audit

- Which sectors are particularly **relevant** to your school? Why?
- What **links** will you make when you get back to school? How?
- Which sectors might be **difficult** to support? What help do you need?

Why worry about context?

- The **context** is the local environment (personal and social), the **sector** is the industry environment (technological and economic).
- All sectors **require** the engineering design process.
- **Different** sectors and contexts develop **different** approaches.
- Manufacturing is more **significant** in some sectors than others.

What is meaningful to your students?

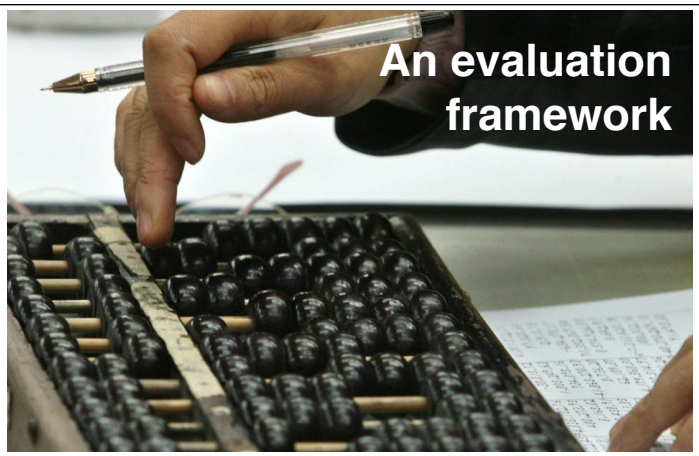


What makes a good context?

- **Provocative** – they excite interest and raise questions
- **Authentic** – they have an obvious link to the student's 'real life'
- **Integrated** – they require a broad range of skills and knowledge to tackle them

Task 2: Convincing contexts

- What could you do to develop a **strategy element**, e.g.problem identification or technique selection?
- What is the **context** for this element?
- How could you **embed** this in a given **sector**, e.g. automotive, energy?



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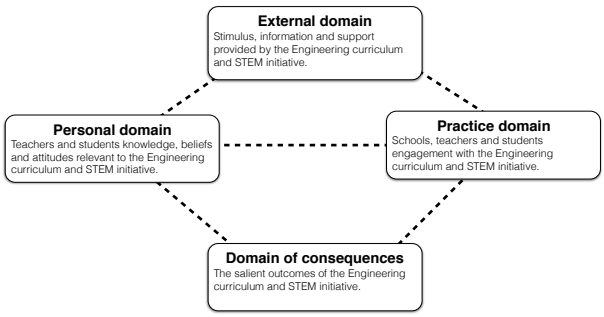
An evaluation framework



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Why carry out evaluation?

- Participation - a chance to be **involved** and **shape** the development.
- Impact - does what we do make any **difference**?
- Development - what is **next** for the project?
- Evidence - what can we prove **works**?

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Evaluation tools

- Qualitative and Quantitative data.
- Questionnaires.
- Interviews.
- Observations.

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Task 1: It's about questions!

- What **questions** would provide you with an understanding of the impact on **students**?
- What **questions** would provide you with an understanding of how **teachers** are deploying the curriculum?
- What could you **observe** in the classroom that would provide you with an understanding of the process involved in **curriculum delivery**?

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Assessment

Which is the most appropriate type of assessment for these modules and why?

Formative assessment

- Informal
- students will take more risks
- Subjective and objective
- Students can act on rapid feedback
- Can modify progress during project
- Better relationship between students and tutors

Proposal

You are a school and you must submit a proposal for an assessment of a module to an examinations board.

Use the criteria in a real module

Two parts:

Teacher assessment

Written section

Assessing the modules

Within module assessments

Element	Assessment criteria	Comments on interpretation	Marks
Producing a definition	• Shows clear understanding of the issues that will impact upon and shape the problem • Can articulate the problem in a concise form that is capable of practical solution	This section tests the higher levels of Bloom's taxonomy. To score highly the group must work together constructively to produce a precise and concise definition.	25
Creativity, originality and choice of preferred solution	• Shows originality in identifying a range of proposed solutions • Demonstrates a logical approach to SWAT analysis of proposed solutions	G&T students display different areas of advanced ability. Creativity, "thinking outside the box" and not being inhibited by current solutions is a common feature of G&T behaviour.	25
Organisation, efficiency and thoroughness of preparation, including research	• The group demonstrates efficient organisation with tasks well directed • Shows a clear approach to the research, seeking the information required, without wasting time on irrelevancies	G&T students often perform well in these areas an evaluating research is an important skill.	25
Quality of presentation, including planning and clarity of explanations	• Shows that the presentation is well organised and progresses logically, each point following logically from the one before • Explanations use simple language	Clear explanations may not come easily to G&T students whose thought processes may be complex. Since communication is highly important in all careers and walks of life, high quality communication is	25

In view of the characteristics of the gifted and talented student, this formative assessment shows:

- Thought clarity
- Creativity, originality of though and acceptance of novel ideas
- Organisation and efficiency – personal as well as in interacting with others
- Presentation skills

Gifted and talented students show empathy. They can see and understand things from the point of view of others

Each module has a question that relates directly to the module topic that asks students to assess the project from another's point of view.

Gifted and talented students are good at reflective learning. They reflect on what they have learned and achieved. The reinforces the learning.

Each module has a question that asks students how they might have approached the task differently, or come to different conclusions.

Can you suggest any other ways of assessing these modules with gifted and talented students?

Using the module you developed, think of questions that will test the following:

- Knowledge gained
- Understanding gained
- Students empathy with others
- Students reflective learning

General feedback

How appropriate are these units for your gifted and talented students?
How would you modify the modules to make them more appropriate for your students?
What other topics would you like to see covered?

Do you feel you could develop your own units and if not what more do you need?

Developing the modules

Reminder

- Designed for gifted and talented students
- Different levels of complexity for grades 7 - 12
- Focused on STEM topics
- Linked to the engineering process and the scientific method
- Designed to last for six weeks plus

Each module comprises:

- Background
- The challenge
- Objectives
- Teaching guidance
- Assessment strategy, levels and guidance

The Modules - topics

1. The drop-off - School traffic management without blocking the road
2. Dry gain where you want it – Mobile, eco-friendly rice grain dryer
3. Smart packaging – prolonging food shelf-life
4. Tsunami town – build a tsunami resistant town
5. Oil spill – cleaning up a spillage
6. Pack popper – extracting pills from blister packs
7. The right amount – measuring volume and dispensing the correct quantities of liquid
8. Cleaner, whiter teeth – develop a new good tasting whitening toothpaste
9. Drone detective – design a system to identify water leaks from pipelines
10. Mars breakdown – rescue a group of astronauts newly arrived on Mars
11. Cleaning up pollution – find novel ways of cleaning pollution from old industrial and mine workings
12. Flood protection – design flood resistant homes

Three examples

The right amount

Pack popper

Cleaning polluted water

The right amount - measuring volume and dispensing the correct quantities of liquid

The challenge:
Students are design engineers who will design, build and test a device that will deliver variable amounts of liquid medicines. The device should be suitable for use in hospitals, clinics and in patient's own homes, or even in field clinics.

- Function in clinical and non-clinical settings
- Deliver accurate volumes of liquid
- Be easily cleaned or disposable
- Be safe for both health workers and patients to use
- Durable and capable of use by multiple people
- Be made from environmentally friendly materials
- Be capable of economically viable manufacture
- Be easily stored in a domestic setting
- Maintain sterility of the liquid it contains, even after opening
- The presentation at the end of the module should involve a demonstration of the device

Pack popper – design a device for easily removing pills from blister packs

The challenge:

Students are design engineers who will design, build and test a device that will enable the elderly and disabled to remove pills and capsules easily from blister packs.

- Function in a domestic setting
- Not cause contamination of the contents
- Easily cleaned
- Be safe to use
- Durable and capable of multiple use or, alternatively, be disposable
- Made from environmentally friendly materials
- Capable of economically viable commercial production
- Be easily stored in a domestic setting
- Fulfil the challenge i.e. allow easy removal of pills and capsules from a variety of blister packs by people who have previously had difficulty with this action
- A presentation and demonstration of the device will take the form of a pitch to potential sponsors and manufacturers

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Cleaning polluted water

The challenge:

To clean polluted water. To remove polluting chemicals from water remaining on an disused industrial site.

- Water in the area surrounding an old mine has become polluted, its is affecting the local ground water and is lying in toxic pools on the site.
- The clean up must use an environmentally sensitive system
- If possible the system, in addition to the production of clean water, should have another advantage to the local community such as the retrieval of saleable heavy metals

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Activity 1

Jigsaw technique

- You are currently sitting in your HOME GROUP
- Give each group member a module title card
  - These are the names of the EXPERT GROUPS
- Pair up with the other member of your group with the same expert group card
- With your partner go to the expert group table
  - This is you EXPERT GROUP TABLE

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Activity 1

Expert group task

- In your expert group read the STEM module so that you understand it
- Answer the questions on the following slide
  - This will help you understand the module from the teacher and students perspective
- Make sure that ALL members of your expert group has the answers to ALL the questions and understands the STEM module
- Prepare to present your STEM module to your home group, using the question answers as a structure
- When everyone has completed the expert task you will return to your home group

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Expert groups

What is the problem?
one problem, concise statement

Why do we need a solution?
What do we need to know in order to solve the problem?

What are the alternative solutions?
what are they, how might they work

Which is THE solution?

How do we know this is the right one?

How are we going to use the chosen solution?

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Activity 1

Home group task

- Return to your home group
- Each expert pair should present their STEM module to the home group and ensure that all members of the group understand the module
  - You can do this by other members of the home group asking the expert group people questions
- When you have shared all three STEM modules, prepare to use the module by answering the questions on the next slide
- Prepare to present your STEM module by summarising your discussion as bullet points on a large sheet of paper

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Implementation - in your school

- ✓ Six weeks – timetable, extra time, what and when
- ✓ Preparation – what will students need? Prior knowledge, techniques, scientific method, presentation techniques
- ✓ Resources – paper based, hardware, software
- ✓ Facilities – laboratory, workshop, meeting room, presentation space
- ✓ Reporting – presentation, written report, scientific paper, video
- ✓ Implementation – usage, marketing

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Your module

Brainstorm Topic

Set the challenge

Brainstorm ideas for solution

Suggest some ideas for a prototype and its evaluation

Make notes for the future

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Which topics (in general) do you think your gifted and talented students will enjoy most?

How might this module approach be extended to non-practical areas or areas where experimentation is not possible, e.g. human genetics, nuclear reactor research, space or planetary research

What do you think are the advantages and disadvantages of this modular/ project based approach?

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STEM COURSES – THE MODULES

Sat. 27 August

13.30 **The proposed STEM courses**

What do we understand by STEM?
A common understanding of Gifted and Talented students - delights and challenges
Teaching gifted and talented students
Course structure and content

Mon. 29 August

10.00 **The Modules - extending concept and design**

Teaching the modules
A typical module - approach and content
Further development
Your own module

11.15 **Activities and resources**

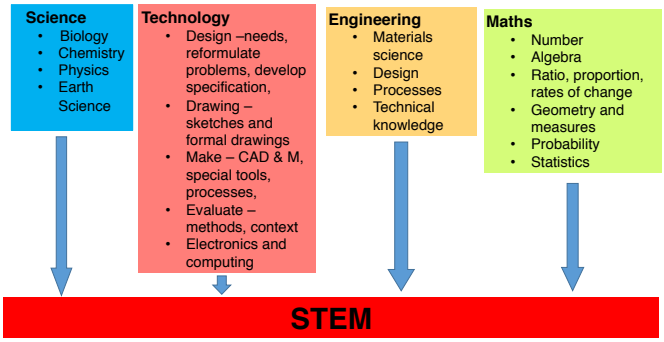
Developing classroom resources for the modules

13.30 **Assessment for learning**

Assessing gifted and talented students
Assessment strategies for the modules

The proposed STEM courses

What do we understand by STEM?



What does Gifted and Talented mean?

- No universally accepted definitions
- Performance against international standards, ability tests, teachers assessment, competitions

'Gifted and Talented' children are those who have one or more abilities developed to a level significantly ahead of their year group (or with the potential to develop these abilities). 'Gifted' refers to those pupils who are capable of excelling in academic subjects. **UK Government**

"Gifted" individuals are those who demonstrate outstanding levels of aptitude (defined as an exceptional ability to reason and learn) or competence (documented performance or achievement in top 10% or rarer) in one or more domains. **US National Association for Gifted and Talented Children**

Young people performing (or who have the potential to perform) substantially (about a year) in advance of their year group. Usually equates to about 10% of the population.

How would you identify a gifted student?

Common characters & identification… Delights ....

- Learns rapidly
- Extensive vocabulary
- Excellent memory Reasons well
- Strong curiosity
- Creative, possibly "silly" ideas
- Mature for age
- Good sense of humour
- Keen observation
- Compassion for others
- Vivid imagination
- Long attention span
- Ability with numbers
- Concern with justice, fairness
- Sensitivity
- Wide range of interests
- Ability with puzzles
- High energy level
- Perfectionism
- Perseverance in interests
- Questions authority
- Avid reader
- Prefers older companions

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…AND…

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…Difficulties

- Often self-critical, but may be excessively so
- Sometimes have difficulty understanding that others cannot grasp concepts as easily as they do
- May take perfectionism to the extreme
- They are not prepared for failure
- Despite their apparent maturity they may be insecure and need support
- At progression stages they experience the move from "big fish in a little pond" to "little fish in big pond"

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Good teaching for gifted and talented students… teaching the modules

1. High expectation of the students - teach to fail safely
2. High cognitive challenge
3. Personalised learning
4. Contextualise ideas - relevance
5. Allow independence – style and speed of learning
6. Give the overall context of the problem, G&T students like to know the purpose of their learning
7. Be ready to justify purpose of learning
8. Admit you are wrong or do not know the answer
9. Providing opportunities for choice, decision making and self-direction
10. Encourage students to reflect on what they have done.

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What's your number 1

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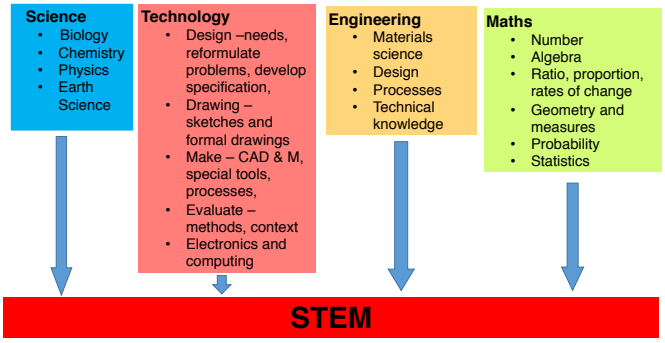
What do we understand by STEM?



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Our challenge:

To design courses for G&T students, at grades 7 – 12, incorporating as many aspects of STEM as possible.

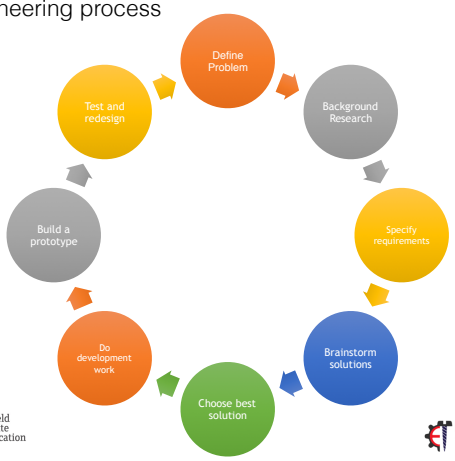
The answer

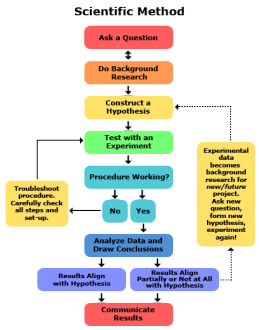
STEM MODULES

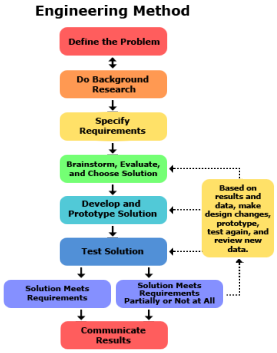
Containing elements of :

- Problem identification and clarification
- Roughly follows the engineering process and scientific method
- Research
- Problem solving
- Opportunity for creative an novel solution
- A real issue relevant context
- Opportunity for reporting, presentation

The engineering process







Smart packaging

Background

Packaging can play an important role in the processing and marketing of perishable items such as fruit or medicines. For example, appropriate packing materials can reduce mechanical damage and the use of sealed-in atmospheres can control ripening. Sterilisation and radiation treatment can slow microbial decomposition. Built-in temperature indicators can show when storage temperatures have been too high. However, these can be expensive and technically difficult solutions. This module is about using innovative approaches to develop simpler ways of making perishable items last longer with good appearance.

The cut surfaces of many fruit and vegetables such as bananas, avocados, apples, pears, bananas and potatoes discolour to brown when exposed to air. The purpose of this module is to find a way of preventing this discoloration for as long as possible.

The discolouration is due to the cut cells releasing an enzyme called polyphenol oxidase. It catalyzes a reaction between phenolic compounds from the cells and oxygen from the air which forms new compounds called o-quinones. In turn these react with amino acids or proteins to form the brown compounds.

Brown colours appear at different rates depending upon the amount of enzyme present, the ripeness of the fruit and its variety.

There are several ways of reducing the browning effect, for example washing the cut surfaces, treating them with syrup, fruit juice or salt. Whilst syrup excludes oxygen the others reduce the surface pH and slow down the oxidation reaction.

This part of this module is about which treatments might be more effective in reducing discolouration and which might last longer. The effect of different packing materials can be taken into account.

Microbial degradation of fruit and vegetables involves bacteria and fungi using the fruit as a substrate (food) from which to gain energy. The process is much faster if the fruit's surface has been damaged. The process can be slowed, for example, by reducing the temperature or washing, especially with non-toxic wetting agents or non-toxic antimicrobials to remove or kill the microbes.

The second part of this module is to find which treatments preserve food from microbial attack longer compared with the normal process of decomposition.

The challenge

Students play the role of food scientists attempting to find better packaging methods for fruit and vegetables.

The purpose of the module is to develop better packaging to reduce or prevent browning and to prolong storage life by cutting down the number of surface microbes.

Information and criteria for design are:

- They might investigate three or four different methods, but each method should be thoroughly studied, e.g. using a dilution series to determine the best concentration of solution to use to wash freshly cut fruit.
- Students should be aware of the scientific method and the need to reduce the number of variables to one.
- For both topics they will need to set up a standard testing system so that treatments can be compared with the normal process. What factors will they need to control?
- Having identified the best conditions to prolong quality, the students should investigate packaging solutions e.g. plastic bags, tight wrapping in film, cellophane packs etc.

Objectives

- To produce a system, including the pack, to preserve high quality in cut fruit and vegetables
- To produce a system, including the pack, to reduce microbial degeneration of fruit and vegetables
- To make prototypes of the packs
- To carry out tests to evaluate the packs
- To produce a report to recommend a system accompanied by the prototypes

Stage	Student	Teacher	Possible week
Problem identification	Taking the role of food scientists students should formulate the questions that need to be answered in order to produce the end result. This will indicate the research required.	Defining the required outcome in this way will clarify the steps needed to achieve the result. The teacher may need to encourage students to take different roles in the investigation. However, the teacher's role is to challenge ideas and to guide students to make their own decisions.	0.5
Background research	In this module there is quite a bit of basic science information to be gathered to understand the underpinning principles. Students will need to gather enough information to be able to select the methods they are going to use and test.	Teachers can bring an experienced eye to the problem. Whilst they should stimulate students to come up with their own ideas they should challenge the ideas and guide students towards systems that are likely to be practical under the module conditions i.e. time allocations etc.	0.5 – 1.5

Specification	The specification is a description, of what the end product should be. It cannot give very precise details at this stage because the development process has to take place.	The main role of the teacher here is to make sure that the demands of the specification are practical and not impossible to reach. Again, an approach that helps the students write their own specification is best.	**1.5 – 2**
Alternative solutions	There may be several ways to meet the specification, for example different substances could be used to prevent oxidation. A number of options should be selected for exploration. Students might like to consider what are the most practical possibilities.	Student solutions must be credible and practical, but teachers should encourage originality. Sometimes discussing an impractical solution can reveal more information that will help solve the problem. Teachers should try not to prompt the students. The students should originate their own ideas. Teachers should try not to point out specific problems involved in an idea – that is for the students to find out.	3
Develop	In this case a number of	Teachers should explain	4

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Develop and prototype	In this case a number of options should be explored by experiment.	Teachers should explain the scientific method and ensure that students include enough controls and that fair tests are conducted.	**4**
Test and redevelop	A leading candidate for the system should be revealed by the experiments. Students should modify it according the results.	This is the stage where modifications can take place. Students should largely work alone at this stage.	5
Report the results	The team should be ready to make a recommendation about the final packaging solution. They should make a presentation supported by the prototypes. The report should	The presentation could be in the form of a scientific paper or a recommendation to a fruit and vegetable marketing chain.	6

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Assessment

In view of the general guidelines for assessing G&T students, it is recommended that this module is assessed in three ways:

- **A general assessment of the report or presentation**
- **A written answer from each individual student to a specific question**
- **A written answer to a specific question to stimulate self-reflection**

Although these assessments are generally subjective, criteria are given to make the evaluation consistent between groups.

The general assessment is an assessment of the overall group performance, with criteria and marks as follows:

A written answer to a specific question
The question is:

- How well does your product meet the original specification? Evaluate it in every-day use. Are there any dangers in its use? What are its strengths and weaknesses and will it improve product quality and profit?

Factors to consider in marking include, how well can the student put themselves in the position of the user (empathising), how well do the students put forward arguments, do the students propose any compromises to make the scheme suit all?

A written answer to stimulate self-reflection
The question is:

- Do you think the original module requirement was important? If so, why is it important to lengthen shelf life? Where do you think are the weaknesses in the experimental techniques and how would you conduct the experiment if you were to repeat it?

G&T students are generally good at self-reflection and use it as a tool to assess their own progress. This will help stimulate that process.

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Element	Assessment criteria	Comments on interpretation	Marks
Producing a definition	• Shows clear understanding of the issues that will impact upon and shape the problem • Can articulate the problem in a concise form that is capable of practical solution	This section tests the higher levels of Bloom's taxonomy. To score highly the group must work together constructively to produce a precise and concise definition.	25
Creativity, originality and choice of preferred solution	• Shows originality in identifying a range of proposed solutions • Demonstrates a logical approach to SWAT analysis of proposed solutions	G&T students display different areas of advanced ability. Creativity, "thinking outside the box" and not being inhibited by current solutions is a common feature of G&T behaviour.	25
Organisation, efficiency and thoroughness of preparation, including research	• The group demonstrates efficient organisation with tasks well directed • Shows a clear approach to the research, seeking the information required, without wasting time on irrelevancies	G&T students often perform well in these areas and evaluating research is an important skill.	25
Quality of presentation, including planning and clarity of explanations	• Shows that the presentation is well organised and progresses logically, each point following logically from the one before • Explanations use simple language	Clear explanations may not come easily to G&T students whose thought processes may be complex. Since communication is highly important in all careers and walks of life, high quality communication is important for G&T students.	25

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