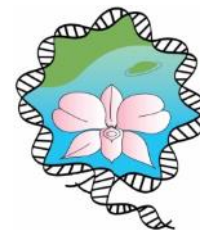


STEM Education Brainstorming Workshop

QUT Gardens Point

28 July 2015

Hosted by The Royal Society of Queensland
and the Office of the Chief Scientist

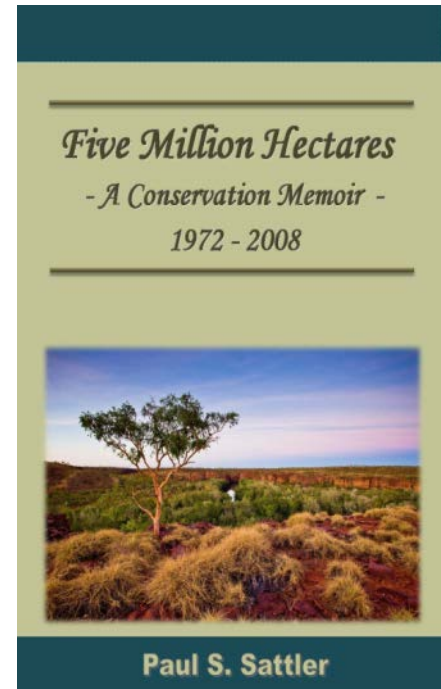


The Royal Society of Queensland

Long, proud tradition: since 1884.

Supports science + scientists;
advocates but is not *activist*.

Scope – science, science-related policy,
philosophy, education.



www.royalsocietyqld.org.au

STEM EDUCATION: Is there a problem? If so, how do we improve?

By Geoff Edwards
President
Royal Society of Queensland



28 July 2015

Origin of this Event

At a seminar June 2014 to launch a new Research Fund, the audience identified STEM education as a major issue warranting Society's attention.

Met Office of Chief Scientist, who had mapped ~90 STEM education projects.

Rather than launch yet another project, Society decided to ask educationists: Is there a systemic crisis?

Objectives of this Event

- Explore whether there is any shortfall in STEM education, given that so many expert people are doing such admirable projects.
- Glean learnings, ideas and insights from STEM education experts.
- Allow participants to take home learnings for their own organisations
- Identify a possible role for the Royal Society as a non-government advocate or facilitator.

Possible Outputs

Primary formal output is expected to be an action list for institutional participants to pursue through policy and advocacy. Also:

- Web publication of something?
- Print publication of something?
- ...
- Whatever the meeting suggests.

Ingredients of effectiveness

A strategy to achieve something effectively will:

- set out a realistic *vision*
- be grounded upon a coherent *theory* linking causes and effects and explaining the forces at work
- map effective *feasible paths* for achieving the vision by overcoming fragmented knowledge and fragmented accountability.

The Five Capacities

To achieve a vision, five capacities are necessary, in one locus of responsibility:

- *a stable coordinating body with organisational authority:* to overcome fragmentation of knowledge and accountability
- *legal authority:* statutory or official power
- *skills:* competent personnel
- *knowledge:* data and interpreted information
- *funds:* budget or revenue-raising capacity.

Empowerment

Empowerment comes when operatives have access to *all five* capacities in their work.

Do STEM educators have access to all five?

Agenda

- 10.00 Welcome and the importance of STEM – Lauren Stephenson on behalf of Dr Geoff Garrett AO, Queensland Chief Scientist
- 10.07 Background and introductory remarks – Dr Geoff Edwards
- 10.15 Presentations in alphabetical order of presenter's surname
- 11.00 Morning tea
- 11.15 General discussion, brainstorm format
- 12.45 Discussion focused on drawing consensus conclusions
- 1.00 Close.

Guests invited to continue discussion over lunch nearby.

Supporting improved STEM outcomes in schools

- build teacher capability
- lift student achievement
- increase student participation in STEM in Years 11- 12 and beyond



Widening Participation Program

A HEPPP-funded initiative to build awareness and aspiration for tertiary studies and careers in STEM for students from disadvantaged backgrounds.

Working to:

- Demystify the uni experience
- Generate interest for tertiary studies in STEM
- Create awareness of careers in STEM
- Improve demand for STEM-enabling school subjects

Through:

- Extreme Science and Engineering Van in-school workshops
- Explore Uni on-campus taster workshops
- Specialised STEM on-campus full-day events
- STEM Futures tailored programs for secondary schools



Fast facts:

*Since 2010, the program has presented to over **100,000 students** through **3,500 workshop presentations** by 100 undergraduate and postgraduate student ambassadors.*

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Wonder of Science

Building passion and enthusiasm for science and technology in Queensland's young people

A program building 'a STEM culture' - ie students committed to STEM education and career pathways with the belief that STEM is accessible to them

Evaluation shows Wonder of Science is enhancing student participation and achievement in STEM education through:

- ❖ Young Science Ambassadors (PhD research students) as mentors
- ❖ Challenging authentic curriculum tasks - aligned to Australian Curriculum
- ❖ Student conferences in university settings
- ❖ University and industry partnerships with schools
- ❖ Focus on regional, rural and remote schools
- ❖ Targets students in years 5 – 9 (+ year 4 on demand)

Observations as a “Scientist in Schools”

Students keen in “real life” scientists – what they do, how they got there

Passion – my journey, hobbies vs profession; hands-on projects

Alternate pathways to reaching goal vs “traditional” (e.g. OPs)

Subject flexibility to explore (process vs outcome), top down vs bottom up, new generations, new technologies and focus subjects





QUT YuMi Deadly Centre

- YDC maths programs to build schools' teaching/learning capacity:
 - YDM TDT: training in YDM pedagogy (years F-9)
 - YDM AIM: remediating by accelerating learning
 - YDM MITI: extending understanding to increase participation in Maths B and C
- YDM successful in schools in:
 - building teacher capacity including for out-of-field teachers
 - improving student attendance, engagement, discussion and performance
- Insights:
 - need to increase pool of potential STEM participants as well as attract students from existing pool; YDM-style programs are important
 - should fill STEM shortfall from Indigenous and low SES students; special funding into training in these schools
 - effective STEM maths teaching requires focus on understanding, inquiry, structure and problem solving, not rote learning
 - requires support of schools and industry and administrator-teacher stability
 - alternative pathways to STEM vocations are also important

Tom Cooper, tj.cooper@qut.edu.au

Engaging a student
hands-on



SPARQ-ed

Students Performing Advanced Research QLD

- Schools science outreach centre located at Translational Research Institute (TRI)
- Established in 2009 following an approach by Prof. Ian Frazer to Queensland Dept. of Education, Training and the Arts
- Aims to address the decline in engagement in science courses by connecting school communities with researchers at the cutting edge of medical science
- Programs:
 - Research Immersion Programs - 5 day programs set around a project designed by TRI researchers for senior science students and teachers
 - Cell and Molecular Biology Experiences – shorter (1-2 day workshops based on a single cell and molecular biology technique
 - Upper Primary / Junior Secondary Workshops

ENGINEERING EDUCATION IN THE PRIMARY SCHOOL

Lyn D. English (l.english@qut.edu.au) and **Donna T. King** (d.king@qut.edu.au)
Queensland University of Technology

Introducing engineering education to the primary and middle year school levels

Funded by Linkage grants from the Australian Research Council

Supported by industry including Transport and Main Roads



Aims included:

- Introducing students to the diverse world of engineering and its roles
- Developing students' appreciation and independent application of engineering design processes in solving real-world problems
- Building on students' learning in mathematics, science, and design and technology in solving engineering-based problems
- Developing students' appreciation of how their learning in these disciplines applies to solving problems in the outside world



Randall Hall | Principal Education Advisor- Science
Department of Education and Training
Queensland Government | South East Region

- Regional support for science
- Griffith Science Education Alliance
 - Griffith University, EQ, DET, GCCC, STAQ
- Cluster Connections



QUEENSLAND MUSEUM

Tania Hall, Director STEM Partnership
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The school perspective

- Schools can be overloaded by projects
- Expand and support proven strategies (CSIRO's *Scientists in Schools*)
- Schools are diverse
- Teachers know what they need
- Funding
- Quality education? Then quality, ongoing professional learning is required...
 - ✓ post graduate courses
 - ✓ A Qld STEM Academy

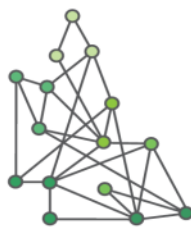


Two Brisbane independent schools - Arethusa College and Brisbane Grammar School



The education of tomorrow





- The **Queensland STEM Education Network (QSEN)** is a new tertiary consortium which aims to improve and advance Science, Technology, Engineering and Mathematics (STEM) capacity in Queensland.
- Funded for three years from the Federal Government's Australian Maths and Science Partnership Program
- **Major goals:**
 - To raise awareness, interest and achievement in science and mathematics among Queensland junior secondary students leading to increased STEM enrolments at senior secondary and tertiary levels
 - To engage students, parents, teachers, guidance officers and the broader community to demystify and raise awareness of the importance of STEM education and STEM related careers
- **Approach: Student engagement** - build on existing STEM outreach programs to allow statewide sharing of best practice. Co-development of innovative in-class curriculum resources complemented by the provision of engaging, informal, out-of-class, STEM experiences which take advantage of the *unique* expertise, resources and infrastructure at each partner university.
- **Approach: School / Community Engagement** - "*Influencing the Influencers*" to demystify STEM-related careers and remove myths, misconceptions and roadblocks to engagement in STEM studies, ie parents, families, teachers and career/guidance officers in schools
- **Collaborative Networks:** Key stakeholders including the Office of the Queensland Chief Scientist, the Department of Education Training and Employment, the Science Teachers Association of Queensland, the Queensland Association of Mathematics Teachers, Queensland Society for Information Technology in Education and community, local education and parent groups.

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Primary Industry Centre for Science Education (PICSE)

The PICSE program's strategy is to **Increase Participation in the Bioscience Professions**; through key goals of based on :

- Raising **awareness** amongst students and those who influence them, about career opportunities in these industries
- Creating an **interest / intention** in young people to seek specific science focussed career options in the primary industries
- Increasing **participation** amongst students in school science courses, in order to increase participation in tertiary science related courses, and ultimately entering suitable primary industry related careers.
- Providing engagement and connectivity with, and between, undergraduate university students and wider primary industry research and agribusiness sectors to enhance workforce capacity.

A Science Education Officer (SEO) undertakes a series of annual, defined and integrated program activities, including :

- 1. Industry Placement Scholarship:** involves Science-based class presentations followed by : a) a five-day industry science induction camp and b) a five day student industry placement, for selected Year 10, 11 &12 students in their vacation period to experience cutting edge scientific research and the exciting opportunities for science graduates in their region.
- 2. Science and Engineering Investigation Awards:** involving Science-based class assistance with Primary, middle and secondary students in undertaking scientific investigations and developing knowledge of scientific methodologies. Student investigations are presented and judged on poster displays and on students' verbal communication of their project. This is supported by on-line **Science for Growth Awards** focussed on engaging rural, remote and urban students.
- 3. Teacher Professional Development:** two phased engagement involving: a) a two-day program of teacher professional development for teachers, to illustrate the contextualisation of the Australian science curriculum and b) One week Industry Internships for secondary science teachers students (in vacation periods) with scientists in specific local industries or research organisations. At conclusion of the placement, they produce a written report or teaching resource to demonstrate its value and relevance.
- 4. Undergraduate Industry Internships:** One week Internships for Undergraduate 'STEM' students (in vacation periods) with scientists in specific local industries or research organisations that relate to their field of study. At conclusion of the placement, they produce a written report to demonstrate its value and relevance.

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An Investigation into Potential Models for Parent Science Committees in Queensland and Their Role in Education

Jackie Mergard, B.Bus.(Comm) and
Sue Stevens, B.Sc., Dip. Ed., COGE, M.Ed.



CoastEd

Maggie Muurmans

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Centre for Coastal Management

CITY OF
GOLDCOAST.

STEMMING THE STEM DECLINE USING A COLLABORATIVE MULTIMODAL INQUIRY APPROACH TO TEACHING SCIENCE

A significant improvement in teacher representational competencies and self-efficacy to:

Evaluate
representations

Choose apt
representations

Sequence
representations

Explain
representations

Evidence of teachers reasoning around representational use and benefits in the primary classroom,

Significant increases in primary student representational competencies including:

Conceptual
understanding

Interpreting
representations

Explaining
representations

Creating
representations

All classes in the study, regardless of starting point, moved to a more similar level of performance on all measures (as revealed by multilevel modelling).

QMEA Program Logic Matrix*

	Years 7, 8, 9 – Stimulating Interest & Making Connections	Year 10 – Informing Decisions & Influencing Pathways	Years 11 & 12 – Challenging & Preparing	Long term vision
	Embedded and connected classroom learning across years 7 to 12 with focus on STEM enrichment and resource sector career pathways targeting students and teachers and supported by QMEA extensive industry network			
Inputs	<ul style="list-style-type: none"> - Oresome Resources targeted units of study - Energy for the Future - Expand Your Mind - Biodiversity Field Day - EnvironmCafes - Physics in Flight (newent Day Career) 	<ul style="list-style-type: none"> - Oresome Resources targeted units of study - STEM4SchoolKids - Toolkit4SchoolKids - It's All About M.E. - Maths/Science Challenge - Apprentice Aptitude Test Training program (AATTP) - Perfect Programming (new) - Resourceful Robots (new) 	<ul style="list-style-type: none"> - Make It Now in Engineering (MINE) camps - Maths/Science Challenge - Safety & Professional Communication training - Cert II RIWP - Make It Now in Trade (MINT) camps - QSMART - Career Cafes - Ambassador Program - Biology Field Day 	<ul style="list-style-type: none"> • Students pursue resource sector and other related university degrees, vocational training & workforce training. • Resource sector job vacancies are filled & industry workforce skill needs are met
	Pre service teacher and teacher professional development (TPD) opportunities focused around developed units which support inspiring teaching of hands-on, inquiry-based learning of STEM with a resources sector context.			
Outputs	<ul style="list-style-type: none"> - Number of students participating in QMEA programs - Number of programs offered - Number & variety of industry engagements with students 	<ul style="list-style-type: none"> - Number of students participating in QMEA programs - Number of programs offered - Number & variety of industry engagements with students 	<ul style="list-style-type: none"> - Percentage of students choosing STEM & resource industry subjects - Number of high achieving students applying for “flagship” programs - Number & variety of industry engagements with students 	<ul style="list-style-type: none"> • Individuals engage in lifelong learning in STEM • Science capital is built which transcends into innovative resource sector solutions
	Number of TPD opportunities offered. Number of teachers and pre service teachers participating in sessions.			
Outcomes	<ul style="list-style-type: none"> - Students are interested & confident in STEM subjects and experiences - Students see connections across STEM subjects & resource sector careers 	<ul style="list-style-type: none"> - Students choose STEM & QMEA subjects for senior study - Students are aware of resource sector and STEM related careers & pathways - Students consider resources industry careers while making important subject choices 	<ul style="list-style-type: none"> - Students feel confident in STEM skills necessary to succeed in university &/or workforce training consistent with resource sector requirements - Students apply for resource sector or STEM related enrolment/employment post school 	<ul style="list-style-type: none"> • Team work and other communication skills across both professional and trade areas are used to solve real resource sector problems and develop innovative solutions
	Pre service teachers and QMEA teachers have increased confidence in teaching STEM subjects with a resource sector context using hands-on, inquiry-based learning methods			

Jackie Rudd | Science Outreach Coordinator | Griffith University

Griffith Science Education Alliance

Science on the GO!

Griffith Sciences Partnership Program

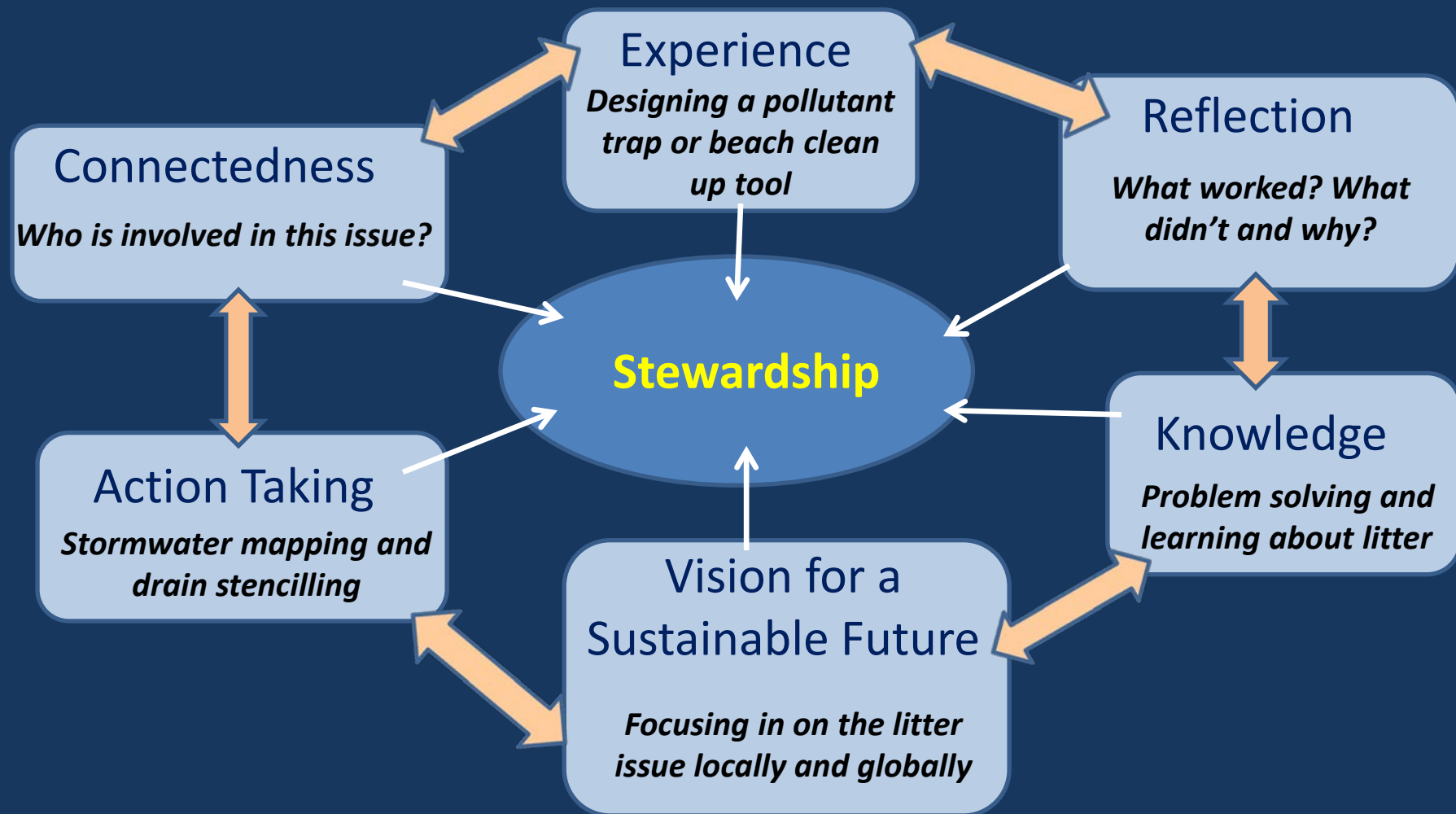
- STEM Ambassador Program
- High School Pathway Programs

MANAGING THE DANGER OF MYOPIA

- Central Policy Issue
- Resource Allocation Issues
- 'Crowded curriculum'
- Optimal level of mainstream maths in different years of schooling
- Impact of maths requirements at tertiary level
- Personnel implications

DIFFERING PERSPECTIVES ON PURPOSE OF EDUCATION

- Cultural values and changing enthusiasm: lessons of History
- Users and consumers of education:
 - students, parents, teachers, employers
- Who should decide?



Discussion Points – Objective of this workshop

1. Explore whether there is any shortfall in STEM education, given that so many expert people are doing such admirable projects.

- a) Having viewed the presentations today are there any gaps to be included in future offerings – what improvements could be made?
- b) What are the outcomes of existing programs? Have these many excellent programs resulted in quantifiable improvements in STEM education?
- c) If no quantifiable outcomes, are there good anecdotal stories which could be followed up?

2. Glean learnings, ideas and insights from STEM education experts.

- a) What works well?
- b) What have you (individual presenters) and your institutions learnt?
- c) Is each program monitored? Is there an evaluation process?

3. Allow participants to take home learnings for their own organisations

- a) How can we share resources more effectively? (Can we share resources?)
- b) Rather than organisations offering programs – supply side – should the Education sector be demanding programs which fulfil their requirements more closely?
- c) What has been measured – is this limited to attendance numbers and schools visited?

4. Identify a possible role for the Royal Society as a non-government advocate or facilitator

- a) Should there be a monitoring/evaluation group established?
- b) Could the mapping of activities be made available as a database with participants able to update regularly? Would this add value?
- c) Would another network add value or should this mapping be added to an existing network to monitor?