

Introducing Step Up: Transforming the nature and delivery of mathematics and science secondary teacher education in Queensland

Discussion Paper 1



Support for this project has been provided by the Australian Government Office for Learning and Teaching.

Acknowledgements

Support for this project has been provided by the Australian Government Office for Learning and Teaching.

Step Up is one of five projects funded under the Enhancing the Training of Mathematics and Science Teachers (ETMST) Program, in response to the report by Australia's Chief Scientist: Maths, Engineering and Science in the National Interest. The ETMST program prioritises:

- Curriculum arrangements that give pre-service teachers of science and mathematics a new vision of how mathematical and scientific content, thinking and pedagogy can work together
- Increasing the supply of graduates with an ability to manage this balance.

Forward

This paper introduces the Step Up project – a project funded by the Office of Teaching and Learning.

The study aims to effect step change in courses, partnerships, academic practice and student recruitment in order to transform the nature and delivery of mathematics and science pre-service secondary teacher education in Queensland.

Step Up is rising to an important challenge set by Australia's Chief Scientist Professor Ian Chubb. He poses that there is a need to look at how science is taught, that we must support science teachers to be confident in their knowledge and able to teach science in a manner that reflects how science is practised. This forms the essence of the Step Up project.

With the future requiring high quality STEM graduates ready to face a growing world and thus changing problems, we must focus on what it means to be a mathematics and/or science teacher, shifts in the pathways to the maths-science teaching profession and innovative ways to educate future mathematics and science teachers in Universities.

This project is a collaborative endeavour between five partner institutions. With Queensland University of Technology (QUT) the lead institute, partnerships on this occur with Australian Catholic University (ACU), Griffith University (GU), James Cook University (JCU) and University of Queensland (UQ). Academics from these institutions have expertise across the areas of STEM education.

The project runs from late 2013 until the end of 2016, and aims to generate sustainable and transferable frameworks so its outcomes may be realised across Australia.

Professor Les Dawes

Project Leader
Queensland University of Technology

Contents

Forward	3
Introduction	5
Background and rationale.....	5
The Queensland Context.....	6
The value of Step Up	7
The Step Up Project	8
Framework	8
Phases	9
Base design of Step Up	9
Evaluation	10
Elements	11
Step Up Curriculum Framework.....	11
Accelerated student recruitment.....	11
MSTEd partnerships and academic collaborations.....	11
Step Up Virtual Classroom and Collaboration Space (technology).....	11
Major outcomes of the project.....	11
Current Projects	12
The STEM Studio	12
Our Aim	12
About the STEM Studio project	12
Integrated STEM teaching pathways	12
Improving science teacher quality through scientific inquiry.....	12
STEAM Room.....	13
Why STEAM?.....	13
Aims.....	13
TeachConnect	13
Why?	13
Learning Science through Teaching	14
Why?	14
Details	14
Going forwards.....	15
Where to from here?	15

Introduction

Step Up aims to effect step change in courses, partnerships, academic practice and student recruitment in order to transform the nature and delivery of mathematics and science pre-service secondary teacher education in Queensland.

The project will also provide transferrable frameworks, resources, technologies and guides in order that its outcomes may be realised across Australia.

Step Up directly involves many academics across five partner Institutions in addition to key staff within the Department of Education Training and Employment. This is a large funded grant from the Office of Learning and Teaching.

Background and rationale

There is urgent need for more highly qualified MS teachers, a need which is neither new nor restricted to Australia. Many nations are seeking MS secondary teachers to foster a mathematically and scientifically literate populace to (1) cope with the everyday demands of 21st century life and be informed decision makers; and (2) provide an adequate supply of trained workers in MS careers especially in secondary teaching. Following Chubb (Chubb, 2012), *Step Up* is designed to effect “high quality, contemporary, engaging and equitable” educational opportunities for Australians through enhanced training of their future teachers. Australia cannot depend on other nations to fill its undersupply of MS teachers and must therefore rely on programs like *Step Up* to avert underperformance of its society and economy.

Mere 'survival' in terms of MSTE will cause Australia hardship. Pursuing the status quo in MSTE will mean that the gap between supply of MS workers and the demand for MS knowledge will widen maintaining the status quo is futile; it equates to “doing nothing” (Ibid, nd). An alternative future involves identifying the conditions in which MSTE can *thrive* in universities. This preferable future guides thinking about the *Step Up Program* which optimizes conditions for MSTE to flourish. The shift from ‘surviving with current MSTE to ‘future MSTE thriving’ requires a step change in what it means to be a MS teacher, significant shifts in the pathways to the MS teaching profession and new ways to educate future MS teachers in universities.

To enhance the quality and number of inspirational mathematics and science teaching graduates, capable of inspiring a generation of secondary students with contemporary and dynamic views of science, requires that a previously diverse group of stakeholders (comprising mathematicians, scientists and educators, experienced and early career academics, secondary and tertiary teachers, and metropolitan and rural and regional institutions together with state-based and national institutions) must collaborate across disciplines, institutions, organisations and distance. *Step Up* is designed to initiate and sustain this effort.

International models, for example, UTeach, MTE/SMTI Partnership, Carnegie Foundation for the Advancement of Teaching programs, Project Kaleidoscope, STEM Centre York will inform the *Step*

Up approach to developing innovative courses, involving MS and TE stakeholders, resulting in high quality MSTE programs within a transferrable and shareable framework.

Step Up received funding from the Office for Learning and Teaching Grants. Funded in 2013, Step Up was provided with \$3, 200, 000 to transform mathematics and science secondary teacher education in Queensland. This project has received approval from the Deputy Vice Chancellor (Learning and Teaching) in consultation with the Executive Deans of Science and Engineering Faculty and Education Faculty at QUT. The project has been endorsed in writing by:

Professor Peter Coaldrake, Vice Chancellor, Queensland University of Technology
Professor Michelle Campbell, Acting Provost, Australian Catholic University
Mr Patrick Bryan, Executive Director, Workforce Initiatives, Dept of Education Training & Employment
Professor Susan Spence, Deputy Vice Chancellor Academic, Griffith University
Professor Sally Kift, Deputy Vice Chancellor Academic, James Cook University
Professor Joanne Wright, Deputy Vice Chancellor Academic, University of Queensland

The Step Up project has a unique opportunity to directly influence policy. Indeed, recent times have seen teachers of mathematics and science education to be of key interest to policy makers.

The Queensland Context

Although the proposed project will focus on Queensland its relevance and reach is national. From 2015 year 7 students in Queensland will join secondary schools and from 2013 state high schools will introduce junior secondary for students in years 8 and 9 (Queensland Government, 2015). These changes align to the project's focus on secondary preservice MSTE converging with other factors relevant to state-wide nature of the proposal. Prasser (2013), for example, points to 20% school population growth 2001-2011 experienced in Queensland compared to the Australian average of 7.7%. DETE Queensland (2013) notes that in NAPLAN test areas Queensland is behind other states and territories and the Dobson Report (2012) indicates that from 2005 - 2010, enrolments in natural and physical sciences (NPS) increased by 20% across the Australian university sector; in Queensland increases in NPS enrolments was only 6% over the same period.

It is within this context that the Queensland Government has committed to lifting the standards and status of teaching in Queensland schools through several mechanisms - pairing new teachers with mentors; rewarding high performing teachers with bonuses and fast-tracked career progression; and encouraging more teachers to lift their qualifications with scholarships for Masters degrees and postgraduate courses (DETE, n.d). *Step Up* complements the State Government's commitment by developing and delivering preservice MSTE teacher training strategies for courses, partnerships, collaboration and recruitment to increase the size, diversity and quality of MSTE (secondary) students in the Queensland university pipeline.

Starting in an environment we know, *Step Up* will be transferrable to others and will link with the recommended National Centre for Mathematics and Science Teachers (Chubb), to ensure that the State's project is aligned with other projects and to provide equitable access to MSTE innovation on the national stage. While this proposal starts from Queensland, project implementation will be

informed by what is occurring nationally as well as bring state-focused solutions to the collaborative national table.

The value of Step Up

There is clear and urgent need for *Step Up* given that international comparative data indicates that, with the passage of time, Australia lags further behind the rest of the world (Chubb, 2012). Investing in the area of MS is very likely to be reflected in Australia's increased competitiveness, as well as increased productivity and higher living standards (Chubb, 2012). *Step Up* recognises that teacher development is a continuum spanning from early learning through to retirement (Coble, 2012). Through the embedding of new and innovative MSTE curriculum underlined by inspirational teaching approaches, *Step Up* will prepare MSTE graduates capable of inspiring secondary school students in a life-long commitment to MS.

Step Up will be the first program in Queensland to bring together MS and TE academics, others leading in the MS field and key stakeholders, to develop, design and teach MSTE programs/units of study. It is novel, distinctive and necessary. The proposed *Step Up* technology developments (*Collaboration Space* and *Virtual Classroom*, refer to Attachment 4) and the *Step Up Curriculum Framework* will capture the outputs of this collective collaboration. These technologies, which along with other outputs of the project form the *Step Up Program*, will connect wherever possible with existing interfaces such as The Cube (QUT), The Science Place (JCU in development) and the Australian Council of Deans of Science (ACDS) Teaching and Learning Centre and the Australian Council of Deans of Education (ACDE) website, ensuring the project outcomes and deliverables are accessible to the sector, in particular to students and academics in rural and remote areas.

The climate of readiness across partnering institutions to successfully deliver the *Step Up Program* is reflected in the collective breadth and depth of innovative developments that are already in place. *Step Up* will build and strengthen the needed cohesion across these developments. Examples include QUT's Science and Engineering Centre and QUT's Exceptional Teachers for Disadvantaged Schools and Teacher Education Done Differently programs, Griffith University's Benowa STEM Centre of Excellence in Teacher Training, Griffith Science Education Alliance and the Science on the GO Programs, JCU's and UQ's Centres of Excellence. *Step Up* will exploit previously untapped synergies across initiatives in the collaborating universities to maximise benefit and opportunities for secondary MSTE pre-service students. Attention to curriculum that supports MSTE students to learn about, and ultimately work in, rural, remote and Indigenous settings will be paramount. This, in turn provides opportunities for future tertiary MS students from these communities (and other previously underrepresented groups) to participate more effectively in MSTE.

Step Up will build on and strengthen synergies with the learnings of the numerous Office for Learning and Teaching (OLT) formerly Australian Learning and Teaching Council (ALTC) Grants and Fellowships in the field of STEM education (in progress and completed). An appraisal of OLT/ALTC projects to build and strengthen synergies will be undertaken in the project initiation phase.

The Step Up Project

Framework

Step Up adopts a theoretical framework underpinned by two interrelated perspectives, namely:

- 1) Teacher development is a continuum spanning from early learning through to retirement (Coble, 2012). Hence, development of preservice MS teachers needs to be conceived as part of an extended process that commences well before formal teacher training and extends until retirement (Coble, 2012). *Set Up* situates its objectives, outcomes and deliverables within the context of this continuum and the *Step Up Curriculum Framework* will allow entry of MS students and professionals at various preservice levels.
- 2) An evidence-based framework for action can be used to achieve project coherence. *Step Up* adopts a similar framework of step changes to achieve its objectives as the Science and Mathematics Teacher Imperative (SMTI) has done to achieve its goal “to measurably increase the *quantity, quality, and diversity* of STEM teachers” (Coble, 2012, p3?). The SMTI framework has five core components, namely: (1) Leadership, policy and infrastructure; (2) Recruitment, selection and admission; (3) Content, pedagogy and clinical practice; (4) Beginning teacher support; and (5) Teacher and school development. The critical design features permeating the SMTI framework centre on the idea that, “Teacher preparation is an all-campus responsibility; it is clinically based, requiring close links with P-12 schools; and it must be focused on reliably preparing beginning teachers that can positively impact student achievement” (Coble, 2012, p8?). These Core Components are explicitly embedded in *Step Up* – they form its step change aspirations.

The overall *Step Up* approach is collaborative involving a broad cross section of key stakeholder groups. The work of *Step Up* will not be divided thematically (that is, vertically) within the four Step Changes but rather the step change agenda of the project is embraced simultaneously by the *Step Up* teams across the collaborating universities, others involved in the *Step Up Community of Practice* and other key stakeholders. Through annual conferences and regular intensive workshops *Step Up* Team members, partners, their advisors and sponsors will regularly collaborate across all aspects of the project. By working as a broad collaborative group, from a core of leaders and team members, *Step Up* will link across stakeholder groups who might ordinarily undertake their own business independently. Given the significance of the problem being addressed by this funding Program, *Step Up* promotes ways of working that regularly bring people together providing opportunity for greater synergies to be developed and sustained across teams and with other stakeholders. In line with *Step Up's* aim to transform pre-service secondary MSTE, the project will be underlined by an action research approach to educational reform. This approach involves a high level of participation and collaboration, where the facilitation of reflection and changes to practice is key (Fletcher, 2008). *Step Up* activities will be underpinned by the integration of robust and intentional approaches to learning design, curriculum design and assessment informed by previous OLT/ALTC projects and

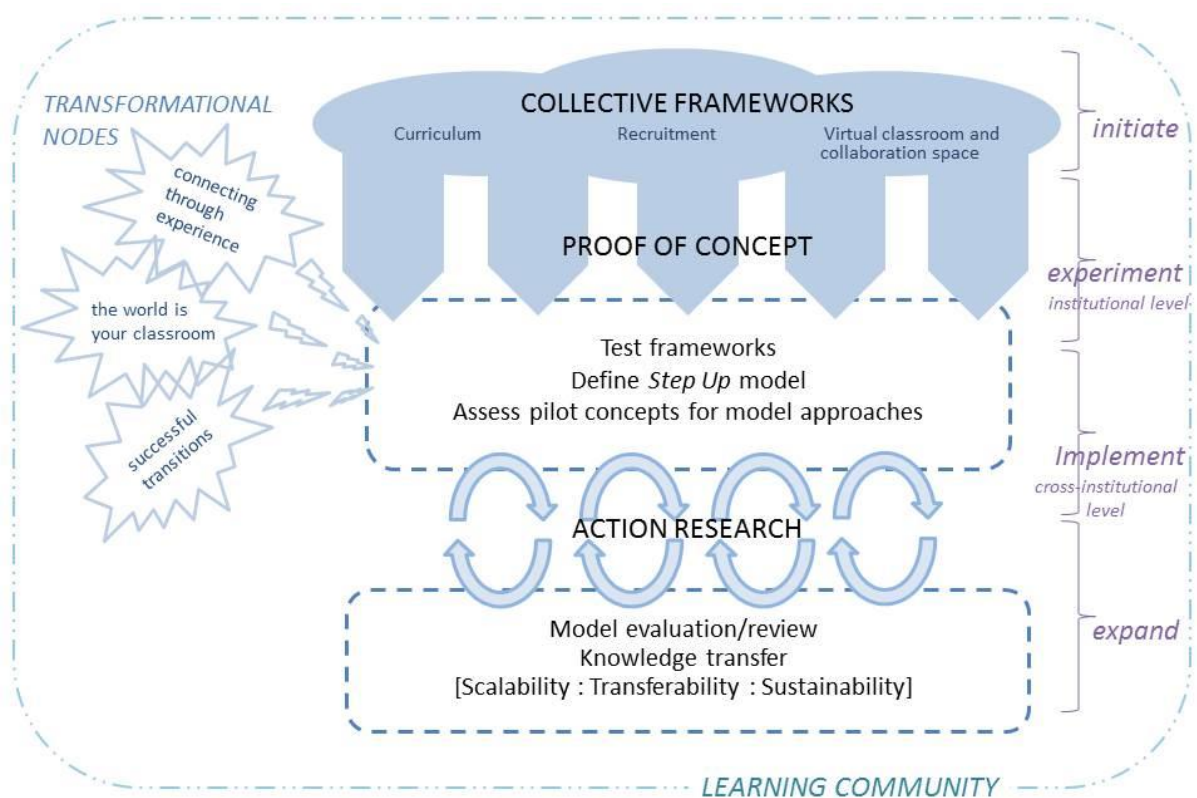
innovative international models. Participants will reflect rigorously, together and often, on the challenges to achieving objectives and, in so doing, build a strong community of practice over the life of the project.

Phases

The study design was chosen carefully to guide future policy regarding MS Teacher education. The following section examines advantages and disadvantages of the chosen design and provides important information for readers.

Base design of Step Up

Step Up activity will be rolled out in four phases of activity – initiate (Sep 2013 – Mar 2014), experiment (Mar – Dec 2014), implement (Jan – Dec 2015), expand (Jan – Dec 2016). These phases are reflected in the project design, planning and evaluation approaches.



Evaluation

Step Up is being evaluated primarily to assess the extent to which it is achieving its objectives. Additional purposes of evaluation are:

1. Improvement (to inform, guide and improve the project as it develops (including approach and processes))
2. Dissemination (to engage key stakeholders in assessing directions and approaches as well as to encourage and guide good practice elsewhere)
3. Accountability (to satisfy Office for Learning and Teaching (OLT) and other stakeholders that the project has been conducted as proposed).

Information gathered in the evaluation will be further used to:

- Assess how well the project is progressing towards longer term outcomes and impact
- Monitor the effectiveness of the project implementation and management processes
- Provide learnings for planning and delivery of future projects aimed at improving pre-service mathematics and science teacher education
- Provide an evidence base to policy change and institutional practice.

A Systems oriented approach will be used as an approach to the Evaluation Cycle (Massachusetts Department of Education, 2013). A systems approach seeks to examine and understand both the parts and the relationships among the parts rather than the parts on their own. Step Up evaluation benefits from systems thinking for a number of reasons:

- MSTEd programs will exist within a system of education, science and teaching.
- There is often a great deal of time between interventions and the goal of these interventions, which is an increased number of new MSTEd teachers.
- MSTEd programs often bring together stakeholders from multiple sectors, or with varied priorities.
- The workforce development emphasis of MSTEd programs relates to national, state and local priorities.

A Systems oriented approach blurs the lines between stages and different stages interrelate and affect one another. Each phase reinforces and informs other stages in the evaluation cycle. A systems approach also brings attention to different evaluation questions and ways of interpreting data.

The standards of evaluation that will be adopted are utility, feasibility, propriety and accuracy.

- Utility standards to ensure that the *Step Up* evaluation will serve the information needs of intended users, with a particular focus on the expectations and needs of key stakeholders outlined in this plan. Presentation and dissemination of findings will also consider where appropriate, other target audiences who may be interested in evaluations findings.
- Feasibility standards to ensure that an evaluation will be realistic, prudent, diplomatic and frugal. The framing of evaluation around the *Step Up* project logic and outcomes statement, as well as optimising the role of the project team in evaluation are approaches adopted in the

evaluation plan to direct evaluation activities in ways that are feasible.

- Propriety standards ensure that an evaluation will be conducted legally, ethically and with due regard for the welfare of those involved in the evaluation, as well as those affected by its results.

Accuracy standards ensure that an evaluation will reveal and convey technically adequate information about the features that determine the worth or merit of the program being evaluated.

Elements

Step Up Curriculum Framework, with courses aligned with the framework and AITSL standards, grounded in mathematics and science (MS) disciplines, developed collaboratively between MS and Teacher Education (TEd) academic communities and delivered by inspirational teachers from multiple university sites.

Accelerated student recruitment through marketing and promotion to prospective and current MS students, MS academics championing MSTEd career pathways, course structures that provide seamless opportunities to transition through MS undergraduate courses into MSTEd and for existing MSTEd students to integrate with the MS disciplines.

MSTEd partnerships and academic collaborations which focus on the long-term sustainability of *Step Up* outcomes and impact, promoting integration of stakeholders in the work of the project, designing and delivering curriculum materials, and producing resources and guides for use by other MSTEd communities in Australian universities.

Step Up Virtual Classroom and Collaboration Space (technology) providing the online platforms to support and extend the above outcomes – including a teaching space for new courses, a critical cohort building strategy, a resource bank with accessible resources and learning materials to better position practicum students to model and inspire secondary students in line with the learning experiences that underpin their MSTEd courses.

Major outcomes of the project

Step Up will address five main outcomes. These five outcomes should underpin all Step Up activities and should be considered at all stages of the project.

1. A significant increase in the number of students specialising in secondary MS teaching in areas of need
2. Collaborative course design and delivery, formalised in curriculum structures and processes
3. A learning community of emerging mathematics and science teachers actively engaged in an inter-disciplinary, professional community of practice
4. Strong maths/science knowledge and pedagogy amongst MSTEd students and graduates
5. Partnerships that provide mechanisms for sustained resourcing and implementation

Current Projects

Several projects are currently being undertaken as part of Step Up.

The STEM Studio

A collaboration space where pre-service science and mathematics secondary teachers can unpack the way science is practised and test best-practice approaches to STEM education. James Cook University, Griffith University and Queensland University of Technology are currently rolling out pilot STEM Studio programs – find out more

Our Aim

The aim of the STEM Studio project is to propose, trial and refine a pedagogical model that could be used to enhance pre-service teacher education (PSTE) through trans-disciplinary STEM teaching experiences. The STEM Studio aims to support the enhancement of pre-service programs by encouraging faculties, schools or departments of science, mathematics and education to collaborate on course design and delivery, by combining content and pedagogy so that mathematics and science are taught as dynamic, forward-looking, and collaborative human endeavours.

In line with the Step Up project, the STEM Studio project proposes to contribute to the enhancement of pre-service teacher educator programs in the following ways:

1. Provide a model of trans-disciplinary learning
2. Enhance university-school relationships
4. Encourage and support intra- and inter-university collaboration
5. Enhance learning outcomes for high school students.

About the STEM Studio project

This is a collaborative project between Queensland University of Technology (QUT), Griffith University, and James Cook University. The initial pilot stage was been undertaken QUT from March to May 2015. Griffith University will be piloting the STEM Studio from July to September 2015 and JCU will follow. These pilots will be used to develop a framework to then be trialled with partner universities and schools in 2016.

Integrated STEM teaching pathways

Developing a shared framework and new pathways for best-practice STEM teacher education. Partner universities are the University of Queensland, James Cook University and Queensland University of Technology .

Improving science teacher quality through scientific inquiry

Addressing the national and international need to improve the quality of pre-service science teachers' capacities for teaching. Partner universities are Griffith University, James Cook University and Queensland University of Technology.

STEAM Room

Led by Griffith University and the University of Queensland, the project is envisioned as a science, technology, engineering, arts and mathematics (STEAM) literacy and learning venture in a community setting .

The STEAM Room is envisioned as a science, technology, engineering, arts and mathematics (STEAM) literacy and learning venture in a community setting. Through informal or 'pop-up' programs it aims to build wider science-maths fluency, appreciation and enjoyment.

This a collaborative initiative led by Dr Chris Campbell (University of Queensland) and Dr Adam Palmer (Griffith University), with Michael Doneman from Edgware Creative Entrepreneurship, as part of the Step Up project which sets out to transform science and maths pre-service secondary teacher education in Queensland.

Why STEAM?

The importance of improving science, technology, engineering and maths (STEM) skills is championed by science and industry leaders, to enrich student learning, workforce capacity and innovation for Australia's future. Incorporating the arts, STEAM brings to the forefront the creativity inherent in STEM and enhances engagement opportunities for wider audiences. The STEAM Room is designed to be fun and meaningful, aspiring to foster STEAM learning in our community as a vital part of this clever country.

Aims

This project connects community members with diverse experts across STEAM through a local space and activities that will be lively, informative and mutually beneficial for participants and presenters:

- From the universities' perspective, the project aims to enhance pre-service (student) teachers' professional development so that they will be better at teaching science and maths in the classrooms
- For STEM academics and industry, geeks and makers, it will also provide a new platform for sharing their insights and skills and for community engagement
- For local business, council and community organisations, it will be a valuable space for supporting educational innovation, vocational and professional development opportunities, and positive social interaction in the local community
- Based on respectful consultation, the community's priorities will inform the shape of project development and events.

TeachConnect

This collaborative project aims to develop a learning network within Queensland, focusing on STEM pre-service and early career teachers. Supported by the Queensland College of Teachers, the Step Up project team is joined by the University of the Southern Queensland and University of Central Queensland.

Why?

Networked learning emphasises the relational nature of learning. As pre-service teachers progress to become early career teachers, they need to access:

- quality teaching resources and information about how to use them

- support from their peers, both professionally and emotionally
- support from experienced teachers, particularly with opportunities for structured reflection.

We acknowledge the numerous online support spaces for teachers on this pathway, including government and university sites and social media, and the gaps between these platforms. This project will address the following needs for teachers:

- A broad community – cross-institutional and involving universities along with other stakeholders, so teachers gain access to a depth of knowledge and experience
- Trust – to enable pre-service teachers and early career teachers to engage in reflection, resource sharing, mentoring and sustained relationships
- Accessibility, simplicity and speed – necessities for time-poor teachers.

Learning Science through Teaching

This new elective offered at Queensland University of Technology (QUT) in 2nd Semester 2015 has been designed for undergraduate science, maths and engineering students.

Why?

There are several potential benefits for students enrolling in this elective, including:

- Get the edge – employers value strong communication and/or education skills
- Enhance your own learning through teaching others and communicating complex scientific and mathematical concepts effectively to non-specialist audiences
- Considered teaching? There is huge demand for quality maths and science teachers in Australian high schools
- Educate and inspire students, community members and decision-makers about maths and science.

Details

This unit is planned as the first part of a four-unit minor in science and maths education. The minor is currently in development by the Science and Engineering Faculty in collaboration with the Faculty of Education.

Going forwards

Where to from here?

The project team is working towards transforming the nature and delivery of mathematics and science secondary teacher education in Queensland. Several steps have been proposed as the project moves into final stages:

- Continue to work with partner institutions and academics to engage with and evaluate the collaborative projects.
- Develop resourcing decision making framework

