

Is it time to start reconceptualising maths and science teacher education?

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Overview

There have been growing concerns with the shortage of trained primary and secondary science and mathematics teachers nationally in Australia. At the same time as there have been surpluses of general primary teachers in metropolitan areas, there have been persistent shortages of suitably qualified teachers in secondary school subjects such as mathematics, science and technology (Productivity Commission 2012). This issue is especially evident in rural and hard to staff schools (Hobbs, 2012).

Enrolment of senior school students in science subjects is at present on a long-term declining trend in both absolute numbers and as a proportion of the total cohort. Mathematics participation declined from 76.6 per cent to 72.0 per cent between 2002 and 2010, and there

is a continuing shift from intermediate and advanced levels of mathematics to the elementary level. Further decline in enrolments are noted for biology, chemistry and physics (Chubb & Chubb 2012).

There are similar concerns in Victoria. Recent national and international data indicate that Victorian students generally perform well in mathematics and science (PISA 2006; TIMSS 2007; NAPLAN 2008). However, students' interest in science and mathematics is declining. According to the blueprint for energising science and mathematics education in Victoria, while more than 80 per cent of Victorian students are studying science and mathematics at the senior years of secondary school, many do not continue to do so at the tertiary level (Department of Education and Early Childhood Development 2009). The Education and Training Committee for Victorian

Parliament noted there are also emerging difficulties in meeting the demand for specialised mathematics and science teachers, particularly in some hard-to-staff locations (Education & Training Committee, 2006).

To address these issues, the Australian Government has committed \$54 million in funding over four years towards the 'Investing in Science and Maths for a Smarter Future' initiative. This is in response to the report by Professor Ian Chubb AC (2012), Australia's Chief Scientist: 'Maths, Engineering and Science: in the National Interest'. By establishing collaborations between education, science and mathematics faculties, departments and schools, the program aims to increase the supply of graduates as well as increase the retention rates of existing pre-service teachers.

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It is widely accepted that students' choices in pursuing careers in science and mathematics are influenced by their school education. The initiative therefore aims to develop teachers' capabilities in bringing contemporary scientific understanding and practice into schools, including primary and secondary year levels.

The 'Investing in Science and Maths for a Smarter Future' initiative is a basis for inspiration to the Office for Learning and Teaching (OLT) program entitled 'Enhancing the Training of Mathematics and Science Teachers' (ETMST). The goal of the program is to drive a major improvement in the quality of science and mathematics pre-service teacher education. A budget of \$12.4 million has been allocated for this sole purpose.

The ETMST Program consists of five major projects across Australia; the 'Reconceptualising Maths and Science Teacher Education Programs' (ReMSTEP) project is centred in Victoria.

Welcome to ReMSTEP

The ReMSTEP project facilitates and supports an improved competence and confidence in the teaching of science and maths, as a pre-service focus, across the Australian Curriculum. Four leading Victorian universities have established a network under the ReMSTEP umbrella, dedicated to developing new teacher education practices that align contemporary approaches in science, technology, engineering, and

mathematics (STEM) with innovative and engaging approaches to teaching and learning.

The project directly promotes collaboration between researchers and educators in science, mathematics and education. Active partnerships have been established with specialist science and mathematics centres, the Melbourne Museum, professional organisations, scientists and mathematicians.

These partnerships will drive positive change in the quality of mathematics and science teachers by creating programs where undergraduate STEM students and pre-service teachers work collaboratively with education faculties and researchers to create new materials, units of study and expertise in inquiry-based classroom practices.

The project partners collaborating under the ReMSTEP umbrella include the University of Melbourne (lead institution), Deakin University, La Trobe University and Monash University. At the core of ReMSTEP, seven innovations have been identified to focus project's activities over the three-year period of the initiative:

Innovation 1: Contemporary science and mathematics in integrated science and pre-service units of study.

Innovation 2: Undergraduate science students engaging with schools.

Innovation 3: Science specialisations within primary pre-service programs.

Innovation 4: Specialist Science and Technology Centre collaborations.

Innovation 5: Practicum opportunities in world-class research environments.

Innovation 6: Building on existing student expertise in science and mathematics.

Innovation 7: Building a recruitment pipeline of high potential mathematics and science teachers.

To achieve the goals of seven innovations, ReMSTEP's funding supports teaching relief for academics involved in curriculum development, professional learning, coaching of other staff, materials and development of resources. In addition, there is funding for laboratory equipment for experimental work, collaborative work with specialist science

centres, dissemination of materials and training. Two annual conferences are planned for 2015 and 2016. In addition, ReMSTEP has identified a number of leading academics and organisations to take part in its External Reference Committee.

Key developments

A mixed project team from Deakin University, in partnership with the University of Melbourne, has developed a model for collaboration with specialist centres and is currently developing three new topics in consultation with the Gene Technology Access Centre (GTAC). These topics are:

- Stem Cells (Secondary)
- Bionic Eye (Secondary)
- Adaptations (Primary)

The topics will be developed by core teams with representation from GTAC staff, scientists, science and mathematics educators and pre-service teacher candidates from the University of Melbourne and Deakin University. A management team, comprising of ReMSTEP and GTAC representatives will oversee the overall process.

One of the aims of this collaboration is for developed components to be trialled and evaluated at rural government and outer metropolitan disadvantaged schools. Core teams will identify appropriate approaches and methodologies for each topic. In addition, concurrent planning is in progress with Melbourne Museum, the Institute for Frontier Materials (IFM) and Quantum Victoria.

As part of the collaboration with Melbourne Museum, a group of pre-service teachers will learn about how areas of the museum's collection relate to areas of the curriculum. The pre-service teachers will be able to work with the museum's science education staff and scientists to gain better understanding of how objects from collections are used to communicate scientific ideas to diverse audiences. The daily research activities of museum scientists will be explored and documented, offering the pre-service teachers rich experience in all aspects of contemporary science practice. ►

▶ The ReMSTEP project team at Deakin University has established relationships with scientists from the Institute for Frontier Materials at Geelong and Burwood campuses. Planning is underway to develop models of embedded scientific research and practice in pre-service teacher education programs. In addition, an innovative project for pre-service teachers enrolled in chemistry curriculum units at Deakin University's Burwood campus is in progress. Pre-service teacher candidates will engage in discussions with researchers in order to develop teaching resources based on current scientific practices, with a focus on the chemistry strand in the Victorian and the Australian Curriculums. This will form part of the teacher candidates' assessment.

Reconceptualising program and course structures is an essential focus for ReMSTEP. Melbourne Graduate School of Education at the University of Melbourne has introduced a new Science and Mathematics elective in Master of Teaching (Primary) program. Professor Stephen Dinham, ReMSTEP's Project Director, has emphasised that 'the teachers would graduate as fully qualified generalist primary teachers with an extra accreditation in maths or science teaching, giving schools flexibility in how they use them' (Ferrari 2014, n.p.) Previous teaching programs have focused on retraining existing teachers rather than embedding the specialisation in a teaching degree, as is the case at Melbourne University (Ferrari, 2014). Concurrently, a number of activities are being planned with Melbourne University's Master of Teaching (Secondary) mathematics focus.

La Trobe University is partnering pre-service teachers with mid-career scientists (a group currently holding Future Fellowships funded by the Federal Government). Each of the scientists manages a small laboratory. A wide range of science disciplines are covered by the group, ranging from sleep disorders and cancer biology to theoretical mathematics and material science. This initiative, elegantly named 'Scientists as Partners in Education' (SPIEs) focuses on giving teacher candidates a personal experience in contemporary science. This will be



Students during the science experiment at the University of Melbourne

a valuable experience for pre-service teachers who will be mentored and guided to develop and trial innovative units of study.

Work is continuing, to identify science researchers to act as partners for pre-service teacher candidates through the Multi-disciplinary Science and Technology Integrated Experience (MSTIE) at La Trobe's Bendigo campus. MSTIE already provides an excellent platform for integrating science and technology into the primary level teacher practicum experience. The work at Bendigo will help strengthen the program, refresh the nature of contemporary science in the program and develop partnerships that will enable the scientists to work directly in schools.

As part of ReMSTEP's collaboration with specialist science centres, La Trobe's project team is working with Quantum Victoria on developing new science materials. The Quantum Centre is one of six specialist science centres, funded by the Victorian Government, with a focus on physical sciences.

The project team at Monash University is currently involved in developing new units of study in its Master of Teaching and Bachelor of Science programs. Alongside these activities, another unit is in planning for a Faculty of Education

Research Project subject. Collaboration with the Faculty of Science is underway to gather ideas for the design of Master of Teaching units. An audit has been completed of the existing science outreach at Monash, and this work has identified the potential for developing curriculum based outreach programs for science students.

Conclusion

The need for strong collaborative relationships will underpin the success of ReMSTEP and the ETMST Program as a whole, by building strategic partnerships between scientists, mathematicians, teacher educators, in-service teachers and pre-service teacher candidates to achieve common goals of increasing science and mathematics competence and confidence in pre-service teachers. This will in turn lead to an increase in qualified and passionate mathematics and science teachers in Australian schools and students with appreciation for these areas. It is an important cycle and a necessary step in re-thinking mathematics and science knowledge for life.

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List of terms and acronyms

ETMST - Enhancing the Training of Mathematics and Science Teachers

GTAC - Gene Technology Access Centre

IFM - Institute for Frontier Materials

MSTIE - Multi-disciplinary Science and Technology Integrated Experience

NAPLAN - The National Assessment Program – Literacy and Numeracy

OLT - Office for Learning and Teaching

PISA – Programme for International Student Assessment

ReMSTEP - Reconceptualising Maths and Science Teacher Education Programs

SPIEs - Scientists as Partners in Education

STEM - Science, Technology, Engineering, and Mathematics

TIMSS - Trends in International Mathematics and Science Study

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