Executive Summary

Introduction

The Step Up project (2013 to 2016) was funded through the Enhancing the Training of Mathematics and Science Teachers (ETMST) Programme for 3.5 years. The project was led by QUT in partnership with Australian Catholic University (ACU), Griffith University (GU), James Cook University (JCU), The University of Queensland (UQ), and the Queensland Department of Education and Training (DET). The focus of the grant was on pre-service, secondary mathematics and science teachers in Queensland. Throughout the project numerous stakeholders were engaged external to the universities (e.g., Queensland College of Teachers [QCT], Independent Schools Queensland, DET Schools, Science Teachers Association of Queensland and State Library of Queensland), along with stakeholders within the university environment (e.g., pre-service teachers and STEM students, Heads of School, teacher educators, discipline experts, curriculum panels, and administration).

Project Intent and Priorities

Step Up’s aim was to effect step-change in courses, partnerships, academic practice, and recruitment of mathematics and science (MS) students to teacher education in order to transform the nature and delivery of mathematics and science pre-service secondary teacher education in Queensland. Step Up further sought to develop transferrable frameworks, resources, technologies and guides to inform the future nature and delivery of pre-service teacher education nationally.

Step Up initially focused on Priorities 1, 2, 3 and 5 of the ETMST priorities\(^1\), but as the project developed it became evident that Step Up also contributed to knowledge and practice associated with Priority 8 and 9. Step Up sought to address these priorities through four major project elements, *Curriculum, accelerated student recruitment, partnerships and academic collaboration* and *TeachConnect online community*. These major elements provided mechanisms to initiate and sustain collaborative action to address the challenge posed by the Chief Scientist that underpinned the ETMST priorities. The elements are interrelated and have evolved over the life of the project, building upon working examples/precedents, and reflecting upon the institutional and locational contexts within which the participating universities operate.

Project Approach

In line with Step Up’s aim to transform pre-service secondary MS teacher education, the project followed an action learning approach to implement educational reform. The ETMST programme did not identify a single institutional problem, but rather a complex and multifaceted challenge based around the notion of combining content and pedagogy so that

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mathematics and science are taught more like they are practised. The action learning approach allowed this challenge to be addressed through ongoing cross-disciplinary collaboration, where the facilitation of reflection leading to action was key. This resulted in six Collaborative Action Projects (CAPs) developing out of initial Proof of Concept stages. The CAPs (TeachConnect, Integrated STEM Teaching Pathways [ISTP], STEM Studio, Practising Science, Pedagogy on Demand [POD], and STEAM Room) were designed in stages, with each stage informing the next. This was a purposeful move by the project leadership to ensure collaboration between CAP team members that could lead to systemic change. Although the action learning approach appears to involve a sequence of established stages, it is important to note that in reality the action learning stages were recursive, nonlinear, and dependent upon the interactions between project team members and their ability to implement structural and sustainable changes. The recursive nature of the action learning approach involved collaborative rethinking, regrouping and reimagining, and to allow team members to refocus on the ETMST challenges within the context of their specific circumstances.

Project resources

A legacy of the Step Up CAPs is the development of four innovative online resources that are available to the higher education sector. These resources will help to develop a learning community of emerging mathematics and science teachers actively engaged in an interdisciplinary, professional community of practice. These resources include:

1. Step Up has developed a webpage that will make the Practising Science instructional resources available for educational professionals (www.stepup.edu.au/inquiry).
2. TeachConnect (www.teachconnect.edu.au) has created an online space where pre-service teachers can propose and envision classroom experiences that are not governed by their supervising practicum teachers during professional experience.
3. TeachConnect has developed a website (www.natureofstem.com) that will integrate aspects of several Step Up CAPs. The website has the intention of deepening pre-service teacher and in-service teacher conversations about how to think scientifically.
4. POD project resources are available on the K-12 learning management website, Schoology (www.schoology.com).

Project Impacts and Outcomes

Project impacts and outcomes are presented from the perspective of the students, institutions, and academic staff. Creating a professional online learning platform for MS pre-service teachers was a unique feature of Step Up. Diverse student engagement activities were designed to support successful transition into teaching careers, foster networks, and enable project dissemination. The goal to increase visibility and awareness amongst Step Up target students to facilitate student awareness and uptake of networks saw over 900 pre-service teachers and maths/science students involved in collaborative projects across the five institutions.

Step Up has also provided emerging evidence of a current and future increase in numbers of MS teachers. Step Up’s ISTP project designed, developed and rolled out the Science/Mathematics Education Minor at JCU (2017), QUT (2015) and UQ (2017) in order to
allow for a wider and more diverse pool of students entering the MS Teacher pathway, thus leading to increased numbers of students specialising in secondary MS teaching in areas of need. At the end of 2016, 67 students were enrolled in the QUT Minor.

Preliminary data of pre-service teachers suggests positive changes in their self-efficacy after teaching in the STEM Studio at QUT and GU especially in the areas of effective instruction, motivating students and coping with change in the classroom. Step Up’s Practising Science project has been embedded within the curriculum of MS pre-service teacher secondary courses at JCU and QUT. These innovative curricula have allowed pre-service teachers to design and implement inquiry based scientific investigations. Emerging evidence suggests that involvement in STEM Studio and Practising Science CAPs has assisted in strengthening pre-service teachers’ mathematics/science knowledge and pedagogy.

A shared framework for operating across the consortium members led to strong foundations for systemic and cultural change. This foundation for systemic change is reflected in documented course structures and articulations across universities. Two CAPs worked on embedding activities within curriculum to enact change. The ISTP for example, included minor subjects available for STEM majors, with students being able to transfer at the end of first year to Bachelor of Education and articulate into a Masters of Teaching after completing their undergraduate degree. Flexibility to adapt the curriculum across institutional contexts is a key learning from Step Up which can inform future collaborative projects involving cross-institutional links. JCU developed a Template to assist cross-disciplinary academics to consider the aspects of subject development that met QCT accreditation requirements and addressed Australian Professional Standards for Teachers (APSTs) as well as the Threshold Learning Outcomes for Science students.

Several CAPs provide evidence for collaborative course design and delivery, formalised in curriculum structures/processes. Practising Science is a curriculum developed in consultation with educators and scientists across partner institutions. The process of implementation differed at each institution in line with local needs or requirements based on existing education course structures. Evidence that Step Up was successful in expansion of networks of MSTEd Educators was demonstrated through interdisciplinary teams planning and delivering the CAPs across institutions.

Emerging evidence provided across all Step Up CAPs demonstrate that continued partnerships provide mechanisms for sustained resourcing and implementation (beyond the life of the project). Through Step Up, partnerships have been established outside of the project (e.g., Australian Research Council grants (3 in progress), successful Queensland DET funding ($100k), and conference publications (6 to date). Partnerships across universities and external stakeholders reinforce the sustainability of the working relationships consolidated through Step Up. Examples of how partnerships have provided mechanisms for sustained resourcing and implementation include the TeachConnect CAP which linked with all Queensland Universities and QCT to secure external funding for ongoing development.
Key findings

Step Up provided initiatives that enabled step-change within the secondary mathematics and science pre-service teacher landscape. Project findings in the context of significant change in higher education practise are grouped across three areas:

1. **Collaborative cross-faculty arrangements**: collaborative initiatives in course design and delivery;
2. **Integrating content and pedagogy to reflect the experience of authentic science**: preparing teachers who have a contemporary and dynamic view of science and who are capable of bringing authentic science into the classroom; and
3. **Developing the professional identity of STEM teachers**: creating, extending and enhancing professional learning and support networks for undergraduates and teachers.

Step Up was considered by participants through semi-structured interviews and feedback from Step Up Intensives as a trigger for several unintended outcomes. These outcomes, not originally part of Step Up’s remit, were seen by academics as significant aspects to enact change within the sector. These included identifying and making use of *Champions at every level* to influence others and *Cross-faculty and cross-institutional respect* where four elements of institutional capital (funding, workload, trust and recognition for your work) between faculties and institution for successful collaboration emerged.

Support for this publication/activity has been provided by the Australian Government Department of Education and Training.

The views expressed in this publication/activity do not necessarily reflect the views of the Australian Government Department of Education and Training.