Enhancing science and mathematics teacher education: evaluating an enhancement module for science pre-service teachers

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Abstract: Motivated and well-trained science and mathematics teachers are a requirement for sustaining an industrialized economy. The Australian government has funded several projects to satisfy this requirement designed to improve pre-service teacher education in regional and rural Australia. One such project uses a collaboration nexus model with lesson feedback and reflection modules in an iterative process using a repeated sequence comprised of an Enhancement Module, a subsequent Teaching Lesson and a Reflection Module. This paper reports on qualitative investigations of the effectiveness of the collaboration nexus in the Enhancement Module and comments on the value of the iterative process. Results from small-scale trials with pre-service teachers indicate that the Module positively engages participants, pre-service teachers, university scientists and specialist educators. The Module and its iterations appear to be effective in grounding pre-service teacher education in targeting regional contexts relevant to the daily lives of both pre-service teachers and their classroom students.

Keywords: problem-based learning, pre-service teacher, mathematics and science education, collaboration nexus, critical moments, teacher education

Reference to this paper should be made as follows: Woolcott, G., Whannell, R., Pfeiffer, L., Yeigh, T., Donnelly, J., & Scott, A. (xxxx). Enhancing science and mathematics teacher education: evaluating an enhancement module for science pre-service teachers. Int. J. Learning and Change, Vol. xxx, Nos. xx, pp. xx–xx.

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Enhancing science and mathematics teacher education: evaluating an enhancement module for science pre-service teachers

1. Introduction

It is increasingly apparent from studies related to sustainable development of industrialized economies that there are fewer and fewer people with a mathematics and science[1] background sufficient to support the industries upon which these economies depend (APA, 2012; Freeman, Margison & Tytler, 2015; Olson & Riordan, 2012; The Royal Society, 2014). Reports from the Australian Government Office of the Chief Scientist (Chubb et al., 2012; OCS, 2014) argue that Australia, like the USA and other industrialized nations, has stagnated in producing the mathematics and science teachers and students necessary to sustain its industrialised economy. This argument is supported, for the Australian context, by reports that standards and interest in mathematics and science are declining (Lyons & Quinn, 2015). Statistical analysis of national and international data, such as that from the TIMSS and PISA[2] surveys, also support this argument, with Australian results disappointing in some areas when compared across the country or when compared across countries, both in Australasia and elsewhere (Haar, Nielsen, Hansen & Jakobsen, 2005; Leigh & Ryan, 2008).

As part of a program to address this situation, five collaborative projects were funded in 2013 as part of an Australian government initiative through its Office for Learning and Teaching (OLT), in order to improve pre-service teacher education in mathematics and

[1] This paper focuses on mathematics and science but recognizes that this focus may lie within the overall framework of Science, Technology, Engineering and Mathematics (STEM).
[2] For information on The Trends in International Mathematics and Science Study (TIMSS) see http://timssandpirls.bc.edu and for the Program for International Student Assessment (PISA) see http://www.oecd.org/pisa/.

science[3]. This paper reports on the development of one of these projects, *It's part of my life: Engaging university and community to enhance science and mathematics education* (IPOML) conducted across six partner universities belonging to the Regional Universities Network (RUN)[4]. This project addresses two critical issues in mathematics and science education in Australia: the lack of confidence of teachers of mathematics and science, particularly in primary (elementary) school; and the related lack of student interest in mathematics and science, particularly in the middle years of high school.

With this in mind, IPOML aims to drive improvements to university education curriculum by connecting pre-service teachers (PSTs) with university-based science and mathematics researchers and education specialists, as well as with the mathematics and science that is part of the daily life of Australian regional communities. The project utilizes the development of a collaboration nexus that links PSTs with university mathematics and science researchers working at or above world standard (ERA 4 or 5)[5], as well as with university education specialists from teacher education courses. The nexus is structured to provide the PSTs with access to high quality mathematics and science knowledge and related pedagogical knowledge as part of a collaborative effort to improve their teaching confidence and competence.

A major focus of the project includes the development of processes that link, for PSTs, the scientific and mathematical thinking of university researchers and educators with the thinking that people use to solve problems in their daily lives. Additionally, the project provides

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[3] Information on these programs can be obtained from the following website: https://www.education.gov.au/australian-maths-and-science-partnerships-program.

[4] The Regional Universities Network (www.run.edu.au/) is based in eastern Australia and comprises Southern Cross University (SCU) and the University of New England (UNE) in New South Wales, Central Queensland University (CQU), the University of Southern Queensland (USQ) and the University of the Sunshine Coast (USC) in Queensland, and Federation University Australia (FedU) in Victoria.

[5] The ratings refer to the Excellence in Research Australia (ERA) ratings, reported on a 1 to 5 scale, with ERA 5 being 'well above world standard' and ERA 4 being 'above world standard' http://www.arc.gov.au/era/

opportunities for the educators to work with the PSTs to break this knowledge down into approachable and familiar scenarios that can be used for student-centred approaches that have high levels of classroom engagement. PSTs also receive support in developing skills in fostering a supportive classroom environment, as well as in overcoming any anxiety they may have in teaching mathematics and science.

This paper outlines the project as it has unfolded in science-based trials and in the embedding of project processes in university curricula, and reports on qualitative data collected from participating pre-service teachers, research scientists and education academics. The project was developed around a model derived from teacher education processes related to the collaboration nexus previously described for Australian contexts (e.g. Cook & Buck, 2013; Gahan & Lawrie, 2011) and seeks to improve confidence and competence in the teaching of science and mathematics. A key focus of the project reported here was to improve PST competence and confidence through collaborations between high-level science researchers and university educators prior to teaching lessons, and to provide feedback through structured reflection sessions after each lesson. In particular, the project investigates how PSTs could use information from scientists about how they solve problems and link this to how people solve problems in their daily lives (mathematics-based trials are reported elsewhere, e.g., Yeigh et al., 2016).

2. Project Context and Background

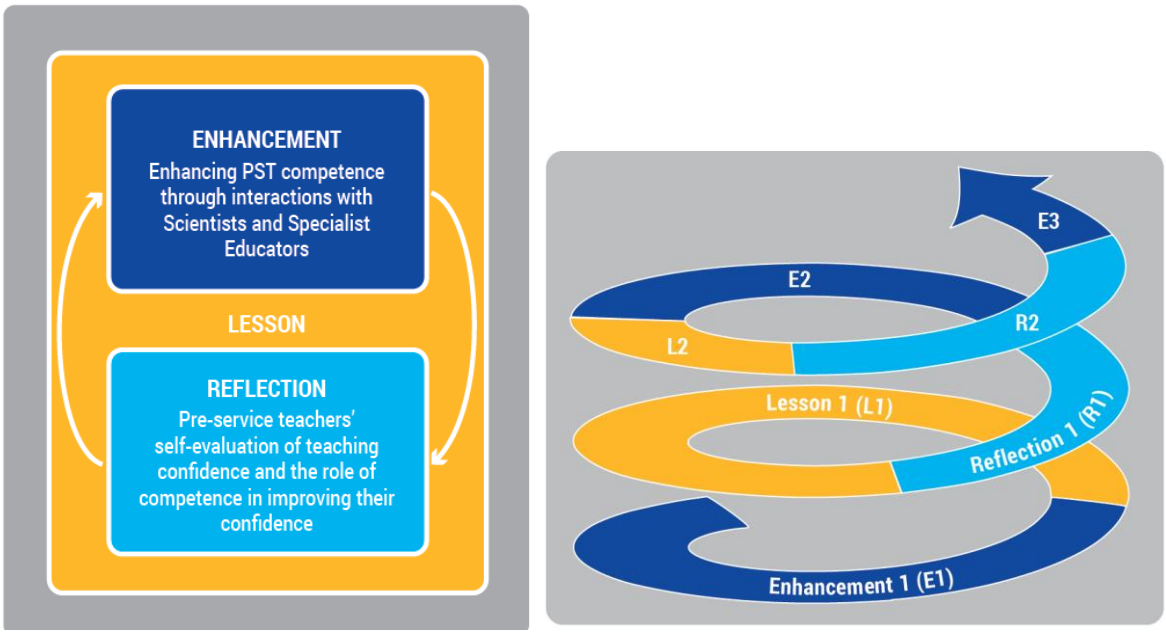
2.1 Enhancement, Lesson, Reflection Structure

The process for pre-service teacher interaction was based around iterations of the following sequence (abbreviated as ELR): an enhancement session (E) with content experts and pedagogy specialists that also involved the PST's peers - where everyone worked

collaboratively to plan for a particular science-based teaching lesson; the teaching of the science lesson (L)—which was also video recorded *in situ*; and a self-reflection and guided collaborative feedback/reflection session (R)—which focused on an examination of critical moments with peers and the pedagogy specialists. The ELR process and its planned iterative structure is shown in Figure 1.

In line with theory on the value of iteration in learning processes for PSTs (e.g., Davis & Dargusch, 2015; Gahan & Lawrie, 2011), this sequence was repeated as iterations of the ELR process. Each Module was treated as a discussion-based learning intervention for the PSTs and each intervention was preceded by a training session that explained the process to be undertaken and the rationale behind each Module.

Figure 1 The Enhancement, Lesson, Reflection (ELR) process and its iterative path



Enhancement Module (E): *Face-to-face sessions of interactions with university research scientists and specialist educators to improve competence in science content, thinking, related science pedagogy and possible local contexts to support situated learning*. Each PST group, comprising up to three students, was given a topic for the relevant primary or secondary science lesson (provided by the target school) and one PST volunteered to deliver the lesson. The PSTs then developed their initial ideas in relation to how the lesson might be taught. All PSTs then met with a science researcher with whom the science content, associated thinking and possible local contexts where the science could be applied were discussed. The teaching PST then prepared the final lesson in consultation with the university educators.

Teaching Lesson (L): *One PST delivered the planned lesson.* The collaboratively planned lesson was taught to a class of students at a local school and videotaped, while the remaining PSTs observed along with specialist educators.

Reflection Module (R): *Feedback/Reflection utilising self- and group-evaluation to examine the experience of teaching science.* In this session PSTs reflected on and evaluated their teaching lesson in a further 60-minute session with the university educators. A feature of this reflection was the use of a positive and negative affect reporting system, based around critical moments in the teaching lesson (Woolcott & Yeigh, 2015; Yeigh et al., 2016). These critical moments were determined by the teaching PST, who reviewed the video of the lesson and selected teaching moments which were considered to be very positive or very negative.

At the end of each ELR sequence, data collected during the process were analysed in order to determine how to re-configure the discussions/lessons in the following iteration. As shown by the iterative path included in Figure 1, this allows the process to follow a design-study

research approach, where each iteration of the process informs the next (e.g., Kennedy-Clark, 2013). Trials reported here used either two or three iterations of the ELR process.

The reflective emphasis of the ELR process for this study can be located in relation to Kram's (1985) model of mentoring, in particular his notion of an inner-oriented mentoring dimension known as psychosocial development. In this model of mentoring, self and collaborative reflection is viewed as a form of coaching, and Kram argued that these aspects of mentoring are particularly helpful in the development of confidence and competence as professional attributes. This reflective construct is also in accord with the ideas of Schön (1987), who described reflection as a key element involved in the development of new understandings and insights related to professional practice.

2.2 The collaboration nexus

The IPOML project utilizes a research/education collaboration nexus model for pre-service teaching drawn together from Australian-based studies. This includes studies that have successfully developed educational resources and teacher professional development programs using a collaboration nexus (e.g., Tytler, 2007; Tytler, Symington & Smith, 2011). The project focuses, in particular, on the projects that have developed sustainable and scalable models through iterative trials of learning procedures (e.g., Gahan & Lawrie, 2011; Lawrie et al., 2011). The project process is iterated to allow opportunities for using both collaboration and feedback/reflection to impact on lesson teaching (e.g., Davis & Dargusch, 2015).

Iteration in early project trials served also as a manageable way of testing processes through repetition across small volunteer groups prior to up-scaling and embedding of similar processes in courses and workshops for larger groups. Collaborations through which undergraduate teachers have developed anchored learning, or similar scenario-based or

problem-based learning strategies, developed since the early 1990s (e.g., Barab & Plucker, 2002), were also considered. There was a focus, however, on strategies that combine explicit teaching or guided instruction with student-centered activities promoting imitation, enquiry, discovery and discussion, with a hoped-for result of meaningful student engagement as a lived or situated experience (Schweingruber, Keller & Quinn, 2012).

In the project, a collaboration nexus model was used as a method for deriving such lived experiences or contexts from everyday community, since it is here that experienced researchers may see mathematics and science where others may not. The collaboration with scientists is designed to provide PSTs with explanations of science in community contexts, allowing the specialist educators involved in the project to assist PSTs to confidently prepare lessons based in the relevant State/Territory curriculum or the Australian Curriculum Framework. The project, therefore, aims to build on PST motivation and personal interests in converting regional and/or community contexts into scenario-based lessons that will engage classroom students**.**

2.3 Confidence and competence of pre-service teachers (PSTs) in teaching science

The project aims to address changes in PST confidence and competence as a result of the collaborative experiences of working with real-world mathematicians, scientists and university education specialists prior to teaching a lesson, as well as feedback and reflection experiences after the lesson. With this in mind, established protocols have been developed in conjunction with a research psychologist in order to assess attitudes and interests of the PSTs (e.g., Rothman et al., 2012). These protocols included assisting PSTs working within the project to identify and consider affective states in their teaching in order to assess their own emotions and motivations, and to ensure that the emotional and motivational climate of the classroom is supportive (e.g., Tobin & Ritchie, 2012; Yeigh et al., 2016). Feedback and

reflection is important for learning, and the scaffolding approach of Howitt (2010), with its expectations regarding the quality of reflection, was used to develop effective reflection in order to increase learning.

Studies of undergraduate education show that student confidence can be built through active engagement in guided teamwork that optimizes co-operative interdependency (Kavanagh, 2007 in Gahan & Lawrie, 2011). Consequently, in the project, PSTs worked in groups to develop contexts and scenarios related to familiar regional contexts. As part of the collaboration nexus, the use of a team approach is aimed at remedying some of the issues related to contextualized or situated learning as applied in the Australian classroom, for example, goal alignment of teacher and student, and teachers' lack of confidence in subject content (Kidman, 2012).

Research Questions

There were a number of research questions being considered within the broader project that related specifically to the use of a collaboration nexus as part of an Enhancement Module. The following is an example of a primary research question considered over the project as a whole.

- *Does improved competence lead to improved confidence in teaching science?*

The key research questions of the pilot program reported here, however, are related to the effect of the Enhancement Module on PST competence and confidence in teaching science as observed in the Teaching Lessons.

- *What were the merits of repeated opportunities within the sequence for collaboration between PSTs, research scientists and university educators?*
- *Did the confidence and competence of the PSTs improve as a result of the trial?*

A complete analysis of the Reflection Module is to be published elsewhere, but some results are discussed here to provide an overall context for discussion of the iterative process.

3 Method

3.1 Participants and Data Collection

Data were collected from trials conducted by two of the partner universities involving primary and secondary school students. Project trials, comprising up to 3 PST participants per team, were analysed from a total of 17 primary PSTs and 7 secondary PSTs. While a range of data collection methods were employed to serve the needs of the full ELR process, the data upon which this report is based were collected from participants via semi-structured interviews and recorded enhancement sessions. Each participant participated in a semi-structured interviewed prior to the commencement of each Enhancement phase, with a second semi-structured interview with the teaching PST completed following the teaching of the lessons based on an Enhancement phase. The trials also involved a team of volunteers at each school, including classroom teachers and school students involved in the lesson taught by the PST. The data collection was conducted under the appropriate ethical guidelines and approvals of the Human Ethical Research Committee at each institution, with appropriate informed consent from all participants.

3.1 Qualitative Analysis and Representation

Qualitative data obtained from the Enhancement sessions, and from the semi-structured interviews prior to the Enhancement Module sessions and after the Teaching Lessons, were first coded and scored using constant comparative analysis (Denzin & Lincoln, 2000). This process allowed meaningful words and phrases to emerge from participant responses, and then to be coded to nodes using the qualitative data analysis software NVivo (QSR

International, version 10). The nodes were then cross-coded with categories of meaning significant to the research questions (focus areas of research), and the participant perspectives within these nodes examined in terms of the research questions themselves.

4 Results and Discussion

4.1 Pre-service teachers (PSTs) and the collaborative experience

The first focus area of research was to investigate the merits of multiple opportunities for interactions between PSTs, research scientists and university educators. The responses from the PSTs about the value of the Enhancement Module were predominantly positive with a number of PST participants referring to the value associated with speaking to the research scientists and educators prior to teaching:

> "*…loved the interpretation of the curriculum from the scientific community on what they considered important and integral in learning particular topics…*".
>
> *"Observing each other in the classroom. Talking with the scientists and hearing their ideas..."*
>
> *"Working with mentors and professionals to brainstorm ideas for lessons. So many options were explored that I would not have thought of as well as exposure to resources that I was unaware of."*
>
> *"I really liked collaborating with the scientists who had so much knowledge about topics in the local area and how they could be related to content in the syllabus. Using that knowledge to teach a lesson was also really interesting."*
>
> *"Loved the interpretation of the curriculum from the scientific community on what they considered important and integral in learning particular topics"*

> *"I think it was useful just to talk to other people about what I was going to do um and yeah discuss it as a group is always good."*

Any negative comments seemed to relate to the time the scientists had available:

> *"The enhancement sessions were good….and seemed a big commitment for the scientists. Whilst they were interesting not sure they would be a sustainable way to do things.".*

Importantly, the PSTs who were given enhancement prior to teaching their first lesson were positive about the whole experience from the beginning of the trial right through to the end. Having educators present in the Enhancement session was also considered valuable:

> "*…Especially with the educators like yourself talking about my outcomes. Leaving that session with my two outcomes written clearly enabled me to go away for the weekend and develop my lesson with a, you know, with a start line and I'd already started so it was good…*"
>
> *"Experience in a school before practicum. Working with researchers and educators."*

4.2 Other participants and the collaborative experience

The scientists and educators also responded favourably about the value of the Enhancement Module, although the discussions functioned differently for them than for the PSTs. Some of the scientists saw the collaborations of the Enhancement Sessions as affirming for the regional focus:

> "*making science relevant to peoples life is important….. a regional context for Science is a great way to do that……application of science to help solve real-world problems and lead to better understanding and management*".

Others saw the collaborative nexus as an integral part of research:

> "*Sharing knowledge of resources and perhaps identifying new ways to describe a topic to help understanding*".

The university educators were also positive, pointing out the value of the overarching views of science that scientists provide:

> "*The portable aspects – science and maths as a way of solving real world problems using methodologies from maths and science, with content learned as required.*"

Some educators remarked on the value of the two-way interaction for their own practice:

> "*I need to focus on the overall concept of this project - scientific thinking in everyday life and the connection to this that people are not aware of!*".

4.3 Pre-service teachers (PSTs) confidence and competence

All responses from PSTs were positive in relation to confidence and/or competence in teaching science improving during the trial. The PSTs reported that the collaborative nexus gave them increased confidence that their planned lesson was correctly aligned with the relevant syllabus outcomes, a feature indicating improved competence in planning for teaching. PSTs also reported that the interchange with the scientists and educators facilitated a more focused attention on precise areas of discipline knowledge in regional contexts and where common scientific misconceptions are more likely to instantiate if not specifically addressed. The combined effect of the collaborative discussions was that the PSTs felt much calmer and more confident in the time leading up to their lesson. These views are exemplified by the following PST comments.

> "*I think they just have so much knowledge to offer and different ideas and that really helped me figure out what I wanted to do in my lesson and that made me feel more relaxed and more confident about what I was going to do...*".

> *"My confidence um it increased my confidence in terms of um having a structure, knowing content is correct, so that I'm like teaching the right principles and um yeah so it just helped getting the concepts down correctly."*
>
> *"I think it was very beneficial, very, very beneficial, yep. Being able to talk through um all different aspects of the topic and really boil it down to what was relevant and then to find out some key things like make it dramatic to get their attention and then um simplifying it down but also having really good activities, getting the students to do things."*
>
> *"A lot um I think they just have so much knowledge to offer and different ideas and that really helped me figure out what I wanted to do in my lesson and that made me feel more relaxed and more confident about what I was going to do."*
>
> *"Meeting with the researchers and educators has been really beneficial as they have given me a multitude of ideas to take away to make my classes more engaging for students."*

4.4 Other participants and pre-service teachers (PSTs) confidence and competence

The university educators also commented positively on how the project sequence, including the Enhancement, allowed PSTs to gain both confidence and competence:

> "*The value of having students build up their … confidence by working with researchers and educators to plan lessons and then having structured detailed feedback sessions*".

The educators in these small-scale trials also observed each lesson and participated in each of the Feedback/Reflection Module interactions. Some of the comments gave insight into the focus on scientific thinking and regional context as an approach to lesson delivery, with content options being investigated once the problem or scenario options were established:

> "*I would target more clearly the scientific thinking that PSTs and students already have, i.e., the problem-solving skills that they use that are based in claim and evidence and in testing predictions*".

Using this type of approach helped the PSTs realize that they do not need to know everything about science, but that they do need to know where to find content as needed and have strategies in place to utilize this content. One educator summed this up by saying:

> "*the importance of having a tool kit of effective teaching strategies to draw from and the importance of time in the classroom…. access to resources e.g., specialists is very inspiring*".

4.5 Reflection as a complement to Enhancement

An important area of focus was whether the Feedback/Reflection Module sessions were useful as a complement to the Enhancement Module. The PSTs indicated that these sessions had an orienting effect that better prepared them to engage in and utilize constructive criticism in the following Enhancement Sessions (in the iterative cycle). The analysis looked specifically for any sign in the PSTs meta-language in the Feedback/Reflection Module that their teaching had benefitted from competence and confidence. As was the case with the Enhancement Module, responses here were positive.

> "*…I feel that the practical experience and the opportunity for constructive criticism was very beneficial in the development of my competence and confidence as a science teacher…*".
>
> *"Getting to discuss it with a group and have feedback and opportunities to watch it on a video is good experience"*
>
> *"having this feedback and everything has really, really helped and identify what I need to work on to become better"*

The PSTs reported that the feedback/reflection sessions created a form of reflective space where they and others could critique their own performance without being too discouraged about the less effective sections of the lesson:

"… the more reflection you get involved in, the more you get comfortable with it…".

The idea of becoming conditioned to constructive criticism, in fact, was a common theme articulated by the PSTs. The idea here was that isolated or one-off criticism, even when expertly given with the noblest of intentions, is nevertheless still daunting and confronting for someone striving to construct an identity of a competent teacher. In contrast, the scheduled feedback/reflection sessions created a very different collegial space, one which the PSTs approached knowing that the expressed purpose of the session was to facilitate a sustained reflection on their performance.

5 Conclusion

This initial qualitative report supports the literature (e.g., Gahan & Lawrie, 2011; Tytler, 2007; Tytler et al., 2011) in indicating that engagement of world-class science researchers in collaboration with specialist educators assists in building the competence and confidence of PSTs and has the potential to enhance university education curricula. The findings support the view that such a collaboration nexus model can be successfully applied to enhance lesson delivery and the confidence and perceived competence of pre-service science education teachers through the incorporation of higher levels of scientific thinking and the use of appropriate regional contexts relevant to students from rural and peri-urban Australia.

One of the challenges of the use of the ELR model in preservice teacher education is that it is a relatively complex process, involving staff from a number of different areas of the university. An institution that embraced the ELR approach in both mathematics and science

would require the active involvement of a range of academics from outside the education area. This appears to be more of a challenge in the science area, due to the number of different disciplines involved, for example, biology, physics, chemistry, and geology. The capacity for the ELR process, which requires multiple sessions of involvement for the researchers due to its iterative nature, to be implemented and sustained would require evidence of the benefit of its use to be made clear to all involved, particularly for researchers outside education. The analysis of the data from this project provides clear support for the benefit to all participants.

The continued success and development of the project processes has encouraged consideration of a variety of ways to embed such processes into the framework of university teaching. Although the results reported here are from a relatively small number of participants at two universities, these results indicate that the Enhancement Module has the potential to have a two-way effect in building PST and educator confidence in the mathematics and science that is ‘out there’ in the real world and in giving participants an appreciation of high-engagement teaching methodologies and strategies. The findings also indicate that the collaborative discussions give PSTs a better idea of the different levels of understanding of science of educators, PSTs and school students. In particular, PSTs understand the key role that science plays in their everyday lives. The discussions in the Enhancement Module have shown them the similarity between the types of thinking that they use in their every-day lives and the scientific thinking used by researchers. The comments that PSTs have made or written, and the classroom student feedback and observer comments, indicate that the PSTs realize that they can utilize the types of thinking that they and their classroom students are familiar with from daily use.

The project as it develops should have a flow-on effect and, if these limited trials are any indication, its broader development should serve to assist in revitalizing pre-service teacher education and current teaching practices in regional Australia. This is particularly the case given that project development is linked strongly to currently accredited curricula in undergraduate university education curricula and in Federal, State and Territory school curricula.

Acknowledgement

This presentation outlines features of the project, *It's part of my life: Engaging university and community to enhance science and mathematics education*, a project supported by a three-year grant awarded to the Regional Universities Network (RUN) by the Australian Government's Office for Learning and Teaching.

References

APA [American Psychological Association]. (2012). *Facing the school dropout dilemma.* Washington, DC: Author.

Barab, S. A., & Plucker, J. A. (2002). Smart people or smart contexts? Cognition, ability, and talent development in an age of situated approaches to knowing and learning. *Educational Psychologist, 37* (3), 165-182.

Cook, K. L., & Buck, G. A. (2013). Pre-service teachers' understanding of the nature of science through socio-scientific inquiry. *Electronic Journal of Science Education*, *17*(1), 3-24.

Chubb, I., Findlay, C., Du, L., Burmester, B., & Kusa, L. (2012). Mathematics, engineering and science in the national interest. Canberra: Office of the Chief Scientist.

Creswell, J. W. (2011). *Educational research: Planning, conducting, and evaluating Quantitative and qualitative research (4th Edition).* Boston, MA: Pearson.

Davis, S. E., & Dargusch, J. M. (2015). Feedback, iterative processing and academic trust - teacher education students' perceptions of assessment feedback. *Australian Journal of Teacher Education, 40*(1), 177-191.

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2000). *Handbook of qualitative research* (2nd ed.). Thousand Oaks, CA: Sage.

Doig, B., & Groves, S. (2011). Japanese Lesson Study: Teacher professional development through communities of enquiry. *Mathematics Teacher Education and Development*, 13(1), 77-93.

Gahan, L., & Lawrie, G. (2011). IS-IT learning? Online interdisciplinary scenario-inquiry tasks for active learning in large, first year STEM courses. Final Report – ALTC.

Haar, J. H., Nielsen, T. K., Hansen, M. E., & Jakobsen, S. T. (2005). Explaining student performance: Evidence from the international PISA, TIMSS and PIRLS surveys. Report from a study carried out on behalf of the European Commission's Directorate-General for Education and Culture.

Howitt, C. (2010). *Science for early childhood teacher education students (ECTES): Collaboration between teacher educators, scientists and engineers*. Final Report – ALTC. Canberra: Australian Government.

Kavanagh, L. (2007*). Developing and disseminating team skills capacities using interactive online tools for team formation, learning, assessment and mentoring.* Final Report – ALTC. Canberra: Australian Government.

Kennedy-Clark, S. (2013). Research by design: Design-based research and the higher degree research student. *Journal of Learning Design*, *6*(2), 26-32.

Kidman, G. (2012). Australia at the crossroads: A review of school science practical work. *Eurasia Journal of Mathematics Science and Technology*, *8*(1), 35-47.

Kram, K. E. (1985). *Mentoring at work: Developmental relationships in organizational life*. Glenview, Ill: Scott Foresman Publishing.

Lawrie, G., Gahan, L., Matthews, K., Adams, P., Kavanagh, L., Loong, P., Weaver, G., & Cusack, R. (2011). Handbook of scenario resources for inquiry learning in STEM. IS-IT learning? Online interdisciplinary scenario-inquiry tasks for active learning in large, first year STEM courses. ALTC.

Leigh, A., & Ryan, C. (2008). How has school productivity changed in Australia? DEST Report.

Lyons, T., & Quinn, F. (2015). Understanding declining science participation in Australia: A systemic perspective. In E.K. Henriksen, J. Dillon & J. Ryder (Eds.), *Understanding student participation and choice in science and technology education* (pp. 153-168). Netherlands: Springer.

OCS [Office of the Chief Scientist] (2014). *Science, technology, engineering and mathematics: Australia's future*. Canberra: Australian Government.

Olson, S., & Riordan, D.G. (2012). Engage to Excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. President's Council of Advisors on Science and Technology report to the President. Washington, DC: *Executive Office of the President*.

Rothman, S., Kelly, D., Raban, B., Tobin, M., Cook, J., O'Malley, K., Ozolins, C., & Bramich, M. (2012). Evaluation of the assessment and rating process under the national quality standard for early childhood education and care and school age care. ACER report for SCSEEC. Melbourne: ACER.

Schön, D. A. (1987). *Educating the reflective practitioner*. San Fancisco, CA: Jossey Bass.

Schweingruber, H., Keller, T., & Quinn, H. (Eds.). (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core Ideas*. National Academies Press.

The Royal Society (2014). *Vision for science and mathematics education.* The Royal Society Science Policy Centre report DES3090. Issued June 2014. London: The Royal Society.

Tobin, K., & Ritchie, S. M., (2012). Multi-method, multi-theoretical, multi-level research in learning sciences. *The Asia-Pacific Education Researcher*, *21*(1), 117-129.

Tytler, R. (2007). Re-Imagining science education: Engaging students in science for Australia's future. Canberra: ACER.

Tytler, R., Symington, D., & Smith, C. (2011). A curriculum innovation framework for science, technology and mathematics education. *Research in science education*, *41*(1), 19-38.

Woolcott, G., & Yeigh, T. (2015). Enhancing mathematics (STEM) teacher education in regional Australia: Pedagogical interactions and affect. In M. Marshman, V. Geiger & A. Bennison (Eds.), *Mathematics education in the margins* (Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia, pp. 651-658). Adelaide: MERGA.

Yeigh, T., Woolcott, G., Donnelly, J., Whannell, R., Snow, M., & Scott, A. (2016). Emotional Literacy and Pedagogical Confidence in Pre-Service Science and Mathematics Teachers. *Australian Journal of Teacher Education*. Accepted.