

The R in the ELR Process: Reflection and the Emotions of Pre-Service Teachers. A Case Study

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Reflective practice in mathematical teaching improves teaching skills and confidence. This paper investigates affect-based critical moments as a reflective practice for pre-service teaching. An embedded case study is presented by one regional university as a discovery into the *reflective* phase of the Enhancement-Learning-Reflection process to uncover the types of emotions and themes from student chosen critical moments. An analysis of these critical moments found students' expressed mainly positive emotions combined with the negative emotion of anxiety. Themes emerged around pedagogical content knowledge: teaching strategies; student thinking; and appropriate mathematical content knowledge.

While not all students will enjoy learning mathematics, a key to confident mathematics students is confident teachers (Cotton, 2013). Research has shown that teacher confidence in their own mathematical abilities, or lack of it, can have a powerful effect on students (Laursen, Hassi, & Hough, 2016). Students taught by teachers with positive beliefs about mathematics generally have positive views about mathematics and confidence in their ability to do, learn, enjoy and discuss mathematics (Uusimaki & Nason, 2004).

There is evidence in the field of mathematics that many teachers lack mathematics confidence (Beswick, Ashman, Callingham, & McBain, 2011). Such studies show that teachers lack confidence in their own mathematical ability and/or their ability to effectively teach mathematics-related curriculum. Studies have also shown that preservice teachers (PSTs) regularly report feeling both a lack of preparedness to teach mathematics at the level they will be qualified to teach (Beswick et al., 2011), as well as mathematics anxiety (Boyd, Foster, Smith, & Boyd, 2014). A consequence of the increasing proportion PSTs entering teacher education programs with negative beliefs and anxieties about mathematics is a relative increase in the number of teachers who have confidence issues when it comes to teaching mathematics. From a school student perspective, the declining level of confidence of those teachers working in the mathematics field has been linked to the declining standards and interest in mathematics exhibited by Australian school students (Lyons & Quinn, 2015; Roberts, 2016), thus indicating intervention is required at the teacher preparation level.

Background

In an effort to address teaching confidence issues in the areas of mathematics and science, as well as the related lack of student interest in these subjects, a preservice teacher (PST) education program targeting teaching confidence has been developed collaboratively by six partner universities belonging to the Regional Universities Network (RUN). The program, titled "It's part of my life: Engaging university and community to enhance science

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and mathematics education” (Woolcott, Scott, et al., 2017), was trialled and refined through multiple iterations at each partner university. A core component of the program is the use of collaborative relationships that connect PSTs with university-based science and mathematics researchers and education specialists. The aim of this nexus is twofold: first, to facilitate the development of improved mathematics or science-related teaching confidence of PSTs through repeated contact with expert mentors who provide high quality mathematics, science and related pedagogical content knowledge (PCK); second, to provide a learning environment in which PSTs develop the skills and confidence required to then themselves be able to create a supportive classroom environment for students.

A key structural component of the “It’s part of my life” program is the Enhancement-Lesson-Reflection (ELR) process. The processes engage PSTs in collaboratively developing a lesson (with their expert mentors) that has a focus on a ‘real life’ local problem or issue; then teaching that lesson to a classroom of high school students; and finally collaboratively analysing the experience with the expert mentors and other PSTs involved in the process. The ELR process is utilised by each university as part of the It’s part of my life program; however each university is investigating how the process may be used to improve the education of preservice teachers in different STEM disciplines and scenarios. In this study the PSTs are studying to become high school mathematics teachers and the STEM teaching scenario utilised is mathematical modelling. While early evidence already suggests the ELR method is effective in its ability to positively affect PST confidence (Axelsen, Galligan, & Woolcott, 2017; Woolcott, Whannell, et al., 2017; Yeigh et al., 2016), the focus of this paper is on the integral role of the reflection component of the ELR process in developing mathematics confidence and mathematics teaching confidence.

The lesson and mathematical concepts to be taught were decided and planned by the PSTs in conjunction with their assigned expert mentor. The lesson had to involve a real-world problem, to be solved using open-ended mathematical modelling: devise a group-generated formulation to the presented problem; discuss assumptions and variables; develop a mathematical solution; model possible solutions; and interpret the real world meaning with further model refinement (Stillman, Galbraith, Brown, & Edwards, 2007). Due to the fluid nature of modelling, a definite answer is not possible and thus PSTs had to be prepared for a range of different mathematical scenarios.

Using reflective practice

The importance of preparing thoughtful, reflective mathematics teachers is well recognised in the literature and arguably many of the benefits associated with reflective practice may also contribute to the development of greater teaching confidence. Reflective practice comes in various forms; however a commonly used technique to evoke reflection involves identifying and subsequently reflecting on a certain moment which may have: evoked an emotion (Yeigh et al., 2016); challenged one’s own assumptions or made one think differently (Ng, Widjaja, Chan, & Seto, 2012); offered an opportunity to offer an insight to students or change the direction of the lesson (Stockero & Van Hoest, 2013); been transformative in its impact on the education of students (Bedeian, 2007); and/or been seen as critical by the individual (Tripp, 1993). The identification of critical moments that occur during classroom engagement are useful for not only guiding PSTs’ reflections on their teaching experiences, but also for exploring accompanying emotions that coincide with the identified moment. Exploring emotions are important because novice teachers and PSTs are often affected by their emotions, particularly when these emotions are triggered by their perception of how well – or more often how poorly – a lesson is progressing (Kilgour,

Northcote, & Herman, 2015). Research also shows that developing an understanding of one's emotions is fundamental to the professional development of confidence in teacher training (Yeigh et al., 2016).

In relation to mathematical teaching, several authors have identified that reflection is essential to effectively facilitate the learning of mathematics (Maree, 2009; Posthuma, 2012) and mathematical teachers can improve their subject and pedagogical knowledge through reflective processes (Sowder, 2007; York-Barr, Sommers, Ghore, & Montie, 2006). Reflective practices in mathematical teaching is important as it allows teachers to shift their thinking from a teaching focus to a learning focus and observe the mathematical thinking that is required for the given situation (Taylor, 2005).

Research Aims

As part of the ELR process being reported in this paper, the PSTs engaged in a collaborative reflection of their mathematics teaching experience, which centered on affect-based critical moments. In order to help the PSTs to develop an understanding of their emotions and the role their emotions played in influencing both their perceptions of their teaching experience and related teaching confidence, the reflection process required the PSTs to identify critical moments that evoked an emotional response – defined here as *affect*. Critical moments are those moments in teaching that are chosen due a self-determined emotion or affect and provide a basis for discussions in reflective self-evaluation of teaching performance. Integral to the reflection of the critical moment is the emotions the PST associates with that moment; that is *how* they felt while they were teaching and *why* they felt that way. To better understand how the use of affect-based critical moments in the teaching of mathematics can be used to improve PST pedagogical confidence, this paper examines the critical moments being selected by the PSTs in their reflections, and considers the questions:

- Are there common themes among the emotions being identified by the PSTs when engaged in reflective practice of critical moments; and
- How do the use of these critical moments and the ELR reflection process contribute to developing teaching confidence and/or mathematical confidence?

Method

The ELR process involves engaging PSTs in multiple, repeated sessions that focus on learning and planning (enhancement), teaching (lesson), and feedback and reflection (reflection) (Axelsen et al., 2017; Woolcott, Scott, et al., 2017). This paper reports on findings from one of the six regional universities which focused on mathematics teaching; and focusses on the reflection process.

Participants and Data Collection

Data was collected in 2015. Nine PSTs participated in the ELR process. The participants were 2nd, 3rd and 4th year students studying to become middle- or high-school mathematics teachers. The PSTs presented their lessons to Year 9 and 10 students from local high schools attending on-campus sessions, run in both Semester 1 and Semester 2. A total of 25-40 students participated in each session, which included ninety minutes of problem solving time. When teaching the lesson the PSTs were assisted by an expert mentor (a university mathematics lecturer and/or a practicing mathematician).

Critical Moments

The PSTs' teaching lessons were video-recorded and, following a viewing of the recording within one week of the completion of the lesson, the PSTs were required to nominate six affect-based critical moments during which they felt they had experienced a significant emotional response (either positive or negative). Two moments were chosen from the beginning of the lesson, two from the middle and two from the end. The rationale of choosing moments from throughout the lesson was to ensure a range of emotional states were selected as PSTs (and indeed teachers) often experience different emotional states at the beginning of their lesson (e.g. anticipation, anxiety) compared to those they feel at the end of the lesson (e.g. relief, satisfaction, disappointment) (Yeigh et al., 2016).

To reflect on these critical moments and to investigate whether the emotions the PSTs think they display in their identified critical moments are perceived differently by people observing the critical moment, the PSTs were required to re-play the recordings to a group of observers that consisted of their mentors and other PSTs. After watching the six critical moments, each of the observers responded to those moments using an emotional diary (Ritchie et al., 2014; Yeigh et al., 2016) and any emotions that were observed were discussed. The idea of this reflection process and asking observers to respond to identified critical moments was to highlight to the PSTs that, while they may have felt certain emotion while teaching, such as anxiety, this may not have been obvious to observers. By reflecting on their emotions, the idea was to help the PSTs build teaching confidence by accepting their negative emotions, which may occur due to, for example, lack of confidence.

The emotion diary displayed the emotions: excitement/enthusiasm; happiness; enjoyment; pride; anxiety/worry; frustration; disgust/contempt; annoyance/irritation; disappointment; embarrassment; interest; and confidence. There was also an 'other' section to place other emotions, however this wasn't utilized by the PSTs. This protocol was developed to allow PSTs to contemplate and reflect on the emotions they associated with each critical moment (Ritchie et al., 2014; Yeigh et al., 2016).

Observers were required to consider how strongly they felt the PST displayed each emotion during a critical moment, and this was recorded using a 1-5 scale that represented the intensity of the emotion, where 1 was 'not observed' and 5 was 'strongly observed' (OR 'emotion was highly obvious'). The PST whose critical moments were being evaluated (labelled the Teaching PST from here forward) was also asked to use the emotional diary to similarly evaluate how strongly they had felt certain emotions during the critical moment. As part of the group reflection, the emotions observed by the group were then compared to the emotions the Teaching PST had recorded feeling during the critical moment. This discussion was important for highlighting differences between emotions felt and emotions displayed, and for PSTs (both the observing PSTs and the Teaching PST) to reflect on and learn from their emotional responses to the teaching of mathematics.

Post-teaching session audio-recorded debrief

At the conclusion of a full iteration of the ELR process, after all PSTs had taught a lesson and engaged in a reflection of that lesson, the PSTs were asked to individually reflect on their experience in an audio-recorded debrief. During this debrief the PSTs were asked to discuss aspects of the ELR process including: how the ELR process may have impacted on their confidence; how watching a video of the lesson and determining critical moments impacted on their teaching and mathematical confidence; and what they learnt from the process from a pedagogical content knowledge (PCK) perspective. This debrief allowed

PSTs the chance to contribute additional comments on the reflective process without the constraints of following a protocol. The purpose of the debrief was to explore further the role using critical moments can play in developing PST mathematical and teaching confidence, as well as helping the PST develop more positive emotions towards their teaching.

Results and Discussion

The most commonly mentioned emotion by the nine Teaching PSTs across each of their six critical moments was anxiety/worry, a negative emotion. This emotion was mentioned by all of the PSTs in relation to several of the moments they each had chosen. The next most commonly mentioned negative emotion was frustration. The other negative emotions were not widely discussed. With regards to the positive emotions, the most commonly mentioned emotions were excitement and happiness. Again, these were mentioned by all of the Teaching PSTs with regards to at least one of the critical moments they had identified.

When the reflection group was asked to evaluate the critical moments identified by each Teaching PST (using the emotional diaries) the results were quite different. While the Teaching PSTs ranked their negative emotions highly – that is, they felt they displayed high levels of anxiety or worry for example – the other people involved in the reflection process indicated that the Teaching PST had not looked as, for example, anxious as the Teaching PST had perceived. For example for one PST the mean response for the emotion anxiety/worry was 3.20 ($s = 1.47$) however the mean of the observants was 1.96 ($s = 1.07$). This was similar across most PSTs.

For the positive emotions, the opposite occurred: while the Teaching PSTs commonly ranked themselves low in how they felt they had displayed more positive emotions, the others involved in the reflection tended to think the Teaching PST had shown stronger outward displays of that emotion. For example for another PST the mean response for the emotion happiness was 2.50 ($s = 0.55$) however the mean of the observants was 3.95 ($s = 0.32$). This was similar across most PSTs.

The largest difference between observers and Teaching PSTs perceptions was for the emotion anxiety/worry. This indicates that while PSTs might feel a high degree of anxiety while teaching a mathematics lesson, they have learnt to mask those feelings in front of their students. Indeed this is an important skill to possess as a mathematics teacher as it has been shown that teachers who show mathematic anxiety are more likely to make their students feel anxious about maths (Laursen et al., 2016). The reflection process is thus important for helping PST realise they are able to disguise negative emotions, such as anxiety and frustration, and they should also be commended for this ability. It is also an important time for being able to highlight the positive role an outward display of positive emotions can have in helping their students experience mathematics in a positive manner.

Post-teaching session audio-recorded debrief

Several themes emerged from the debrief sessions. The main themes to emerge were:

All PSTs felt the reflection session had contributed positively to how confident they felt when teaching their classroom lesson. As articulated by one PST:

With building my confidence I could see (from the enhancement sessions) that unforeseeable problems are inevitable and that you can still basically have a successful session.

Compared to ‘prac’ placements where reflections regarding teaching experiences often rely on individual self-reflection’ following an experience, the ELR reflection process was

considered a more superior process for the fact that the PSTs had to sit and watch a recording of their teaching and consider the emotions they were experiencing and/or showing. It was therefore an important teaching method for helping the PSTs to consider the role their emotions played while teaching mathematics. As articulated by one PST:

The video component of this process was the best thing; you actually sit back and watch what you are doing. You cannot possibly do that on prac. In prac you are so caught up in the classroom with student's emotions and responses that you don't get a moment to reflect and watch your own teaching.

An important lesson from the ELR reflection process was the realisation that there is a discrepancy between how the PSTs feel and the emotions they display while teaching. This realisation thus contributed to the PSTs feeling more prepared for their classroom teaching experience. As articulated by one PST:

In our heads when we thought we were anxious, we actually didn't come across as that in the video, and more importantly others didn't notice it either.... on prac we don't do this; it is all reflect on how we think we went (instead of actually observing ourselves on video).

From a PCK perspective, the reflection in the ELR process, and in particular the requirement to identify and discuss affect-based critical moments helped the PSTs to identify elements that they may need to focus on or improve. The most common themes related to PCK were:

- The need to obtain student interest by presenting the mathematical problem right at the start of the session. Most of the PSTs were concerned that the students would not engage and consequently the lesson would be a disaster. A few students were anxious about potential non-engagement, however most felt excitement as the students became engaged (PCK: teaching strategies and student thinking).
- PSTs typically identified as a critical moment the time/s when they felt 'caught out' by the mathematics behind the problem being presented, describing the emotions they felt as anxiety (or in some cases panic). For example, one PSTs needed help with converting from square meters to square kilometres. Another ran out of materials 30 minutes ahead of their scheduled time and thus had to 'make up' mathematics on the spot. Such experiences were important for Teaching PSTs to understand what concepts are required in order to teach mathematics more effectively and to develop a deeper understanding of the mathematical knowledge required for teaching (PCK: Content knowledge in a pedagogical context).
- Another moment across the PST teaching experiences that was identified as a critical moment for the anxiety the PSTs felt was when students were not grasping the mathematical concepts or concept of the problem. Understanding the cognitive demands of their students and the appropriateness of questions, particularly in understanding the underlying mathematics and connections in topics, is a very important skill for mathematics teachers (PCK: cognitive demands of a task and appropriate representations).
- From a positive emotion perspective, the most common theme for positive emotions was when students were connecting the problem. PSTs discussed feeling excitement and happiness when their students demonstrated understanding or interest in the problem, or when they became involved in animated group discussions. For the PSTs this is important as it allows them to gain an appreciation of students' ways of thinking about certain concepts and the levels of their understanding (PCK: Student thinking).

Conclusion

The ELR teaching method was trialled across six regional Australian universities. This paper reported on some of the results of one university's 2015 reflective iteration of the program.

With regards to the research questions explored in this paper, it was shown that there are common emotions PSTs associate with teaching mathematics; the strongest of these being anxiety. Importantly however, the study showed that while the PSTs felt anxiety or felt they displayed anxiety while teaching a mathematics lesson, other people (i.e. other PSTs and their mentors) observing were less likely to observe displays of anxiety. Here the use of critical moments and engaging with video recordings in reflective practice is important for helping to demonstrate to PSTs that while they may feel certain negative emotions and indeed feel they are displaying those emotions, often those feelings are being professionally and well contained. This intervention therefore helps PSTs to build a certain level of confidence for the realisation that their teaching 'performances' are often better than they perceived. Arguably, individual self-reflection following a teaching session, without the use of critical moment analysis, group reflection and the ability to re-view video recordings of one's teaching does not allow such detailed examination of emotions and the role these play in teaching confidence. Particularly in areas such as mathematics, the development of positive emotions related to teaching content are integral to helping address those problems related to teaching confidence in this subject area.

Even though the paper presents a snapshot of the emotions displayed during the reflective process from one iteration of the ELR process at one university, similar results have been reported from the other five universities. This thus indicates that from the ELR process the PSTs are able to learn how to use their affective states to assess their own emotions (Woolcott, Scott, et al., 2017; Woolcott, Whannell, et al., 2017). While the results are not generalizable and there are limitations with the sample size and scope in the data, the purpose of this paper was to show the effectiveness of the reflective phase of the ELR process in helping PSTs to improve their confidence in mathematical teaching and to learn from the process to help PSTs in the future.

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