

Paper Title: **Putting principles into Action: Improving Pre-Service Teachers' Mathematics Teaching through an Innovative Affect-based Reflection**

Author(s): **Geoff Woolcott**

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Putting principles into Action: Improving Pre-Service Teachers' Mathematics Teaching through an Innovative Affect-based Reflection

Geoff Woolcott

Southern Cross University, Lismore, Australia

geoff.woolcott@scu.edu.au

Abstract: This proposal outlines a successful innovation in reflective practice within a multi-university project conducted across regional eastern Australia, *It's part of my life: Engaging university and community to enhance science and mathematics education* (itspartofmylife.scu.edu.au/). The reflection forms part of an iterated sequence of enhancement-lesson-reflection (ELR) and the innovation is built around a protocol based on affect-based critical moments in teaching. These moments are related to positive or negative emotions experienced during teaching, which the PSTs select and examine, with peers and experts, in the reflection sessions. These moments become a focus for improvements in teaching through aligning PST pedagogy with the mathematical thinking that occurs in authentic, real-world contexts and through questioning and problem-solving as a basis for student-centered learning.

Objectives or purposes

This paper describes results from the first of three phases of the project with an overall aim of improving pre-service teacher (PST) confidence and competence in teaching STEM subjects (Woolcott, 2015). The project is innovative in utilizing a novel protocol for identifying and analyzing critical moments based on positive or negative affect (Woolcott & Yeigh, 2015). An iterated sequence of enhancement-lesson-reflection (ELR) enabled PSTs to prepare lessons using expert advice, deliver those lessons and then use reflection based on emotional states as a non-judgmental way of reflecting on lesson content and pedagogy. The paper highlights the qualitative analysis of the largely positive PST responses to the reflection and a critical moment protocol based on affect.

Perspective(s) or theoretical framework

In Australia, as elsewhere, there has been a steady reduction in the number of students who are studying STEM subjects at school or in tertiary education (Chubb et al., 2012; Holdren & Lander, 2012). There is specifically a shortage of appropriately qualified STEM teachers, particularly in Australian rural schools (Ainley et al., 2008). *It's part of my life* focuses on PST education in regional/remote Australia, where courses may be tailored to either partial or exclusive online delivery. The project directs discussion to rural/regional concerns, not only as a way of engaging PSTs and school students, but also the STEM researchers at regional universities who often build their global profiles through examining regional problems (Woolcott, 2015). The project goals consider

specifically mathematical thinking (e.g., Niss & Højgaard, 2011), with attention to lesson delivery that is transferrable across content areas.

The project uses a design research approach (Rowell et al., 2015) employing iterations of the ELR sequence. These are enacted by having PSTs work in groups to develop pedagogical contexts and scenarios, guided by expert mathematicians and pedagogy mentors, in a form of lesson study (Groves et al., 2013) to construct and optimize interdependent and collaborative scenario-based lessons that utilize local community contexts to increase the meaning of the lessons (e.g., see Woolcott, 2015; Woolcott & Yeigh, 2015). The iterations allows for a change, at the end of each iteration, such that the new ELR sequence may have a slightly different take on the use of the project goals and strategies, depending on past experiences and current collaborators.

The use of critical incidents or moments has also become important in the development of reflective practices of teachers as well as in pre-service teacher education (Griffin, 2003). In general, however, critical moments are necessarily judgmental and, in pre-service practicum in particular, subject to differences in subjective evaluations of both competence and confidence (Huntly, 2011). Pre-service teaching can be an emotional experience and this paper takes a direction more in line with Tripp (2012) that the emotional content of critical incidents requires careful consideration. With this in mind the critical moment protocol developed within the project utilizes research that relates confidence and competence to how a PST may feel when teaching (Ritchie et al., 2014) and the protocol, therefore, facilitates PSTs considering and reporting on their emotions. Emotional literacy and emotional regulation in this study, therefore, are aspects of self-reflective professional development for PSTs and these are conceptually related to improving their competence and confidence in teaching mathematics.

Research Questions

There are a number of research questions being considered within the broader project, but the key research question reported here is related to PST responses to the reflection and critical moment protocol.

What was the PST response to reflection based on the critical moment protocol?

Methods, techniques, or modes of inquiry

The project overall employs a mixed methods approach (Creswell, 2011), but for the qualitative analysis reported here, video transcripts and written responses of participants were first coded and scored using constant comparative analysis, then coded to nodes using the qualitative data analysis software NVivo (Version 10). The nodes were then cross-coded with categories of meaning significant to research questions. The participant perspectives within these nodes were then examined in terms of the relevant research questions.

Separate trials were conducted across several partner universities with volunteer team comprising 2-6 PSTs and 2-4 university educators and mathematics researchers, as well as schoolteachers and their classroom students. All trials were conducted under

appropriate ethical guidelines and with informed consent, and each trial was preceded by a training session that explained the trial process and rationale (see Woolcott & Yeigh, 2015)

Data sources or evidence

The ELR process: After receiving a lesson topic, PSTs had a 60 minute face-to-face discussion with the researchers and educators on themes including: scientific thinking; local/regional (everyday) issues around the lesson topic; transferable teaching skills; student-centered learning; and, locating appropriate scientific information. The specialist educators then assisted the teaching PST in further lesson preparation in a second 60 minute discussion. One PST delivered the planned lesson, while the remaining PSTs and the specialist educators observed the lesson.

Critical moments were selected from video by the teaching PST, as times during their lessons where they felt strong positive or negative emotions. These moments were then analyzed using an emotion diary (Ritchie et al., 2014) completed by: selecting appropriate affect icons to represent the teaching PST's emotions during critical moments; rating the intensity of the emotion; and, writing open-ended comments about the selected emotions. Discussion centered around affective identifications in terms of such elements as: the teaching PST actions; the classroom activity; and, the subject of the emotion.

Results and/or Conclusions

The analysis indicates that affect-based critical moment analysis may serve as a powerful tool for development of classroom teaching practices. It is through such an innovation and adaptations of it that PSTs, and classroom teachers, may gain confidence and competence without intensive resourcing while, at the same time, engage in self- or peer-guided reflection based on emotions experienced while teaching. The comments sampled here serve as a summary of a very large data set and will be elaborated in the presentation. The quantitative data is reported elsewhere, but supports a positive evaluation of the innovation and its use in changing PST motivations and behaviors.

PSTs and the reflection

The PSTs reported that the reflection 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 critical moment protocol, with its non-threatening self-evaluation, served as an excellent focus for students in the group reflection: “...*it was good to get multiple perspectives on my teaching and to be able to watch myself back and see that even when I was feeling a negative emotion it wasn't always visible to people observing me.*” PSTs also reported positively on the focus on emotional moments, with one student listing the following as the most interesting parts of the reflection: “...*reflecting on emotions rather than practice, assessing student*

emotions instead of performance based assessment, assessing key emotional moments that others are possibly unaware of...”.

Educational or Scientific Importance

This initial qualitative report, and other project reports on science teaching (Woolcott, 2015) indicates that affect-based critical moments can be a powerful tool for emotional and behavioral change if successfully applied in regional contexts that include students who are from rural and peri-urban Australia. Trials also suggest that this protocol is inclusive and that engenders high levels of engagement through a focus that supports regional issues and the mathematical thinking of everyday life.

The continued success of these and similar trials has encouraged consideration of the protocol, within the ELR iterations, as having the potential for a two-way effect in building PST confidence in the mathematics that is ‘out there’ in the real world and in giving participants an appreciation of high-engagement teaching methodologies and strategies. 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 mathematical thinking that they use every day. The developing project is having a flow-on effect and its broader development may serve to revitalize pre-service teacher education and current teaching practices in regional Australia.

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