

Variations on a Theme: Pre-service Mathematics Teacher Reflections Using an Affect-based Critical Moment Protocol

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Examining critical incidents in the mathematics classroom is a useful way for pre-service teachers to understand the experience of teaching. This paper examines the development and trialling of variations of a novel affect-based critical moment protocol that enables pre-service mathematics teachers to reflect on their teaching performance. The emotions experienced in these moments were examined using self and group reflection, considering the thoughts and actions occurring immediately prior to, or during those moments. The four case studies presented report on trialled variations of this reflection process in a range of programs and delivery modes in four regional Australian universities.

Teacher performance is generally assessed by observation of classroom practice. In initial teacher education (ITE) programs, such observations are traditionally made by a mentor classroom teacher during practicum. There is a multitude of processes and literature around the practicum experience and an expansion in the range of strategies designed to improve teaching performance, including group or team reflection strategies (Woolcott et al., 2017). Studies of critical incidents (events) and/or critical moments, which include reflective pedagogical analysis and interpretation, provide an important way of determining the aspects of a lesson to examine and improve teaching performance (Tripp, 2011; Yeigh et al., 2016).

Critical incidents and critical moments, often treated or identified separately, have become important, in developing the reflective practices of teachers and in ITE (Griffin, 2003). Studies focussing on critical moments have included emotion and/or affect of pre-service teachers (PSTs) (Yeigh et al., 2016), and detailed measures of teachers' emotional states at particular times in a classroom (Tobin & Richie, 2012), but both critical incidents and critical moments are largely determined through observation of teaching as it is related to student learning. The lack of reliability and validity of findings from observational studies is widely reported (Madigan & Ryan, 2011) and critical incident or critical moment protocols do not escape this uncertainty. They are necessarily judgmental and, in pre-service practicum their effectiveness may be constrained by subjective differences in evaluations of both competence and confidence by an observer (Huntly, 2011).

Practicum can be an emotional experience and the emotional content of critical incidents or moments requires careful consideration. The critical moment protocol discussed in this article deals with self-determined emotion or affect as an important discussion point for reflective self-evaluation of teaching performance. The innovative

protocol presented here was developed in a project investigating how to increase the perceived teaching competence and confidence of mathematics and science PSTs. The protocol builds on teaching performance being linked to how an individual feels at particular moments during teaching (Ritchie et al., 2014). The protocol includes affect-based critical moment analysis as part of the PST learning experience, sometimes, but not always, referring back to incidents or thinking processes immediately prior.

Background

Critical incident analysis in the classroom began in the late 1980s, and was used as a focus for reflective practice, for example in the case of a behavioural incident (e.g., spitting in class, see Tripp, 2011). Meyer and Land (2005) extended the conceptualisation of critical incidents to include those when threshold concepts are understood, that is, when previously inaccessible ideas are understood which lead to “significant shifts in perception of a subject” (p. 373). This concept extension embraces ‘teachable moments’, when either a misconception has been observed or a desire to know has been sparked in the students providing a teaching opportunity (Patahuddin & Lowrie, 2015) to develop deeper conceptual understanding (Griffin & Ward, 2015). Woods (2012) proposed that, as a critical incident is unplanned and unanticipated there is a higher potential for impact on the affective/emotional state. Recent developments have broadened the conceptualisation as critical moments are not distinguished primarily on the basis of an event or incident and can be used to exam learning in a range of different contexts (Woolcott et al., 2017). In ITE, for example, PSTs can use critical moment analysis to improve their classroom performance while on practicum.

This report uses the term ‘affect-based critical moments’ to distinguish lesson performance foci from the event-based critical incidents discussed above. The protocol was developed as a part of a broader project, *It’s part of my life: Engaging university and community to enhance science and mathematics education* (IPOML), undertaken across the Regional Universities Network (RUN) (Woolcott et al., 2017). The project developed around a model derived from teacher education processes related to a collaboration nexus, previously described for Australian contexts (Gahan et al., 2011). The Enhancement-Lesson-Reflection (ELR) process (Figure 1a) was designed and trialled to develop the perceived competence and confidence of PSTs to engage with and inspire classroom science and mathematics learners. The ELR process shows PSTs how to use science and mathematics to solve problems in their local region through collaborations with university and community experts. Ideally, the ELR process is iterated (Figure 1b) and 1, 2, 3 and 5 cycle iterations have been documented.

Initially the critical moment protocol was used in face-to-face reflection sessions, but this article aims to examine trialled variations of this reflection process adapted to a range of programs and delivery modes across the RUN universities. This protocol is supported in most cases by peer observers and university educators through engagement in collaborative group reflection following self-reflection on selected positive and negative critical moments. The reflection has an added dimension in being structured around lesson study.

The critical moment protocol

Each teaching PST was asked to identify, from the video of their lesson, a number of critical moments, representing an important (positive or negative) emotional feeling or experience. In initial trials, PSTs identified two critical moments, generally less than two

minutes in duration, for each third of the lesson and recorded their perception of the start and end time for each moment. Later trials used variations adapted to their teaching contexts depending on whether PSTs were: attending a face-to-face session at a university campus with university educators and mathematicians; teaching classroom students, large school groups at a university campus or peers in a university class; and/or, undertaking a group reflection either face-to-face or online (Table 1). An emotion diary (Ritchie et al., 2014, Yeigh et al., 2016), such as seen in Figure 1c, was used by both the teaching and observing PSTs to explore experienced or observed emotions from the lesson. An individual may feel different emotions at different times while teaching mathematics/science and this protocol allows PSTs to consider and reflect on the emotions they associated with each critical moment.

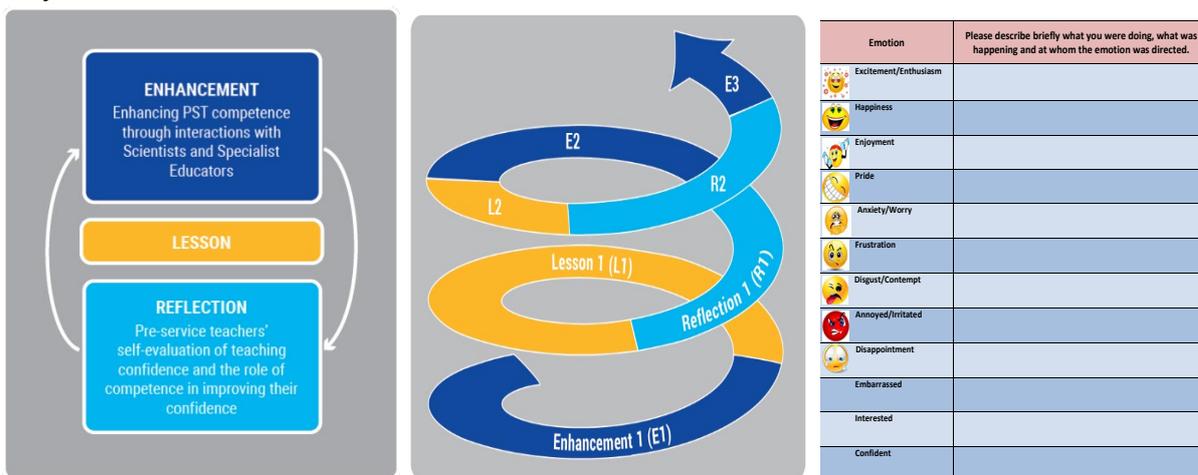


Figure 1. a. The Enhancement-Lesson-Reflection (ELR) process. b. The iterative path of the ELR process. c. The initial emotion diary with emotions; Excitement/Enthusiasm, Happiness, Enjoyment, Pride, Anxiety/Worry, Frustration, Disgust/Contempt, Annoyed/Irritated, Disappointed, Embarrassment, Interested and Confident

The teaching PST then engaged in a reflection, ideally as a group discussion guided by university educators, concerning what the teaching PST was doing or thinking just prior to and during each critical moment. The reflection discussion is structured around the following questions:

1. What happened that made you see this as a critical moment? What were you doing or thinking just before this moment?
2. What was the main emotion you felt at the time? How strongly was it felt?
3. (If reflecting with others) What did others think about your emotion? Was it the same as your view?
4. What would you do if you had an opportunity to recreate that moment in future lessons?

This served to focus how a PST could utilise or maintain positive, or perhaps change negative, emotions during future lessons. This paper examines the critical moments being selected by the PSTs and their reflections to determine: *How engaging with variations of the critical moment protocol can facilitate change in PSTs' confidence and competence when teaching mathematics;* and, *How protocol variations can be successfully adapted to a range of ITE contexts.*

The Study

A mixed methods approach involving four embedded case studies is reported. Cases were purposefully selected based on their focus on mathematics teaching, but present a diversity of characteristics with respect to mode of delivery, program variation (including number of iterations of the process), geographic distribution, size of PST and school student cohorts involved, and availability of mathematics experts. The variation between cases provided an opportunity to compare the effect of the protocol and better understand its deployment across this diversity and the associated variation in protocol implementation. The case studies and participants are summarised in Table 1.

Table 1

Reflection process variations reported in this study in Cases 1 through 4

Trial delivery context	Reflection participants	Reflection process variation
Case 1: Reflection on campus, on lessons delivered at a school (Year 6)	Four PSTs from a BEd-Primary and three university educators	Self and group reflection face-to-face with university educators, ELR with 3 iterations
Case 2: Reflection on campus within university tutorials, on presentation of conference posters by two PSTS	A class (40 students) of one-year Grad Dip of Education (Primary) and one university educator	Class reflection face-to-face with university educator, assignment submission including a written self-reflection, ELR with 2 iterations
Case 3: Reflection during a series of community events every 3 weeks at a university campus (25-40 Year 9 and 10 students from 15 schools), PST delivered lesson face-to-face and online as part of ELR	Five secondary PSTs and up to six university educators	Face-to-face reflection with PSTs outside of event at university campus, ELR with 5 iterations
Case 4: ELR online (asynchronous and synchronous), instruction embedded into the university Learning Management System for an assessment task built around the reflection	A class of PSTs (secondary mathematics) and one university educator	Self-reflection assignment supported by a video of the lesson and PST recollection of experiences during teaching, 1 iteration

Data collection and participants

Data from the four separate cases outlined in Table 1 were collected from June 2013 to December 2016. In each case the entire ELR process involved either a group of up to six PSTs or a larger tutorial group, up to three university educators, and/or up to two university mathematicians, who collaborated to help develop mathematics lessons, poster presentations or workshops delivered by the PSTs. In Case 4, PSTs worked in partnership with community mathematics experts. Reflections were assisted by the educators, either in face-to-face, blended or online (synchronous and asynchronous) learning environments, and/or assessed as an assignment within the university education curriculum.

Data collected included video transcripts of the reflection sessions, as well as transcribed or written responses of participants in semi-structured interviews, recorded after each lesson, as well as prior to or after a reflection session. The semi-structured interviews allowed for flexible exploration of emerging themes as interviews unfolded. Data were also available in the written responses made on forms included in the protocol resourcing.

Data analysis

Data were first coded and scored using constant comparative analysis and then coded to nodes using the qualitative data analysis software NVivo Version 10 (QSR International). The nodes were then cross-coded with categories of meaning significant to emergent themes. The researchers responsible for implementation in each case provided an overall summary of each case that was also used to identify key themes, identify process changes over time and to clarify similarities and differences in implementation.

Results and discussion

This section discusses how, for each case study, PST confidence and perceived competence was supported using the affective based critical moment protocol.

The effect of common protocol components

All PSTs reported increased confidence and competence following collaboration and/or self-reflection—no negative feedback was reported. Interestingly, PSTs reported increased confidence when others did not notice their negative emotional states, since this meant that any lack of confidence felt by them was not noticed by observers (and, therefore, not something the PST should worry about). One PST went further in noting:

... the fact that our peers don't really notice when a student teacher has a negative critical moment can be flipped. I have been able to spot that 'glazed' look on students' faces when they don't understand a concept being taught, which is particularly useful when they do not vocalise their lack of understanding. (PST)

Another typical comment, supported by Tripp (2011), was that no one had previously asked the PSTs how they felt during their teaching, even though it was a very emotional time. This comment echoes the stress of the practicum experience, a stress that perhaps observing teachers and university educators do not always acknowledge:

The opportunity to have a peer observation and reflection program in a real classroom setting allowed us to allay our fears and stresses with our peers and university educators as observing mentors. That our feelings were acknowledged helped to build our confidence. On prac, the mentor never actually asked 'How do you feel?' (PST)

The protocol allowed PSTs to play a stronger role than when observer reports are used for reflection, as PSTs facilitate their own self-judgement and self-determination. The focus on short self-identified elements was the subject of a comment in Case 2—the PST identified a negative moment as after students misunderstood a teaching instruction, or positive moment as when students presenting in classroom feedback were able to demonstrate to the class an understanding of the intent of the curriculum point:

The reflection process provides a very effective structure that encourages reflecting carefully on smaller sections of their lesson rather than retelling the whole experience which can often not lead to significant improvements. By looking at small sections of the

lesson, this method is non-threatening and appears to lead to much more specific discussion and then improvements. (Educator)

The commonality of process was evident in comments from the workshops in Case 3, where PSTs conducted mathematical modelling enrichment classes (Axelsen et al., 2017) with school students, but with separate enhancement and reflection sessions. An emerging theme was the support that such a collaborative reflection provided—support lacking in practicum contexts, but common to all variations reported here:

Compared to going on pracs, in this program there is much more of a review process and you can have that enhancement and for me that was really important. For me it confronted me and made me change my teaching track and that was because I had the opportunity to sit back and look at how I had gone. Because in prac there is none of that; there is no review—it is more about ticking the boxes. (PST)

While reflection variations that included iterations provided feedback mechanisms that led to improved confidence and competence, PSTs using the single iteration seen in the assignment of Case 4 appear to have gained some benefit also:

The reflection process has shown me just how much I can learn from videoing myself teaching a lesson, watching it and reflecting on it. Whilst I was aware of the benefits of reflection as determined by lecturers and texts, I had not yet actively engaged in ‘watching myself teach’. This process allowed me to critically reflect upon everything from my body language to the way I explained difficult concepts and thus learn how to better myself as a teacher. In the future, I will aim to consistently reflect upon my teaching, videoing lessons and gaining feedback from students when possible, so that I can continue to learn from my mistakes and recreate my successes. (PST)

PSTs believed the protocol assisted them develop their ongoing mathematics teaching:

In terms of lesson plan reflections, it is easy to see that although other pre-service students may have not noticed anything wrong, in some cases a mentor will have noticed such things. Importantly, the ability to take constructive criticism is easier when a student teacher already has an idea of what might have not been working. This is a kind of preparedness for critical feedback. Again on my 2nd practicum, where I at least feel a lot more is expected of me and my mentor has certainly expected a lot, the experience of emotion diaries (the video reflection as a whole) has allowed me to cope better with this experience. (PST)

Most importantly, the protocol enabled PSTs to also consider emotion, including those of their students, as an indicator of teaching effectiveness. For example, in response to the question, “What aspects of the trial did you find most interesting?” posed after a lesson, one PST said:

Reflecting on emotions rather than practice, assessing student emotions instead of performance based assessment, assessing key emotional moments that others are possibly unaware of (PST)

The effect of protocol variations

The ELR protocol as initially trialled in Case 1 (Figures 1a and 1b) became ‘variations on a theme’, as the ELR process and the critical moment reflection protocol, was adapted in other ITE programs. Case 1 may be seen as an ideal way to improve confidence and competence in PSTs in practicum, although it would be time and resource consuming unless it was adapted more directly to on-site utilisation with enhancement and reflection sitting alongside lesson delivery (see Woolcott et al., 2017).

In Case 2, the effect was similar, but in an adaptation to a university tutorial class, rather than a school class. The enhancement occurred with mathematicians in lectures and the educator modelled the critical emotion reflection process using two critical moments from a previous lecture—one positive, one negative—and invited the pre-service teachers to reflect on them with her. After poster presentations, two PSTs taught lessons to their peers based on their posters. PSTs then identified critical moments from the video recording, followed by a group rating of these critical moments and group reflection and discussion.

The experience changed their way of thinking. It opened their eyes that maths isn't so prescriptive. They complained that the emphasis was on thinking—so it pushed them. It changed their mindset. (Educator)

Case 3 illustrates the ELR reflection protocol in a workshop context, a context that may easily be adapted to professional learning experiences (Woolcott et al., 2017). The educator facilitated the reflection process where PSTs, an educator and mathematician reflected after a workshop and then discussed the plan for the next workshop. The lesson and reflections session was repeated every three weeks for five iterations. All PSTs taught a lesson. The iterative process helped reduce PSTs' nervousness with regard to teaching mathematical modelling with its open-ended nature of inquiry:

I had been pretty nervous dealing with the unknowns but coming in today on the back of the other sessions, it's not going to be that difficult. (PST)

The Enhancement–Lesson–Reflection process taught me a lot about trying to get the kids more engaged. It helped me to focus on the maths side of things rather than focusing (too much) on the modelling process. It taught me to try to get the kids engaged without giving them too much. It taught me to make it (the problem) real life with lots of variables and to facilitate rather than telling them (the students) how to do it. It really taught me to change the way I teach. (PST)

In contrast, Case 4 successfully adapted the critical moment protocol to teaching PSTs studying online. The reflection phase required self-reflection on three critical moments for short lesson segments taught to peers (family and friends in most cases). The self-reflection was completed as an assignment supported by viewing a video of the lesson. Students who fully engaged in this task reported that it was demanding, but beneficial:

The final assessment task was very challenging, however provided an excellent opportunity for reflection and skill development. (PST)

Conclusion

Findings from these variations support the use of the critical moment protocol in examining the impact of emotions on thinking and behaviour in the PSTs' classroom teaching experience. PSTs learnt how to identify and analyse their teaching-related affective states in order to assess their own emotions and to understand the relationship between emotional literacy and effective pedagogy (Woolcott et al., 2017; Yeigh et al., 2016). Many PSTs valued reflecting with a video of their lesson. The educator emphasised the importance of using critical moments, *small sections of the lesson*, rather than the whole lesson, since this led to more focussed discussions in the reflection sessions so that PSTs could identify specific aspects for improving their teaching. PSTs also acknowledged that the collaborative nature of the ELR sessions improved their confidence and competence.

The study emphasises the importance of reflective analysis of affect for teacher performance, and thus links the affective protocol to increasing competence through

increased pedagogical confidence. The critical moment protocol appears to be a method that can be embraced easily by PSTs, and potentially by teachers to support a reflective process for improving teaching and learning, and which appears to be relatively non-judgmental, being essentially a self-regulatory process.

Ensuring those who facilitate reflection and affective analysis are skilled in guiding PSTs in the exploration of their experiences, while also considering the perspectives of peers and pedagogical mentors, appears essential. Overall, these findings indicate that it is important for PSTs to better connect emotional awareness to their teaching goals, as an aspect of pedagogical confidence and competence. These findings appear to be consistent across all the variations of the protocol supporting its adaptability, although additional research and trialling is needed to determine long-term effectiveness of the process.

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