"Change my Thinking Patterns towards Maths": A Bibliotherapy Workshop for Pre-service Teachers' Mathematics Anxiety

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In small-group workshops, a joint initiative of the researcher and the student counsellor, primary (elementary) pre-service teachers (PSTs) wrote about critical incidents in their mathematics learning, and shared them with the group. Then, PSTs read extracts about mathematics anxiety (maths anxiety), and wrote and shared their reflections (bibliotherapy). Their experiences illuminated factors in their maths anxiety and helped them identify alternative conceptions. The discussion highlights the need for teacher educators' awareness of perspectives of PSTs, verbalisation and sharing of emotions, and includes recommendations for further research.

This research recognises the importance of emotion as a determining factor in learning. Emotion disrupts cognitive processes. However, emotional confrontations also offer learning opportunities. Emotional responses are not determined by objective reality but by *interpretation* of events - by subjective reality - and people make decisions based on their emotions.

This paper examines factors contributing to primary (elementary) pre-service teachers' (PSTs') mathematics anxiety (maths anxiety). This study investigated PSTs' images of themselves as learners of mathematics, through a small-group bibliotherapy workshop, This built on previous research where PSTs recalled critical incidents in their mathematics learning, read about maths anxiety and reflected on, and perceive their situations differently (Wilson & Thornton, 2008). The design of the workshop aimed to bring together two fields of expertise – mathematics education and counselling – in a collaborative process that would allow better outcomes for participants.

The process of verbalisation and writing can be used to reflect on PSTs' actions and decisions, and offers an opportunity for them to analyse their past actions and emotions. This paper is part of a larger project investigating the use of bibliotherapy to address PSTs' maths anxiety (Wilson, 2012). The research aims to lead PSTs to change their perceptions and re-evaluate their potential. This affects not only their current study but also their future teaching of mathematics and their students.

Theoretical framework

The study aimed to access the narrative or storied nature of PSTs' experiences. Narratives are important for meaning construction (Ricouer, 1985). Bandura's socio-cognitive (1986) theory linked emotion to cognitive and motivational processes in the learning process and stimulated research on emotions.

The structural model of emotion, called the 'transactional model of emotion' (Lazarus, 1991) links motivational, social and cognitive dimensions, and suggests that emotions are based on the person's cognitive assessment of the situation and the meaning they assign to it (called an 'appraisal pattern'). According to Lazarus (1991), a lived experience consists of contextual and personal factors, and the appraisal of these determines whether the event is primarily harmful or threatening (the emotion will be negative), or challenging or

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beneficial (positive emotions). At the secondary level of evaluation, the person assesses the likely future outcomes, and their coping strategies. Lazarus' model divides coping strategies into either emotion-focused (perception that nothing can be done to modify a threatening or challenging event) or problem-focused (the person appraises the situation as able to be changed and takes direct action).

Background and literature review

Engaging successfully in the modern technological society requires a command of mathematics. Hence, failing to engage with mathematics has social, economic and political implications. This research is located within a context of falling levels of participation in physical science and mathematics courses in Australian schools, and underrepresentation of low SES students in higher education. Wilson, Lyons, and Quinn (2013) discuss factors involved in falling enrolments. In addition, international studies such as the Programme of International Student Assessment (PISA), have reported falling levels of mathematical and scientific literacy in Australian students (Thomson, De Bortoli, Nicholas, Hilman, & Buckley, 2011).

Two main bodies of research informed this study. The first concerns maths anxiety in PSTs and the second reflective thinking in teacher education, using critical incident technique and bibliotherapy.

Maths anxiety

Anxiety towards mathematics has been widely publicised as an issue internationally. Many students suffer from maths anxiety and this may be independent of whether they are good at mathematics, for example, Breen, (1991), working with successful mathematics students stressed "… the way in which the past is so easily and frighteningly recalled by students, even when these memories go back to the early years' of schooling" (p. 33). Maths anxiety is more than just a dislike of mathematics. It refers to feelings of tension and fear that interfere with solving mathematical situations in school and in everyday life. It is a complex phenomenon, involving physiological symptoms negative thoughts, avoidance behaviours, and poor cognitive performance. Children as young as those in first grade show maths anxiety (Vukovic, Keiffer, Bailey, & Harari, 2013). Students with maths anxiety participate less in mathematics classes, demonstrate lower performance, and avoid maths in high school and university courses. Hence, high maths anxiety impacts on performance and achievement in mathematics (Sheffield & Hunt, 2006; Stubblefield 2006).

Many primary or early childhood PSTs have anxiety about mathematics and see themselves as unable to learn effectively. Many students come to tertiary teacher education with limited mathematics understandings, and a pattern of alienation, avoidance and anxiety. "Impoverished school mathematics experiences have left many pre-service teachers with strong *negative* affective responses about mathematics" (Namukasa, Gadanidis, & Cordy, 2009, pp. 46-47). Primary PSTs' maths anxiety has important impacts on their studies and on their future students.

Reflection and pre-service teacher education

Bibliotherapy is a technique that was developed in psychology (Shrodes, 1950), and library science. It involves guided reading of written materials used in gaining understanding or solving problems, followed by individual or group discussion in a non-

threatening environment. Reflective writing is important in teacher education. In the bibliotherapy phase of the study, PSTs' reflections and discussions were stimulated by selected readings on mathematics anxiety. Narratives are important for meaning construction (Ricouer, 1985). PSTs' current experiences are filtered through their perceptions, reinforcing their attitudes. Reflective thinking is important for professional practice to identify the assumptions that underlie thoughts and actions.

Researchers have used mathematical autobiographies to encourage PSTs to reflect on the origins of their anxiety (Baroody & Coslick, 1998). Ellsworth and Buss (2000) identified five themes which included the powerful effect of teachers and three facets of the ways mathematics was presented (relevance, comprehension, and emphasis on skills and memorisation); and Sliva and Roddick (2001) found that almost all students mentioned the role of the teacher. Also, many described a trend of fear and failure, followed by avoidance, in their mathematics experiences.

Critical incident technique (CIT) is a well proven qualitative research approach that offers a practical step-by-step approach to collecting and analysing information about human activities and their significance to the people involved. It is capable of yielding rich, contextualized data that reflect real-life experiences (Hughes, Williamson, & Lloyd, 2007). Advantages of using critical incidents come from their focus on observable behaviours (Pedersen, 1995) and participants' lived experience. They allow for the experiences to be represented in rich and vivid ways. "The critical incident technique is intended for qualitative and subjective descriptions of people, the situations they encounter, and participants' interpretations of their experiences" (Brookfield, 1995, p. 3).

Researchers have used CIT with PSTs in a range of contexts. For example, McAllister et al. (2006) analysed critical incidents reported by education and health students undertaking fieldwork. Goodell (2006) asked PSTs to identify critical incidents during a field placement course). A 'critical incident' is an incident that the PST selects and defines as having had an impact (Hughes, Whiteford, Hill, Thomas, & Fitzgerald, 2007).

The critical incident may not have happened as they remembered. It is not important to establish if the interpretation is correct, as the way a person perceives an event is real in its consequences. Our emotional responses are not determined by objective reality, but by our interpretation of events – by our subjective reality. Like all data, critical incidents are created. Incidents happen, but critical incidents are produced by the way we look at a situation: a critical incident is an interpretation of the significance of an event (Tripp, 1993).

The aim of asking the PSTs to write a critical incident reflection is to help them reflect on their perception of that event, its impact on their construction of what it means to learn mathematics, and on themselves as a learner of mathematics, and how these perceptions have been reinforced by the experiences that followed.

In the traditional, binary (positive/negative) analysis of critical incidents using Lazarus' model, when critical incidents are perceived as a threat, the outcome can be a lack of action, leading to the emotion-focused coping strategy of minimisation. The individual feels inadequate, blames herself and anticipates negative consequences. Anxiety dominates the emotions, increasing the level of discomfort, which is resolved by avoiding the situation. If the appraisals are predominantly positive or negative, an alternative method to binary analysis, is to undertake a thematic analysis.

The purpose of the study described in this article was to illuminate key factors in the development of mathematics anxiety through exploring the experiences of PSTs, in order to address the research questions:

1. How do PSTs describe their mathematics experiences?
2. What influenced the way PSTs think about themselves as learners and potential teachers of mathematics?
3. What do PSTs identify as causes of their mathematics anxiety?

Methodology

Given the complex nature of the phenomenon, a qualitative approach was appropriate. The methodology is in the interpretive tradition characterised by prioritising of lived experiences, with a focus on meaning of interactions and events. People create and associate their own meanings of their interactions with the world. In this methodology the researcher attempts to understand a phenomenon by accessing the meaning that the participants give to it. An interpretive approach seeks to gain insights into lived experience from point of view of subject, and thus present the researchers' own constructions as well as those of participants (Walsham, 1995).

A two-hour workshop with six participants and two facilitators was carried out in a community room with comfortable furniture, and refreshments provided. The workshop included time for writing. The participants were second year primary PSTs (one male, five females) studying Bachelor of Education (Primary) degree courses, at an Australian university. Data were collected from the perspectives of the participants, using their own words, by asking them to identify and discuss critical incidents and then exploring further through reflecting on readings (bibliotherapy). The reflections aimed to access the narrative or storied nature of PSTs' experiences. They recorded participants' feelings and perceptions, and identified outcomes such as changes in their behaviour.

Procedure

Ethics approval, based on accepted informed consent procedures, was received from the university's ethics committee. PSTs who agreed to participate in the study completed the Positive and Negative Affect Schedule (PANAS) before and after the workshop. The PANAS, (Watson, Clark, & Tellegen, 1988), distinguishes affect. It is a tool that gives a snapshot summary of positive and negative affect at the time, by asking participants to rate each of ten positive and ten negative affect terms out of five. Results are summed, and a higher summed score indicates higher levels of positive or negative affect. The results from the pre and post workshop PANAS were used as an indication of the immediate impact of the workshop on positive and negative affect.

PSTs were asked to write a description of a critical incident (positive or negative) from their own school mathematics education, that was significant for them, and that impacted on the way they thought about themselves as learners and future teachers of mathematics; and encouraged to share as much as they decided with the group. This was followed by bibliotherapy, in the form of written reflections and discussions on a reading about maths anxiety (Dossel, 1993). The aim of this writing was to reflect on their perception of the reading and their own experiences.

Data analysis

Written PSTs' descriptions of feelings, expectations and concerns as experienced during the critical incident experiences, and reflections on the readings and transcriptions of subsequent discussions, were used to identify the basis of the PSTs' anxiety. Instead of the traditional binary analysis of positive or negative experiences, thematic analysis was chosen as the PSTs had self-identified as anxious about mathematics. PSTs' narratives and vignettes reflect real experiences. Female pseudonyms were used to protect participants' privacy. As the sample was small, average results of the PANAS at the beginning and end of the workshop were calculated, to show whether positive and negative affect increased or decreased during the workshop.

Results and discussion

The results section reflects the structure and logic of the workshop, and reports the results of the CIT, bibliotherapy and the PANAS. In the analysis of the critical incidents, themes consistent with the themes from mathematics autobiographies (Ellsworth & Buss, 2000; Sliva & Roddick, 2001) were identified. These were the role of the teacher, the cycle of fear failure and avoidance, the students' perceptions of the nature of mathematics, their self-image as a learner of mathematics, and the influence of parents. The PSTs' written critical incidents focused on the powerful effects of a teacher or the way in which mathematics was presented as a subject; and their image of themselves as learners of mathematics. They are illustrated using quotations from the PSTs' transcripts.

The role of the teacher

PSTs retained intense memories of their experiences with "disabling" teachers. In their reflections many PSTs recognised the lasting impact on individual teachers. Maria recalled: "I never had a teacher that taught. The teacher used the textbook and board and when students asked questions, said 'I've taught you that'".

Other PSTs recalled an experience where the teacher made them feel embarrassed in front of their peers. For example, Jodie recalled an incident from Year 8:

> On one occasion the teacher made me complete a problem in front of the entire class on the whiteboard. I had absolutely no idea what I was doing and yet the teacher still made me complete the task. I tried to attempt the problem and it made me a joke in front of all the other students. It was a humiliating and degrading experience.

Cycle of fear, failure, and avoidance

Lack of action, emotion focused coping or the strategy of minimisation were the coping mechanisms that some PSTs used in situations which they found extremely stressful - a cycle of fear, failure and avoidance (Sliva & Roddick, 2001). The "teacher modelled on the board. I sat playing around, pretending I was doing maths"… "I just don't get it, so I didn't do it." (Jodie). Kay reported: "I tend to block – as soon as a student talks to me about a concept I go deaf – can only hear the word 'maths'".

Nature of mathematics and ways mathematics was presented

The critical incident accounts highlighted the prevalence of a right/wrong dichotomy in school mathematics, the discomfort that comes from getting things wrong, and the

development of the mathematics avoidant PST. Maria recalled mathematics lessons as "always got taught rules" and for Li, it "depends on topic, fractions and decimals– red rash, freak out, like a rollercoaster".

Image of themselves as learners

These images displayed the characteristics of emotion-focused responses. PSTs accepted blame, and felt inadequate. The cycle of fear, failure and avoidance has implications for their self-concept as learners of mathematics. PSTs reflected on the potentially debilitating effects of some assessment practices, for example, testing times tables. Kay recalled:

> Every morning we had an A4 sheet of multiplications. That just wrecked me. We were timed to do it. I couldn't do it and everyone else could. I still get anxious when papers are handed out in class and with multiplication.

Parents

Although comments about the influence of parents and families tended to be less common, Kay recalled:

> Dad was good at maths. Mum was not. I got blessed with mum's background. Mum tried to help. Dad could do it straight away. He said why are you crying, this is the answer. Dad yelled the roof off. He couldn't see why I couldn't understand. I said I get it, to stop him. Then I wouldn't ask him. Now we are best friends, but when it comes to maths [pause, shakes head].

Reflections on the bibliotherapy reading led PSTs to understand "how I get anxious from maths", "change my thinking patterns towards maths" and "that I am not the only person that is anxious about maths". The PSTs developed insights from the workshop: "I found it very interesting to find out about anxiety and why we feel this. How we can cope with it", and "realising that my maths anxiety was a thing of the past and I can change the way I feel". In addition to results that reinforced the themes identified by previous researchers, a consistent theme of shame and humiliation emerged (as exemplified by Jodie characterising the incident in Year 8 as "humiliating and degrading"). This theme will be further explored in future reports of this research. Table 1 shows the average results of the PANAS at the beginning and end of the workshop. Although the sample is small, the results show that at the end of the workshop positive affect had increased, and negative affect had decreased. This indicates there was a reduction in participants' distress during the workshop.

Table 1
Results of the Positive and Negative Affect Schedule (PANAS) before and after the workshop

	PANAS (average)	
	before	after
Positive (/50)	26.2	33.8
Negative (/50)	14	8.6

PSTs were also asked for feedback on the workshop. Responses were positive: "I enjoyed the workshop. It was relevant and helpful towards my needs" and, "It was really

good to have open discussions with [author] and [author] and relate these to why we feel this way and how we can overcome it." PSTs reported that they appreciated the opportunity to have quiet time writing and reflecting as part of the workshop, and requested "More time", and "More quiet time to complete questionnaires." PSTs also requested additional workshops.

Conclusions and implications

Ongoing research has aimed at addressing pre-service teachers' images of themselves as learners of mathematics, through critical incident methodology and bibliotherapy (Wilson, 2012; Wilson, 2014). This research is timely because maths anxiety and its impact on PSTs and the students that they ultimately teach are critical in the current technological age.

The purpose of this study was to encourage and analyse prospective primary teachers' reflections on key aspects of their mathematics learning experiences through writing about and discussing critical incidents and readings. The aim was to better understand the impacts of these incidents on their anxiety about mathematics. Self-blame and feelings of inadequacy were common. Increasing levels of discomfort led to avoidance of situations. This is of concern, as PSTs with low self-efficacy perception are less able to cope and reach their learning goals.

Reflection on the incident enables them to imagine another perspective on that meaningful and emotional situation, and retelling allows insight to be developed. Understanding their appraisal processes and coping strategies helps them to reassess their anxiety towards mathematics and their previous evaluations of themselves as potential teachers. This is vital, as studies have identified a link between maths anxiety of PSTs and their effectiveness as teachers of mathematics to young children.

The findings go beyond identifying the critical behaviours at the descriptive level in critical incident technique, to contribute to teacher educators' knowledge and understanding of the experiences of PSTs and their context. They can reveal the worldview of the PSTs who write them. Teacher educators need to know about the experiences of PSTs and the complexity of the interaction between personal and contextual factors. Critical incidents illustrate some aspects of this complexity. The descriptive and indicative findings about PSTs' critical behaviours identified in CIT, contribute to teacher educators' understanding of the importance of verbalisation and the sharing of emotions experienced by PSTs.

Bibliotherapy is an important technique to address mathematics anxiety in pre-service primary teachers. Teacher educators can use it as a powerful tool to facilitate meta-affective change in PSTs, who reflect on their school experiences and reconstruct their assessment of their capacity to learn and teach mathematics, and thence re-examine their identity as teachers of mathematics.

Collaboration between researchers and student counsellors can lead to greater understanding of the issues and obstacles faced by PSTs. Future research will investigate the application of the critical incident techniques used in the workshop, in combination with bibliotherapy, to investigate their potential to combat maths anxiety.

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