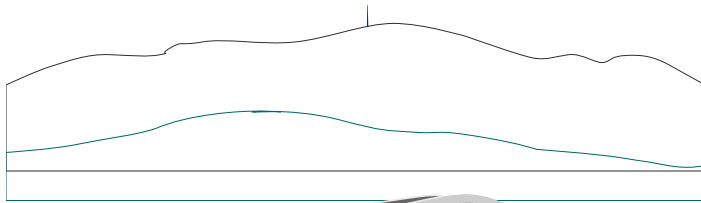


**Proceedings of the 39th Conference of the
International Group for the
Psychology of Mathematics Education**



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Volume 4

Research Reports

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Editors: Kim Beswick, Tracey Muir, & Jill Fielding-Wells



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International Group for the Psychology of Mathematics Education
Volume 4*

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Kim Beswick, Tracey Muir, & Jill Fielding-Wells

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USING CRITICAL INCIDENT TECHNIQUE TO INVESTIGATE PRE-SERVICE TEACHER MATHEMATICS ANXIETY

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High level of mathematics anxiety in pre-service primary teachers affects both their current study, and their future teaching of mathematics. This paper proposes Critical Incident Technique as an appropriate research method, and reports how it was used in a teacher education course to increase pre-service primary teachers' understanding of the impact of previous mathematics classroom experiences on their identities as learners and teachers of mathematics. The results also provided insights for teacher educators and teachers into strategies that could prevent or diminish their students' mathematics anxiety. The discussion highlighted the need for teacher educators to be aware of the perspectives of PSTs, the importance of verbalisation and the sharing of emotions, and outlined recommendations for further research.

INTRODUCTION

This paper demonstrates the use of the Critical Incident Technique (CIT), a robust research technique that is widely used for problem solving. This study applied CIT in order to investigate primary pre-service teachers' (PSTs') images of themselves as learners and future teachers of mathematics. The PSTs were asked to recall critical incidents in their mathematics learning, and examine their associated emotions. These written reflections were used to identify factors contributing to primary PSTs' mathematics anxiety (mathematics anxiety).

Critical incident reflections are descriptions of events that people remember as being meaningful in their experience. As this research sought to investigate factors that had an influence on PSTs, this paper defines "critical incident" in the sense of an incident that the participant selects and defines as having had an impact (Hughes et al., 2007); whereas some researchers, for example, Vanderclayen, Boudreau, Carlier, and Delens (2012) define a 'critical incident' as any incident on which the PST critically reflects.

Research methods are needed which will identify strategies to elucidate the impact of mathematics anxiety. The paper suggests CIT as a method in teacher education to investigate the issue of mathematics anxiety. It contributes to an ongoing project investigating the use of CIT and bibliotherapy to address PST mathematics anxiety (Wilson, 2014), and aims to assist PSTs with mathematics anxiety to perceive their past experiences differently and re-evaluate their potential to become effective teachers of mathematics.

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This study is based in the interpretive paradigm, which holds that people socially and symbolically construct their realities. Blumer (1969) coined the term "symbolic

interactionism” for the idea that people’s actions are based on the meaning things have for them, derived from social interaction and modified through interpretation.

Emotional responses are not determined by objective reality but by interpretation of events - by subjective reality. The ‘transactional model of emotion’ (Lazarus, 1991) links motivational, social and cognitive dimensions. According to Lazarus, a lived experience consists of contextual and personal factors, which determine whether the event will be appraised: primarily as harmful or threatening (negative emotion), or challenging or beneficial (positive emotion); and secondly, for likely future outcomes, and their coping strategies.

Emotion disrupts cognitive processes, but PSTs learn when their beliefs, knowledge and skills are challenged. The self-analysis of an emotionally-charged experience is an opportunity to analyse their past actions and emotions, and the process of writing can be used to reflect on their actions and decisions.

Causes of mathematics anxiety in PSTs

Anxiety towards mathematics in PSTs has been widely publicised as an international issue. Mathematics anxiety refers to feelings of tension and fear in mathematical situations in school and in everyday life. High mathematics anxiety impacts on performance and achievement in mathematics (Sheffield & Hunt, 2006; Stubblefield 2006). Primary PST’s mathematics anxiety has important impacts. It affects not only their current study but also their future teaching. Hence, identifying and addressing primary PSTs’ perceptions of these experiences, is a critical aspect of their education.

Previous researchers have investigated the sources of mathematics anxiety, using a range of methods. Hoyles (1982) using semi-structured interviews, identified three areas for explanations of anxiety particularly related to mathematics - those derived from the nature of the subject mathematics, based on the influence of past experiences in mathematics and the self-concept of ability in the subject, and, concerned with how mathematics is taught and learned (including teacher pace and pressure). A number of researchers have used PSTs’ mathematics autobiographies (Ellsworth & Buss, 2000; Sliva & Roddick, 2001) to identify themes such as the powerful effect of teachers, the ways mathematics was presented (relevance, comprehension, and emphasis on skills and memorisation); and fear failure, and avoidance, in mathematics experiences. More recently, Lutovac and Kaasila, (2009), using an autobiographical interview with a student, identified that the teacher was the main character in her memories of negative experiences. Teachers who are hostile, hold gender biases, or embarrass students in front of peers play a powerful role in mathematics anxiety (Vukovic, Keiffer, Bailey, & Harari, 2013). The perceptual changes that occur as a result of mathematics classroom experiences are persistent and enduring.

“People who claim that they were born without mathematical ability will often admit that they were good at the subject until a certain grade, as though the gene for mathematics carried a definite expiry date. Most people will also recall an unusual coincidence: that the year their ability disappeared, they had a particularly bad teacher.” (Mighton, 2004, p. 20)

Reflective thinking and Critical Incident Technique in PST education

Reflective thinking is important to identify the assumptions that underlie thoughts and actions. Researchers have suggested scaffolds to elicit detailed reflections; for example, Gibbs' (1988) reflective model can be summarised under six headings: Description – what happened? Feelings – what were you feeling? Evaluation – what was good or bad about the experience? Analysis – what sense can be made of the situation? Conclusion – what else could you have done? and, Action plan – if the situation arises again what would you do?

Although Flanagan (1954) developed CIT to establish facts in situations where the critical incidents relied on accurate and truthful reporting, he later adapted his technique, and CIT has been widely used to solve problems in education, health, and industry, by focusing on real-life incidents. In particular CIT was modified to include individual perspectives and affective responses (Chell, 1998).

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 et al., 2007 p. 49)

The exploration of critical incidents can challenge participants' concepts of self. When analysing a critical incident, individuals ask: Why did I view the original situation in that way? What assumptions about it did I make? How else could I have interpreted it? What other action(s) might I have taken that could have been more helpful? What will I do if I am faced again with a similar situation? (Serratt, 2010) These questions can extend and elaborate the Analysis, Conclusion and Action plan sections of Gibbs' (1988) reflective model.

Critical incidents focus on participants' lived experience. The method allows researchers to examine common situations, shared by a group, from the individuals' unique perspectives, and in their own words. CIT permits a degree of replication, in that the context and outcomes may be apparent in other PSTs' experiences. At the same time CIT provides the opportunity to identify and analyse even quite rare events, which may have devastating effects on vulnerable people (Pedersen, 1995).

Flanagan (1954) was concerned to make sure that descriptions were factually correct because he was trying to identify good procedures, and accurate reporting was essential. However, where critical incidents are descriptions of vivid events that people remember as being meaningful, it is not important if the interpretation is correct, as the way a person perceives an event is real in its consequences.

... 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. To take something as a critical incident is a value judgment we make, and the basis of that judgment is the significance we attach to the meaning of the incident (Tripp, 2012, p 8.)

The process of writing helps PSTs reflect on their perception of the event and its impact on their construction of themselves as a learner of mathematics. The study used CIT to access the narrative or storied nature of experiences, as narratives are important for meaning construction (Ricoeur, 1985). The aim was to understand the meaning PSTs attach to lived experiences. Instead of researchers selecting which parts of mathematics autobiographies to analyse for themes, in CIT the participant chooses the experience and identifies the impact. Participants were not guided to the selection of a negative experience, so their choice provided comparative data on PSTs' positive and negative responses. By asking the research question: How do PSTs describe their mathematics experiences? the researcher used critical incidents identified by PSTs to illuminate key factors in the development of mathematics anxiety.

METHODOLOGY

The research aimed to examine the range of ways mathematics anxiety is experienced within a given context, with a range of participants. Given the complex nature of the phenomenon, and the aim of the study to access the narrative or storied nature of experience, a qualitative approach was appropriate. The interpretive tradition is characterised by prioritising lived experiences, with a focus on meaning of interactions and events. Erickson (1986) argued that it be used for answering questions like "What is happening, specifically, in social action that takes place in this particular setting? What do these actions mean to the actors involved in them, at the moment the actions took place?" (p. 121). These are clearly the type of questions asked in this study. The researcher attempted to understand mathematics anxiety by accessing the meaning that the participants gave to it, and to develop insights into lived experience from point of view of the participant. The quotations from PST narratives and vignettes reflect real experiences, chosen to illustrate themes identified by the literature.

Procedure

Ethics approval was based on accepted informed consent procedures. PSTs who agreed to participate in the study wrote a description during a tutorial of a critical incident (positive or negative) from their own school mathematics education that impacted on the way they thought about themselves as learners and future teachers of mathematics. Two important aspects of the research method were that PSTs chose the incident, and that they could choose a positive or negative experience. The participants were 268 primary PSTs studying mathematics education units from Bachelor of Education (Primary) degree courses, at an Australian university. Data were collected from the perspectives of the participants, using their own words. Pseudonyms were used for privacy.

Critical incident data analysis

The traditional, binary analysis using Lazarus' model of emotion, was used to identify ratios of positive and negative responses. A preliminary analysis based on the themes identified by other researchers was commenced, and further thematic analysis is in progress.

RESULTS AND DISCUSSION

The critical incidents described occurrences that were pivotal not only personally, but also potentially had an impact professionally. They were related to situations that impacted on and potentially interfered with the PSTs' beliefs, and identities. The binary analysis showed that the majority of the critical incidents were perceived as threats. Of the 268 PSTs, 236 (88%) wrote incident reflections. Of these, 102 (39%) were negative, 157 (61%) were negative and 2 (1%) described a neutral incident.

The thematic analysis of the critical incidents identified similarities with themes from the existing literature. Of the 236 PSTs, 135 (57%) wrote about the teacher. Of the 140 comments about the teacher, 46 (33%) were positive and 94 (67%) were negative. To be coded as teacher, comments had to specifically mention the teacher. If a comment mentioned two teachers, in separate years, both were counted separately. The emphasis on the role of the teacher reflected findings from other researchers (Ellsworth & Buss, 2000; Sliva & Roddick, 2001; Lutovac & Kaasila, 2009).

In addition, themes of 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, were consistent with the themes identified from mathematics autobiographies (Sliva & Roddick, 2001; Ellsworth & Buss, 2000). The themes show specific links to Hoyles' (1982) second and third categories. Themes are illustrated using quotations from the PSTs' transcripts.

The role of the teacher

Many PSTs recognised the lasting impact on individual teachers. For example Amanda wrote: "I never had a teacher that taught. They used the textbook and board and said, 'I've taught you'". Another theme that emerged from interactions with the teacher was shame and humiliation. PSTs recalled experiences where the teacher made them feel embarrassed in front of their peers, for example, "I felt all the students at the tables were watching me and thinking I was stupid" (Patsy). Josh, another PST, recalled an incident from Year 8:

On one occasion the teacher made me complete 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.

These feelings of humiliation have strong links to avoidance. Previous researchers identified that PSTs retain intense memories of their experiences with disabling teachers. (Ellsworth & Buss, 2000; Sliva & Roddick, 2001; Wilson & Thornton, 2008).

Cycle of fear, failure, and avoidance

Feelings of embarrassment gave way to resignation and a sense of inadequacy –for example, Joyce wrote: "Can anyone blame a girl for wanting to stick to what they feel they can cope with – rather than risking the humiliation of tackling the unknown connections between big ideas". This demonstrates the cycle of fear, failure and

avoidance (Sliva & Roddick, 2001) and is similar to reflections reported in previous research (Wilson, 2014). When an incident is perceived as a threat, the outcome can be lack of action, emotion focused coping, or the strategy of minimisation.

The PSTs accepted blame, and felt inadequate, struggling with a lack of understanding. “We never understood what the formulas were or why they worked” (Joyce). “If I did finally work out how, as soon as the question changed slightly, I wouldn’t be able to do them” (Christine). Some responses showed the coping mechanisms that some PSTs used in situations that they found extremely stressful. “I didn’t understand and everything began to move away too quickly. I questioned and questioned but still couldn’t come to an understanding, so I quit.” (Hilary)

Nature of mathematics and ways mathematics was presented

The accounts highlighted the prevalence of a right/wrong dichotomy in school mathematics, and the discomfort that comes from mistakes. Mandy explained “this is how I viewed mathematics, as long as I knew the set of rules and applied them appropriately then I didn’t really need to know why. To me mathematics was all about getting the right answer.” Kay wrote:

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.

Debbie said she “was able to retain the formula, and put the correct variable in it but I did not really understand the concept”.

Parents

Although comments about the influence of parents and families tended to be less common, some PSTs felt pressured by parental expectations:

I was okay up until Year 9 when I was taken into the 5.3 pathway and I could deal with it for a bit but it got VERY overwhelming. Anyway, my parents wanted me to stay in 5.3- it was a big thing for them that I was 'excelling' but in truth I was drowning (Danielle).

Dad was good at mathematics. 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. (Marilyn)

CONCLUSIONS

The purpose of this paper was to explore CIT as a mechanism to encourage and analyse prospective primary teachers’ reflections on key aspects of their mathematics learning experiences, and to better understand the impacts of these incidents on their anxiety about mathematics. The technique helps PSTs to reflect on their construction of themselves as a learner of mathematics, as a result of their perception of that event. CIT can provide the catalyst for introducing a contradictory consciousness (Gramsci, 1971) to question previous assumptions that they made as a student and stimulate

different ways of reflecting on past experiences. Understanding their appraisal processes and coping strategies helps them to reassess their anxiety towards mathematics and their previous evaluations of themselves as potential teachers.

The findings contribute to teacher educators' knowledge and understanding of the experiences of PSTs and their context, and how CIT could be incorporated into teacher education courses. Teacher educators need to know about the experiences of PSTs, and the importance of verbalisation and sharing of their emotions. The research also provides insights for school teachers on how their actions may be interpreted by students, and strategies to help avoid stimulating students' mathematics anxiety.

Future research will investigate the application of the critical incident techniques used in the study, in combination with bibliotherapy, to investigate their potential to combat mathematics anxiety in PSTs. Additional analysis will explore the themes of shame and humiliation that have arisen so strongly in the accounts.

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