

Quality of Life: Domains for Understanding Maths Anxiety in First Year Pre-service Teachers through Identity Work

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Mathematics anxiety in primary pre-service teachers' affects their future teaching of mathematics and achievement of students. Data collected via Critical Incident Technique were used to investigate this anxiety as perceived and identified by first year pre-service teachers. This paper proposes the application of the Quality of Life conceptual framework of being, belonging and becoming, as a lens for analysis of these reflections to elucidate the concepts of identity and projective identity. This paper makes a contribution to the frameworks through which primary pre-service teachers' maths anxiety, and its implications for their identity development, might be understood.

Introduction and Context

The 21st Century has been marked by rapid social and technological change. Mathematics is a vital part of 21st Century society. Students compete globally in a world that is increasingly based on using mathematics confidently. Successfully engaging with mathematics has social, economic and political implications. Mathematical understanding is essential not only to the life chances of individuals, but also to the health of communities and the economic well-being of nations (Walls, 2009, p. vii).

For people to participate fully in society, they must know basic mathematics. Citizens who cannot reason mathematically are cut off from whole realms of human endeavor. Innumeracy deprives them not only of opportunity but also of competence in everyday tasks." National Research Council. (2001)

Students who exhibit persistent problems learning mathematics during their education usually transfer these difficulties into their adulthood and professional lives (Robinson, Menchetti, & Torgesen, 2002). Poor mathematical literacy skills have far reaching effects, as mathematical skills and understanding have been linked to better employment outcomes and higher salaries (Shapka, Domene, & Keating, 2006). Addressing this problem has benefits for social justice because being mathematically literate and becoming competent citizens who are able to make informed decisions is an important aspect of equity in our society.

Anxiety towards mathematics or mathematics anxiety (henceforth, maths anxiety) has been identified as an issue nationally

There is considerable anecdotal and research evidence to suggest that many people dislike mathematics and may even feel intimidated in situations in which it is used. Of considerable concern is the effect on individuals of having to deal with an increasingly mathematical society while feeling inadequate or alienated from mathematics. (Curriculum Corporation (Australia), 1991, p. 7)

and internationally (OECD, 2015). Maths anxiety is an issue for pre-service teachers (PST) entering primary teacher education programs, and this has been recognised by the profession (AAMT, 2014). There has been increased scrutiny of teacher education courses, for example, the Australian Institute for Teaching and School Leadership (AITSL) stated that universities need to establish strategies to ensure PSTs have the required standard of numeracy to engage

effectively in mathematics units in a rigorous program, (AITSL, 2011), and in 2015, the then Minister for Education announced compulsory numeracy testing of pre-service teachers graduating their courses from 2016 (Pyne, 2015).

The Quality of Life Approach

There has been a history of extensive application of the scientific and social view of quality of life (QOL) developed in the field of intellectual and developmental disabilities (Brown & Faragher, 2014). Previously the author used this view of QOL as a theoretical lens to examine the issue of maths anxiety in PST using the concepts of perception, choices, self-image, empowerment, personal control and lifespan, and the principle of inclusion (Wilson, 2014). This exploration showed that these core ideas resonate in mathematics education. They can contribute to understanding learning and development in mathematics education especially of those in need of support and intervention. In particular they can serve to heighten mathematics educators' awareness of the importance of students' social and emotional wellbeing.

Positive QOL predicates a life “that is very meaningful to people and provides them with resources” (Brown & Brown, 2003, p. 19) and “a richness of opportunities to choose from” (Brown & Brown, 2003, p. 20). The QOL approach is based on the understanding that “people have their own ideas about what is most meaningful to them, what fits their self-image best, and what adds richness to their lives” (Brown & Brown, 2003, p. 20). This approach aims to achieve improvement in the person's self-image and increases in levels of personal empowerment. However, the researchers caution that “opportunities to improve must be within the person's grasp” (Brown & Brown, 2003, p. 32).

Two important elements of the QOL approach (Brown & Brown, 2003) are that the practitioner needs to understand the person's environment and that the practitioner needs to ask for and listen to the individual's perspective on the issue. These requirements can also be applied to a researcher seeking to address an issue, such as maths anxiety. Two potential outcomes of this approach which are relevant to addressing maths anxiety in PST, are empowerment of the individual and increased self-image, and improved practice which provides strategies for similar interventions with other individuals. The QOL approach (Brown & Brown, 2003) is based on values, and uses a specific conceptual framework. This paper describes a work in progress that aims to use the QOL conceptual framework (Renwick and Brown 1996, pp.82–84) to investigate how primary PSTs' maths anxiety, and its implications for their identity development, might be understood.

Conceptual framework

The QOL framework is based on a conceptual framework of three domains of life, Being, Belonging and Becoming (Renwick and Brown 1996). These domains are described in Table 1.

Several subdomains within this conceptual framework are particularly apposite to the study of maths anxiety. These are Psychological being (involving thoughts and values), Social belonging (relating to persons), Community belonging (concerning resources in the person's environment and access to these), Practical becoming (purposeful activities) and Growth becoming (activities involving development).

Table 1:
Domains of Life from the Quality of life approach.

Domain	Refers to
Being	Individual attributes
Belonging	The individual in their environment
Becoming	Life goals

Within this framework it is possible to examine factors which help improve wellbeing and those that hinder development. These factors may be common to a group or may be specific to an individual. The domains of the QOL conceptual framework provide a framework that can contribute to the study of identity in the affective dimension in mathematics education.

Literature review

Three bodies of research informed this study. The first concerns maths anxiety in PSTs, the second involves PST identity, and the third, the use of a reflective strategy, Critical Incident Technique (CIT), in teacher education.

Researchers of PSTs report high levels of mathematics anxiety, low confidence levels to teach elementary mathematics, and low mathematics teacher efficacy (Swars, Daane, & Giesen, 2006); and find that high levels of teacher mathematics anxiety impact on student achievement (Beilock, Gunderson, Ramirez, & Levine, 2009). “Students’ beliefs about their capacity to learn and the perceptions they have about how their teachers see them, can result in powerful and destructive emotions which are self-limiting” (Wilson, 2014, p. 77). These can be perpetuated in classrooms (Furner & Berman, 2005). The transfer of mathematics anxiety from teacher to student also has long-term educational implications.

Maths anxiety and its causes and impact on PST have been investigated for many years, for example, Namukasa, Gadanidis, and Cordy noted “impoverished school mathematics experiences have left many pre-service teachers with strong *negative* affective responses about mathematics” (2009, p. 46 - 47). Previous researchers have used a range of methods. However, more studies are needed to investigate this issue.

Socio-cultural models of identity propose that identity is developed by social and cultural practices. Identity can be viewed as “how individuals know and name themselves ... and how an individual is recognised and looked upon by others” (Grootenboer, Lowrie & Smith, 2006, p. 612). Grootenboer and Zevenbergen (2008, p. 248) contend that “it is essential that teachers of mathematics (at all levels) have well-developed personal mathematical identities”. In order to achieve this, it is important as Walshaw, (2004, p. 557), argued that “teacher education must engage the identities of pre-service students”.

Sfard and Prusak (2005) define identities as stories about people, especially narratives that are reifying, endorsable and significant. Reification is indicated by verbs such as be, have or can (as opposed to do) and with adverbs that indicate repetition such as always, never and usually. They state “identity talk *makes us able to cope with new situations in terms of our past experience and gives us tools to plan for the future* [emphasis in original]” (p. 16). The future aspect, when exploring teacher identity and reflection however, has mostly been overlooked until recently (Lutovac & Kaasila, 2012; Di Martino & Sabena, 2011). Wilson and Thornton (2008) applied the concept of “projective identity” (Gee, 2003) to the

development of PSTs' identity, as a way of describing this future perspective. According to Markus and Nurius (1986) in this future orientation, individuals imagine the selves they would like to become as well as those they want to avoid.

With respect to past experience, reflective thinking is important for developing professional practice as it assists in the identification of the assumptions that underlie their thoughts and actions. When students "discover that the interpretations of events can be changed, it can free them to search for new perspectives on their mathematical past and future" (Kaasila, Hannula, & Laine, 2012, p. 991).

The critical incident technique (CIT) focuses on real-life incidents. These incidents are descriptions of vivid events that people remember as being meaningful in their experience, and often can be identified, upon looking back, as a crisis or tipping point (Wilson, 2015b).

Methodology

The study is based on the understanding that people create and associate their own meanings of their interactions with the world. Given the complex nature of the phenomenon of maths anxiety, and the aim of the study to access the narrative or storied nature of experience, a qualitative approach was appropriate to investigate the causes of this anxiety.

The research study participants were a cohort of students undertaking their first year mathematics unit on a major metropolitan campus. A total of 246 level 1 students from the Bachelor of Education (Primary) course completed the reflections. The data was collected in the participants' setting. The participants chose the relevant experiences and identified their impact. PSTs were identified only by a code. Reflections were sealed in envelopes immediately and sent to the researcher.

The researcher used CIT to investigate how PST felt about themselves as learners and future teachers of mathematics, by asking them to recall a critical incident which impacted on the way they feel. The critical incident may not have happened as they remembered. However, the aim of this writing was to help PST reflect on their perception of the event and its impact on their construction of themselves as a learner and potential teacher of mathematics.

Methods

Ethics approval, based on accepted informed consent procedures, was received from the university's ethics committee. The pre-service teachers firstly completed a maths anxiety survey which identified a range of maths anxiety among PST (Wilson, 2015a).

In tutorials, PSTs were asked to write a description of a critical incident (positive or negative) from their own school mathematics education that impacted on their image of themselves as learners and potential teachers of mathematics. Thus, the research methods focus on aspects of emotional responses to lived experiences (Lazarus, 1991).

The responses were examined for evidence of anxiety, by searching for terms indicating anxiety, such as anxious, nervous, and not confident. Then an initial examination was commenced, in which the data were examined for alignment with the being, belonging and becoming conceptual framework. The aim of this was evaluate the potential for using the QOL conceptual framework as a tool to explore the meaning that individual PSTs ascribe to the problem of maths anxiety, and how it impacts on the development of their identity as learners and potential teachers of mathematics.

Results and discussion

This paper proposes that the three domains of the QOL approach, i.e. being, belonging and becoming ((Renwick and Brown 1996) comprise a useful framework to analyse the reflections, that might progress the understanding of development of the mathematical identities of PST. See Table 2. In this study the concept of storied or “telling” identity (Sfard & Prusak, 2005) was used. The evidence from the reflections of reification of storied identity is indicated by the use of verbs such as be, have or can, which relate to the first domain of being, in PST reflections such as “I am an average learner”, “I have an open mind towards maths” and with adverbs that indicate repetition such as “always”, “every time”.

Table 2:
Application of the Quality of life approach.

Domain	Application to the study
Being	Link to identity
Belonging	Connection to others
Becoming	Link to projective identity

Further analysis investigated how several of the sub-domains of the conceptual framework might function to identify factors which help improved wellbeing and those that hinder the development of a positive projective identity. An example of this initial analysis relating PST reflections to the QOL domains is provided in table 3. These provide insights into the factors that impact on PST identity.

The most common focus of comments that linked to the sub-domain of Social Belonging, i.e., the “person in the environment” who featured in the PST reflections of their experiences in the classroom, was the teacher. The reflections described both positive and negative experiences, with the emphasis being on how the PST felt at the time as a result of the interaction with the teacher. The following examples of positive experiences show the impact of teachers who provided safe and supportive learning environments, and the sense of connection that the PST describes related to the Quality of Life domain of belonging.

“Year 8 – my teacher made me comfortable and helped me understand the task in a way that was not uncomfortable.”

“Year 11 to 12. Previously I had never been very good at maths. My teacher found ways to connect maths in ways I could relate to, making it fun. This developed my maths skills and attitude towards maths.”

However, some PSTs retained intense memories of their experiences with disabling teachers, and these ranged from primary school to senior secondary. The following are examples of critical incidents that impacted negatively on their identity as learners of mathematics:

“In primary school I had one teacher who would always put you on the spot in front of a class and he would read out everyone’s results in front of everyone too. This always made me anxious and from then on I aimed to avoid maths.”

“In year 9, my teacher would make us answer questions on the board and if we got it wrong, he would say “Poor _____. What can we do with you?”

“Year 11 ... My teacher made it hard for me to learn and understand because he would give the class a time to finish answering a question and if I didn’t know an answer, he would look at me and say “You should know this”.

These comments reflected findings from other research (Wilson & Thornton, 2008; Lutovac & Kaasila, 2009) on the important impact of individual teachers on students.

Table 3:
Analysis using Sub-domains from the Quality of life approach.

Sub-domain	Refers to	Example
Being		
Psychological being	Individual attributes involving thoughts and values	“I had always felt nervous about maths. I felt as though teachers didn’t expect anything better of me”. (female, 19 years) “I feel I have low self-esteem when it comes to maths. I see myself failing maths every time in high school. (female, 21 years)
Belonging		
Social belonging	Relating to persons in the individual’s environment	“Year 6. I couldn’t understand the concept of long division so the teacher gave up on me and said don’t worry about it. Looking back it makes me feel like a failure”. (female, 18 years) “My image of myself as a learner and teacher of maths started at a young age (year 4-5) where I couldn’t keep up with the children in my class. This continued in high school therefore shaping my attitude negatively towards maths”.(female, 20 years)
Community belonging	Resources in the individual’s environment and access to these	“Year 8. Just made to do exercises from the textbook. Made me feel boring and like I wasn’t included”.(female, 20 years) “Something that had to be done and involved boring worksheets”. (female, 19 years)
Becoming		
Practical becoming	Purposeful activities	“As a future maths teacher I feel that I will be able to teach maths with confidence once I gain the knowledge to do so. I feel I will find ways to make maths fun for children”. (PST reflection)
Growth becoming	Activities involving development	“I know that if I learn the right strategies and tools I can successfully teach maths in an interesting manner”. (female, 20 years)

This research proposes that challenging the perceptions of past experiences identified via critical incidents and the feelings that they invoke, will assist PST in addressing maths anxiety and becoming more effective teachers of mathematics. At the beginning of their course PSTs’ current identities are filtered through and reinforced by their perceptions of their past experiences. The Becoming domain of the Quality of Life conceptual framework, relates to the concept of projective identity. This domain has a future focus, as evidenced by the PST reflections quoted in table 3. These provide evidence of how the PSTs view themselves as a future teacher of mathematics at the beginning of their course. This has

important implications for teacher education. Challenging the way PST identify as future teachers of mathematics will allow them to develop a more robust projective identity.

Conclusions

Previous research demonstrated that the QOL concepts of perception, self-image and empowerment can provide new insights into the study of maths anxiety (Wilson, 2014). This paper demonstrates that the domains from this approach (being, belonging and becoming) and their sub-domains have the potential to offer a useful framework within which to analyse and understand the concepts of identity and projective identity and their development in PST. This paper makes an important contribution to the frameworks available to analyse the development of identity in teacher education courses to address maths anxiety.

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