Pre-service Teachers Constructing Positive Mathematical Identities: Positing a Grounded Theory Approach

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Mathematics anxiety in pre-service primary teachers is an important issue in teacher education. This leads to the question of how pre-service primary teachers with mathematics anxiety perceive their mathematical identities. The paper explores the potential to develop a research-based model to identify the process whereby pre-service primary teachers with mathematics anxiety could develop more positive identities as learners and potential teachers of mathematics. It indicates emerging themes from previous research using subsequent preliminary data analysis and argues that a grounded theory approach to building a theoretical model for this process would make a valuable contribution to teacher education.

> If the artist does not perfect a new vision in his process of doing, he acts mechanically and repeats some old model fixed like a blueprint in his mind.

John Dewey

Mathematics anxiety in pre-service primary teachers has been identified as an important issue, with significant impact on teacher preparation. Although extensive research has been done to identify the causes of mathematics anxiety in pre-service teachers, more research in addressing this issue would add to the repertoire of strategies available to teacher educators. Reviews of the literature underpinning the concepts of mathematics anxiety and bibliotherapy have been published in previous research papers, (Wilson & Thornton, 2006; Wilson, 2007, 2009). There is evidence that the repercussions are broader than effects on learning mathematics. Research using 156 pre-service teachers found significant negative relationships between mathematics anxiety and mathematics teacher efficacy (Gresham, 2008). In addition, Utley, Bryant and Moseley (2005) found that mathematics and science efficacy in pre-service teachers are directly related.

In considering ways to progress research on the challenge of primary teacher preparation of students with mathematics anxiety, the researcher proposes a new initiative. The following overarching questions emerge from previous findings: What are the factors that could lead primary pre-service teachers with mathematics anxiety to develop a more positive identity as a learner and teacher of mathematics? What research-based framework can be developed to describe the process by which pre-service teachers with mathematics anxiety achieve a more positive identity? The goal of the proposed research is to develop a replicable research-based explanatory framework that will identify practices in an initial teacher preparation program that positively influence this identity development. This theoretical model will inform the repertoire of strategies for teacher preparation and contribute substantially to teacher education programs.

Grounded theory (Glaser & Strauss, 1967) is "a general methodology for developing theory that is grounded in data systematically gathered and analysed" (Strauss & Corbin, 1994, p. 273). It is a research method that allows for theory to be generated through comparisons among data sources. It presupposes that the issue may be illuminated by the accounts of people in the area of enquiry. It allows a theoretical model of the process to be developed, and extended as patterns are extracted from empirical observations of data.

Grounded theory requires repetition of the method, sampling and coding participants' experiences until no further concepts emerge. There are differences in approaches to grounded theory. Lehmann (2001, p. 9) has suggested that the Straussian approach is more useful for studies of individuals.

This paper revisits the analysis of previous research, using a grounded theory perspective, and proposes the next stage of the research should focus on the development of a theoretical framework. It provides background to the proposed research including the grounded theory process of building a framework and a perspective on the data progress so far. Finally the paper provides a provisional framework that will underpin the next phase of the research.

Previous Research

Research at two metropolitan universities found that using readings with an explicit focus on school students' learning difficulties in mathematics provided a powerful additional element in addressing some of the well-documented anxiety felt by many pre-service primary teachers.

In the initial research project, data was collected through critical incident methodology and written reflections, followed by focus group discussions, and analysed used qualitative methodologies. The research team did not start with a preconceived set of ideas, but identified emerging themes, and sought relationships between them. They identified existing related research and formed propositions relating the research to the process of bibliotherapy (Wilson & Thornton, 2006).

Two further research projects (Wilson, 2007, 2009) involved students at a second university, and practising primary teachers. Written reflections were completed and voluntarily shared with focus groups. The critical incidents and reflections were analysed for evidence of the stages of bibliotherapy. The analysis focused on the extent to which the bibliotherapy process was taken up by pre-service and in-service teachers in this context. Students responding to critical incident methodology identified an interaction or demeaning encounter (often with a teacher) where they were identified or defined by another as persons who couldn't learn mathematics, or started to think of themselves as such. Reading and reflecting about children's difficulties provided a stimulus for pre-service teachers to reflect more effectively on their beliefs about mathematics learning and teaching. Bibliotherapy is able to address Ambrose's (2004) criteria for mechanisms which have potential for changing beliefs, as it can provide emotion-packed experiences, encourage teachers to become immersed in a reflective community, and connect beliefs and emotions.

Fullan has identified three primary elements fundamental to substantive change in educational institutions. They are new materials, new teaching approaches and alteration of beliefs. (Fullan, 2001). This study is not considering whole-institution or systematic educational changes, but focuses on positive change in students in order to empower them. Pre-service teachers' pedagogical orientations, perceived value of mathematics, and self-efficacy beliefs are relevant to this study. Underlying beliefs and assumptions about mathematics learning and teaching professional knowledge and practice are important, especially if there is a mismatch of pedagogical assumptions and theories.

Themes identified through the analysis of data sources through the phases of bibliotherapy, strongly suggest the importance of insight as a major factor. Difficulties from school were reinterpreted as: "The teacher hadn't explained in the class in a way that I understood, or was relevant to me" (Christine). Realising this insight was a valuable part

of the process, these pre-service teachers questioned not only the views that they had developed of themselves as learners of mathematics, but also the image that they had previously held of themselves as prospective teachers of mathematics. Practicing teachers also reflected on their experiences. Cathy remembered her frustration in Year 7 struggling with a lack of understanding, and she "lost all confidence and went slowly downhill from there". Teachers also developed insights about their learning, "I am sure the connections were there, but I couldn't see them in the textbook" (Becky), and the impacts on their teaching, "I incorporate the methods by which I was taught, by doing the exact opposite" (Doris).

The analysis completed in these preliminary research projects corresponds to descriptive coding in grounded theory research. Further research is needed to confirm whether insight emerges as a major theme and analyse the connections that link the emergent themes. A visual representation of the framework will then be developed.

Theoretical Framework

The researcher has explored a range of potentially relevant literature. Through the review of the literature, potential elements that could inform the development of the framework have emerged. Several important areas that impact on a consideration of the development of teacher identity are underlying beliefs and assumptions, both about mathematics learning, and about teaching professional knowledge and practice.

The question that prompted the review of the literature on pre-service teacher beliefs about mathematics was: How do pre-service teacher beliefs about the nature of mathematics and mathematics teaching and learning guide, and later impact on, their approaches to teaching in the classroom? Studies have found that primary teachers teach mathematics in a way that is consistent with their pedagogical beliefs about mathematics and this can conflict with their beliefs about how children learn. Teachers' beliefs about their own ability are significant factors in their approaches to teaching mathematics or even their willingness to teach upper primary classes (Wilson, 2007).

In the previous research many students identified an interaction where they experienced a loss of confidence and started to think of themselves as persons who couldn't learn mathematics. This can be interpreted as a change in their identity, as they were no longer what they thought they were. When students are marginalised and do not identify themselves as confident learners of mathematics, they are unlikely to map mathematics into their future identities in a positive way (Boaler, 1997). This is not only a cognitive experience, but also an emotional one. For potential teachers of mathematics this emotional impact becomes doubly significant, potentially affecting not only their current study but also their future teaching of mathematics and hence the attitudes of their future students. Previous research indicated that developing insight (part of the bibliotherapy process) and reinterpreting these past experiences, leads to the development of a more positive projective identity (Wilson & Thornton, 2006).

Teacher Identity

The way individuals perceive themselves is integral to their continued learning of mathematics and to their teaching. As Grootenboer, Smith and Lowrie (2006) have indicated, identity is a term that used by researchers from a range of perspectives. There are a variety of lenses for looking at identity. These include personal (individual), social (shaped by society) and symbolic. All are useful lenses to consider as potentially informing

further research. Identity can be examined within and externally, and considered the "negotiated nature of the self" (Kashima, Foddy & Plastow, 2002). Gee (2001) listed four ways to view identity:

- · Nature-identity (developed from natural forces)
- · Institution-identity (authorised by an institution)
- · Discourse-identity (recognised in dialogue with other individuals)
- · Affinity-identity (shared practice with a group)

These are not separate but interact. "Identity is a unifying and connective concept that brings together elements such as life histories, affective qualities and cognitive dimensions." (Grootenboer & Zevenbergen, 2008, p. 243).

For the purposes of this paper and the preliminary investigations of how previous research might be extended, identity will be viewed as "how individuals know and name themselves … , and how an individual is recognised and looked upon by others" (Grootenboer et al., 2006, p. 612). Students construct a professional identity that is consistent with their perception of their personal capabilities. Their views of themselves as learners of mathematics impact on the identities they construct. Mahlios (2002) examined three domains of teacher identity – self-image, program conceptualisation, issues in work context – and showed that teacher educators need to be aware what images pre-service teachers bring with them and explicitly address them. Pre-service teachers' identity includes their self-perception as learners of mathematics as well as looking ahead to "future selves" (Franken, 2002).

Actions carry meanings and generate further meanings. "Actions are embedded in interactions – past, present and imagined future." (Corbin & Strauss, 2008, p. 6). In the discipline of mathematics education, this accords with Grootenboer and Zevenbergen's, (2008, p. 248) contention that "it is essential that teachers of mathematics (at all levels) have well-developed personal mathematical identities". Walshaw, (2004, p. 557), argues that "teacher education must engage the identities of pre-service students", and describes the journey of a pre-service secondary teacher, Helen, who "through a process of formation and transformation, finally at the end of the year, understood who she might become" (p. 563).

According to Barton, (2009, p. 7) "a key factor in transforming … mathematical knowledge into effective teaching lies in a teacher's attitudes and orientations towards mathematics, the way they hold their mathematics". He proposes the concept of "holding" mathematics as one that embeds a person's vision, philosophy, role for mathematics and orientation.

Discussion

The focus of the present paper is on the developing framework rather than a detailed discussion of the findings as these have been reported in previous research papers (Wilson & Thornton, 2006; Wilson, 2007, 2009). This paper aims to tease out the scope for future research directions. The planned research design seeks a way of operationalising the research question. Specifically the research will focus on the critical question:

What is the process by which first year students with mathematics anxiety attain a more positive identity as a learner and teacher of mathematics?

This question is timely because mathematics anxiety and its impact on pre-service teachers and the students that they ultimately teach has been a problem but its impact is even more critical in the current technological age. It is of contemporary social and theoretical concern and is relevant to society because of the extended impact on children.

In addition it is relevant to the scholarly literature because of the potential to develop theory that is currently missing from mathematics education. This will also relate to the national debate about falling numbers of students in science.

Subsequent preliminary data analysis, of previous responses of students (Wilson, 2007), has led the researcher to postulate insight as a central theme in the process. Bibliotherapy is an iterative process that can offer pre-service teachers the opportunity to remove obstructive feelings and to reframe the way they see themselves as learners and teachers of mathematics. Further research focusing on an exploration and careful integration of emerging factors will enable the identification of a system of relationships between some of the major themes shaping this positive identity formation. Dynamically related aspects that comprise the model will emerge from the data. This will allow the interaction of important themes with barriers and enablers to be identified. Thus, factors hindering the process may be identified and subsequently addressed.

Extensive further data collected will make it possible to move past the standard analysis of change in identity as a response. It will seek to verify the interpretation of the descriptive coding completed retrospectively from the early research projects and incorporate a detailed analysis following the collection of more complex data. This can then be reduced in complexity by further coding, producing a model to explain how and why these changes occur, and how students perceive and negotiate tensions in their reflections. The aim is to validate and extend the preliminary findings. The framework, grounded in the experience of the students, will focus on understanding the process from the point of view of those who lived it.

The research will explore previous indications of the importance that insight plays in the development of a projective identity as a teacher of mathematics. It will examine how these students see themselves as teachers of mathematics, and how this perception develops during the bibliotherapy process. The aim is to produce a framework for the process that has coherence and continuity that flows into the mathematical units in the degree program. Constant comparisons and questioning the data from the start of the research will produce a theory tested and expanded by subsequent studies. The literature relating to these emerging themes, guided by the main concerns of the participants will be read as a source of more data.

In grounded research methodology, the researcher's assumptions and knowledge form part of the data and are compared with the data from the participants. Thus, the framework development includes a consideration of the author's philosophy and belief system. It is important to document the researcher's reflections and for them to be considered as data, capturing the experiences of the researcher. This is a way to ensure rigour as the researcher's reflections are not separated from the research process. Greater credibility is developed if the researcher interprets her own experience rather than implying that this could be detached and creates an audit trail of her own reasoning, and analysis of issues. The impact of the research on the researcher and a consideration of the influence of the researcher on the research are worthwhile contributions, and the researcher's experiences can be examined. (Glaze, 2002)

Quoting Mihalko (1978, p. 36), Wood (1988) wrote that it is logical that elementary school teachers "cannot be expected to generate enthusiasm and excitement for a subject for which they have fear or anxiety. If the cycle of mathophobia is to be broken, it must be broken in the teacher education institution" (p. 11). It is for these reasons that pre-service teacher education has become a crucial site for further research.

Educational Importance of the Study

Grounded theory aims to understand the action in a substantive area from the point of view of the participants involved, and examines how the behaviour of the participants resolves their main concern, giving texture and significance to their reflections. Future research will focus on elaborating and tuning this preliminary framework.

This project sits within debates and agendas that have long-term implications. The presence of well-prepared teachers in schools who are comfortable with teaching mathematics is a key factor in engaging students and enhancing their learning. Education courses carried out in teacher education institutions to prepare primary pre-service teachers to teach mathematics has a strong focus on providing the updated resources and teaching methods that Fullan identified as part of educational change. This research is related to his third aspect of change, that of changing students' beliefs. This is potentially one of the factors that contributes to the development of insight, and hence the establishment of a more robust teacher identity. Negotiating this issue has the potential to transform learning and teaching beyond that of the pre-service teacher to the future students. Promoting positive change for future teachers strengthens their engagement in the learning process. Empowering pre-service teachers contributes to social justice in that it can make a difference, not only for them, but also for their future students and hence impact on social change.

Practically speaking, the study is useful because it provides insight into strategies that can positively inform teacher preparation. Bibliotherapy can be a powerful tool for teacher educators to facilitate meta-affective change in pre-service by encouraging them to reflect on their own school experiences and reconstruct their assessment of their capacity to learn and understand mathematics, and hence re-examine their identity as teachers of mathematics. Ultimately the framework will inform teacher educators and assist in improving student learning outcomes in pre-service teacher education. It is in the teacher education sphere that identities and their associated insights are negotiated and eventually reified.

References

Ambrose, R. (2004). Initiating change in prospective elementary school teachers' orientations to mathematics teaching by building on beliefs. *Journal of Mathematics Teacher Education, 7*, 91-119.

Barton, B. (2009). Being mathematical, holding mathematics: Further steps in mathematical knowledge for teaching. In R. Hunter, B. Bicknell, & T. Burgess (Eds.), *Crossing Divides*. (Proceedings of the 32nd Annual Conference of the Mathematics Education Research Group of Australasia, Vol 1, pp. 4-9). Palmerston North, NZ: MERGA.

Boaler, J. (1997). When even the winners are losers: Evaluating the experiences of 'top set' students. *Journal of Curriculum Studies 29*(2), 165-182.

Corbin, J. & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. (3rd ed.). Thousand Oaks, CA: Sage Publications.

Franken, R. (2002). *Human Motivation*. (5th ed.). Sydney: Wadsworth.

Fullan, M. (2001). *The new meaning of educational change*. New York: Teachers College Press.

Gee, J. (2001). Identity as an analytic lens for research in education. *Review of Research in Education, 25*, 99-125.

Glaser, B. & Strauss, A. (1967). *The discovery of grounded theory*. Chicago: Aldine.

Glaze, J. (2002). Ph.D. study and the use of a reflective diary: A dialogue with self. *Reflective Practice*, *3*(2) 153 – 166.

Gresham, G. (2008). Mathematics anxiety and mathematics teacher efficacy in elementary pre-service teachers. *Teaching Education 19*(3), 171-184.

Grootenboer, P., Smith, T. & Lowrie, T. (2006). Researching identity in mathematics education: The lay of the land. In. P. Grootenboer, R. Zevenbergen & M. Chinnappan (Eds.), *Identities, Cultures and Learning Spaces*. (Proceedings of the 29th Annual Conference of the Mathematics Education Research Group of Australasia, Canberra, Vol. 2, pp. 612-615). Adelaide: MERGA.

Grootenboer, P. & Zevenbergen, R. (2008). Identity as a lens to understand learning mathematics: Developing a model. In M. Goos, R. Brown & K. Makar (Eds.), Proceedings of the 31st Annual Conference of the Mathematics Education Research Group of Australasia, Vol. 1, pp. 243-249). Brisbane: MERGA.

Kashima, Y., Foddy, M. & Plastow , M. (2002). *Self and identity: Personal, social and symbolic.* Lawrence Erlbaum Associates.

Lehmann, H.P. (2001). *A grounded theory of international information systems*. Unpublished Ph.D. Thesis. University of Auckland.

Mahlios, M. (2002). Teacher role formation. *Action in Teacher Education. 24*, 9-21.

Strauss, A. & Corbin, J. (1994). Grounded theory methodology: An overview. In N.K. Denzin & Y.S. Lincoln (Eds) *Handbook of qualitative research* (pp. 273-285) Newbury Park, CA: Sage.

Utley, J., Bryant, R., & Moseley, C. (2005). Relationship between science and mathematics teaching efficacy of preservice elementary teachers. *School science and Mathematics 105*(2), 82-87.

Walshaw, M. (2004). Becoming knowledgeable in practice: The constitution of secondary teaching identity. In I. Putt, R. Faragher & M. McLean (Eds.), *Mathematics education for the third millennium: Towards 2010.* (Proceedings of the 27th annual conference of the Mathematics Education Research Group of Australasia, Townsville, pp. 557-563). Sydney: MERGA.

Wilson, S. (2007) My struggle with maths may not have been a lonely one: Bibliotherapy in a teacher education number theory unit. In J. Watson & K. Beswick (Eds.) *Mathematics: Essential research, essential practice.* (Proceedings of the 30th annual conference of the Mathematics Education Research Group of Australasia, Hobart (pp. 815-823). Adelaide: MERGA.

Wilson, S. (2009) "Better you than me": Mathematics anxiety and bibliotherapy in primary teacher professional learning. In R. Hunter, B. Bicknell, & T. Burgess (Eds.), *Crossing Divides*: (Proceedings of the 32nd Annual Conference of the Mathematics Education Research Group of Australasia, pp. 603-610). Palmerston North, NZ: MERGA.

Wilson, S. & Thornton, S. (2006). To heal and enthuse: Developmental bibliotherapy and pre-service primary teachers' reflections on learning and teaching mathematics. In P. Grootenboer, R. Zevenbergen & M. Chinnappan (Eds.), *Identities, Cultures and Learning Spaces:* (Proceedings of the 29th annual conference of the Mathematics Education Research Group of Australasia, Canberra, pp. 36-44). Adelaide: MERGA.

Wood, E. (1988). Math anxiety and elementary teachers: What does research tell us? *For the Learning of Mathematics*, *86*, 8-13.