NAS0448 Developing maths-confidence in sixteen maths-anxious preservice student teachers.

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Abstract

Large numbers of primary preservice student teachers' in Australia lack confidence in their own mathematical abilities and skills when entering teacher education courses. This study investigated the development of maths-confidence in sixteen self-identified maths-anxious preservice student teachers. These students were engaged in the development of their mathematical repertoires within the context of a supportive computer-supported collaborative learning (CSCL) environment. The design of the Intervention Program used in the study was informed by a theoretical framework derived from the literature in the fields of learning environments, novel open-ended mathematical activities, computer supported collaborative learning, community of learners and negative beliefs about learning. The findings from this study indicate that the continuous support from their group members via the computer-mediated Knowledge Forum community, and the support they received from the researcher and facilitator within the non-intimidating workshop environments was crucial in the development of maths-confidence in these preservice student teachers.

Introduction

Large numbers of primary preservice student teachers lack confidence in their own mathematical abilities and skills when entering teacher education courses (Uusimaki & Nason, 2004). This lack of confidence often is manifested in what is known as maths-anxiety (Ingleton & O'Regan, 1998; Martinez & Martinez, 1996; Tobias, 1993) which is a feeling of intense frustration or helplessness about one's ability to do mathematics (Smith & Smith, 1998).

In contrast to maths-anxiety, maths-confidence can be described as an enjoyment in participating in mathematical activities and rather than perceiving mathematics as being hard and boring, mathematics is seen as challenging and worthwhile. Confidence is defined as "an emotion with a subjective component of feelings, a physiological component of arousal and a motor component of expressive gesture" (Barbalet, 1998, p. 86). Confidence functions in opposition to shame, shyness and modesty, which are described as emotions of self-attention or thinking what others think of us (Barbalet, 1998, p. 86).

Ingleton and O'Regan (1998) suggest that confidence has its origins in particular experiences of social relationships, such as "where a person receives acceptance and recognition in contrast to the onset of anxiety and shame where a person is denied this acceptance or recognition" (p.3). Indeed, many of the negative beliefs and anxieties about mathematics experienced by preservice student teachers can be traced back to the frustration and failure in learning mathematics caused by unsympathetic teachers who incorrectly assumed that computational processes were simple and self-explanatory (Karp, 1991). In contrast, preservice student teachers who were taught by teachers with positive beliefs about mathematics and who enjoyed successful mathematical experiences generally have both positive views about mathematics as a discourse worthwhile of study as well as confidence in their ability to do, learn, enjoy and discuss mathematics (Ball, 2001; Brett, Woodruff & Nason, 2002; Ingleton, & O'Regan, 1998).

A number of authors have stressed the importance of teacher confidence, especially the aspect termed self-efficacy, in successful teaching (Lloyd, Braund, Crebbin & Phipps, 2000; Ginns & Watter, 1996). This is where the teacher needs to be confident in communicating his or her own understanding of the mathematics he or she seeks to teach. Considering the large proportion of preservice student teachers entering teacher education programs with negative beliefs and anxieties about mathematics, it seems imperative that one of the major aims of preservice mathematics education programs should be to address student teachers' negative beliefs and anxieties about mathematics and enhance their levels of confidence about doing and teaching mathematics.

Therefore the aim of the study was to design, implement and evaluate an intervention program whose purpose was to reduce levels of maths-anxiety and develop maths-confidence in a cohort of sixteen self-identified maths-anxious preservice student teachers.

Theoretical framework for the study

The theoretical framework for this study (see Figure 1) was derived from research literature from the fields of learning environments (e.g., Brett, et al., 2002; Doerr & Tripp, 1999), novel open-ended mathematical activities (e.g., Becker, 2000; Morse & Davenport, 2000; Ogolla, 2003), computer-supported collaborative learning (CSCL) (Brett et al., 2002; DiMauro & Jacobs, 1995; Sproull & Kiesler, 1991), community of learners (e.g., Brett et al., 2002; Brown & Campione, 1994; Watson & Chick, 2001), and negative beliefs about learning (Boekaerts, 2002; Ernest, 2000; McGriff, Hare,1999; Pehkonen, 2001).

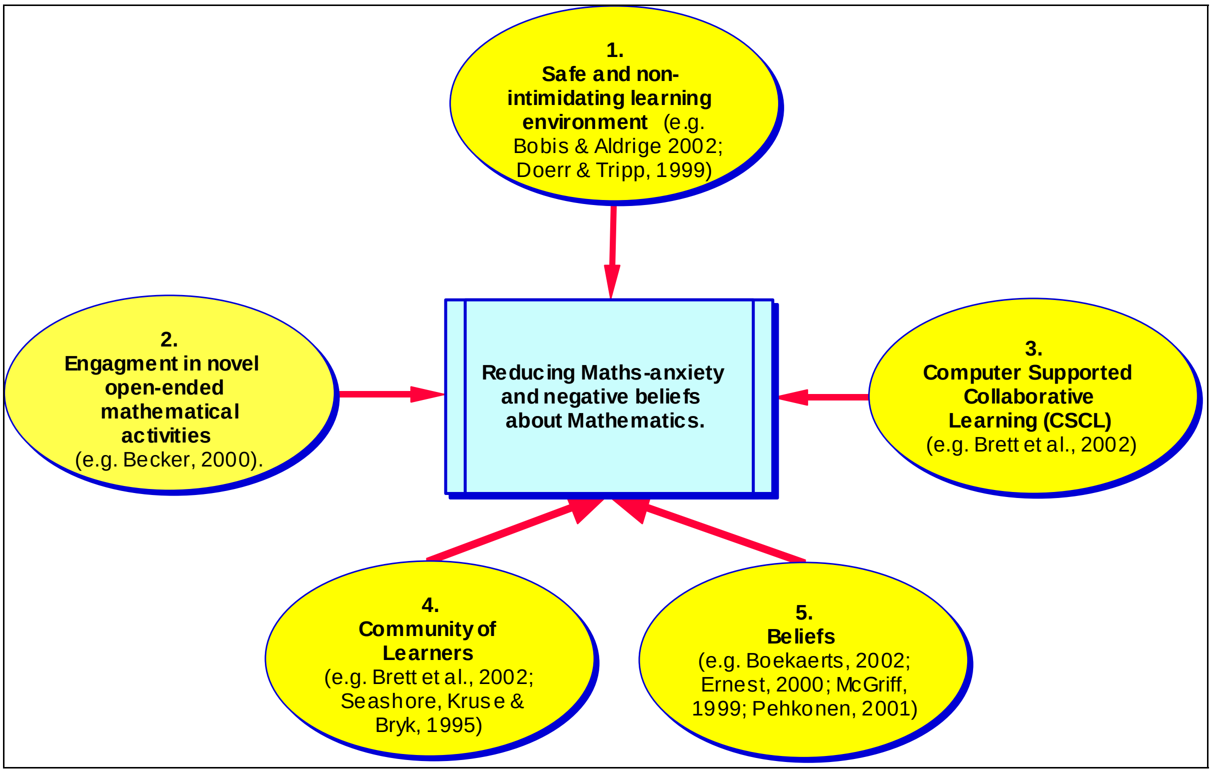

Figure 1. Theoretical Framework

A review of the research literature indicates that first and foremost, the development of safe and non-threatening learning environments are crucial to ensure that preservice student teachers who lack confidence can feel safe to explore and communicate about mathematics and to explore and relearn basic mathematical concepts (Brett, et al. 2002; Doerr & Tripp, 1999). Furthermore, the development of confidence and the development of a community of learners usually can occur simultaneously provided that participation is made available and perceived as an opportunity for negotiation of meaning and agreement (Bauersfeld, 1995). This is reflected in Component 1 of the theoretical framework presented in Figure 1.

The literature also suggests that without a conceptual knowledge of mathematics, mathematical power is diminished which leads to an increase in maths-anxiety and a decrease in maths-confidence (McCulloch Vinson, Haynes, Sloan, & Gresham, 1997). Therefore, it has been argued that maths-anxious preservice student teachers need the opportunity to engage in practical inquiry and reflection about mathematics and mathematics teaching (Borko, Michalec, Timmons, & Siddle, 1997; McGowen & Davis, 2001; Stipek, Givvin, Salmon, & MacGyvers, 2001) as can be afforded by engagement in novel mathematical tasks that allows for multiple approaches (e.g., model-eliciting problem solving activities, open-ended mathematical investigations, etc.). This is reflected in Component 2 of the theoretical framework.

Component 3 of the theoretical framework relates to the benefits of CSCL environments. The literature suggests that CSCL environments may provide a particularly useful support for maths-anxious preservice teachers because the users themselves define the function and disposition of the math inquiry conference in order to meet their needs (Brett et al., 2002; DiMauro & Jacobs, 1995).

Component 4 of the theoretical framework, Community of Learners, was based on research into the development of a community of learners (Brown & Campione, 1994; Watson & Chick, 2001). The benefits of group work or collaboration is that it can bring positive results such as deeper understanding of mathematical content, improved self-esteem and higher motivation to remain on task (Hare & O'Neill, 2000; Walker, 1985). More importantly, collaborative and cooperative learning helps students to become actively and constructively involved in content, and takes ownership of their own learning that leads to their development as critical thinkers.

A review of the literature also indicates that it is crucial to assist maths-anxious preservice students to become aware of their learned negative beliefs and emotions about learning mathematics, and that self-monitoring these emotions allows for them to overcome and control maths-anxiety (Martinez & Martinez, 1996; Pintrich, 2000). This is reflected in Component 5 of the theoretical framework. This component of the framework which was manifested in the development of the thirty second Online-Anxiety Survey used in this research project to enable an awareness of participants' emotional state was based on many aspects of Boekaerts (2002) ideas and research into students' motivational experiences.

Methodology

Participants

The sixteen participants in this study came from a cohort of approximately 300 third-year pre-service primary student teachers enrolled in a mathematics education curriculum unit at a major metropolitan university in Eastern Australia. The sixteen participants (15 female and 1 male) were selected from a pool of forty-five self-identified maths-anxious students who volunteered for the study. The criteria for selection were degree of maths-anxiety, access to internet, and availability to attend workshops.

Data Collection

The sources of data utilised in this study were:

1. Semi-structured pre-and post-enactment interviews.
2. Online Anxiety Survey.
3. Knowledge Forum notes.
4. Written reflections.

Semi-structured pre-and post enactment interviews

Semi–structured pre-enactment interviews helped to identify the causes of the preservice teachers' maths-anxiety/lack of maths-confidence and particular mathematical topics that were anxiety causing. The analysis of this data was also used to inform the selection of appropriate mathematical learning activities in later stages of the study. The post-enactment interviews that took place at the end of the study provided information regarding any changes that may or may not have occurred to the participants' maths-anxiety and levels of maths-confidence.

Online Anxiety Survey

The purpose for the Online Anxiety Survey (Uusimaki, Yeh & Nason, 2003) was to: (a) have the participants recognize and accept their feelings about the introduced mathematical activity, and (b) measure trends in the participants' negative or positive emotions about mathematics as their learning process was unfolding.

Knowledge Forum notes

Knowledge Forum notes that included as attachments the participants' individual and group mathematical models and comments about other participants' models were collected and viewed on a regular basis by the researchers. Knowledge Forum has automatic tracking programs which provide data about patterns of browsing and commenting. This enabled the researchers to assess changes in participants' patterns of collaboration and discourse.

Written reflections

The written reflections focused on what the participants learnt about their own feelings in undertaking the project and mathematical activities. They were encouraged to document issues that their group encountered in the process of group work (c.f., Hare & O'Neill, 2000; Walker, 1985). This facilitated the development of meta-cognition. The participants were able to reflect upon their group thinking as well as their own, make note of their group difficulties such as not working as a team and logistical problems preventing regular meeting times as well as progressively comment on how the group dealt with any difficulties.

Procedure

The research study proceeded in three phases over a period of thirteen weeks:

1. Identification of origins of maths-anxiety.
2. Enactment of Intervention Program.
3. Summative evaluation of the intervention program and post-interview.

Identification of origins of maths-anxiety

In order to ascertain the causes and negative feelings about mathematics held by the participants, individual thirty minute semi-structured interviews were conducted. Prior to the submission of questions, verbal permission was sought from each participant to tape-record the interviews for subsequent transcription. Questions relating to maths-confidence were informed by the research literature about maths-anxiety (e.g., Barbalet, 1999; Ingleton & O'Regan, 1998; Martinez & Martinez, 1996)

Enactment of intervention program

There were four mathematics activities chosen for this phase that were carefully and deliberately selected based on participants' interview responses with respect to the causes of their maths-anxiety and lack of maths-confidence. These four mathematical activities were:

- Number sense activity
- Space and Measurement activity
- Number and shape activity
- Division operation activity

A brief description of each of these four activities is presented in Appendix 1.

To ensure an encouraging learning environment, workshops situations were deliberately designed to create a safe and supportive environment to help participants to feel secure to take risks, and feel supported by each other.

Participants were introduced to an Online Anxiety Survey (Uusimaki, Yeh & Nason, 2004) to measure their subjective experiences prior to and after partaking in each of the various mathematical activities introduced in the workshop situations.

In order to assist participants with the development of their mathematical models, they were also introduced to the functions of the computer mediated software programs Knowledge Forum and Mathematics Ideas and Process Pad (Yeh & Nason, 2003). The purpose for using Knowledge Forum was that it provides an effective platform for facilitating learning that is centred on ideas and deeper levels of understanding (Brett, et al. 2002). Mathematics Ideas and Process Pad (MipPad) provided the participants with mathematical representation tools that enabled them to: 1) generate multiple representations of mathematical ideas in order to reveal explicitly and dynamically the different facets of a complex idea embedded in a mathematical problem, 2) dynamically link the different representations, 3) communicate the mathematical ideas they have constructed and transmit meaning, sense and understanding via concrete, iconic and symbolic representations, and 4) make movie-like sequences of animation slides which enabled others to not only "see" the solution generated from a model-eliciting problem but also to replay the process used to generate the solution (Nason & Woodruff, 2004).

During each of the mathematical activities, each group of participants was required to first generate a mathematical model. Then they were required to post it onto the Knowledge Forum shared database where it could be viewed and critiqued by all the other participants in the study. They also were required at this time to view and post feedback comments about other groups' mathematical models via Knowledge Forum. Based on the feedback they received via Knowledge Forum from the other participants, each group then went through a number of iterations of revising and re-posting their model. At the concluding phase of each activity, the groups were required to post their final mathematical model so that it could be viewed by all participants in the study.

Summative evaluation

At the end of the study, all participants were required to produce a written reflection about their experiences in the project. These reflections were then analyzed in order to identify potential relationships between perceptions of higher mathematical competence, lower levels of anxiety and/or higher levels of maths-confidence.

Following the written reflections, semi-structured interviews were conducted by the researchers to further investigate any changes that may or may not have occurred to their levels of maths-anxiety/ maths-confidence. These interviews also allowed for the elaboration of the participants' written reflections in the project. These thirty minute interviews were tape-recorded and subsequently transcribed for analysis.

Results and Discussion

The results from both the pre-enactment and post-enactment interviews are presented in Table 1. As was expected the analysis of data from the pre-enactment interview to the question, “*How confident are you about mathematics?*” indicated that most participants did not feel very confident about mathematics. Many of the participants’ responses to this question revealed the reasons for their lack of confidence. Some indicated that the rote-learnt nature of their repertoire of mathematical knowledge was the main reason for feeling not confident. This was typified by Ron’s response:

> …I just sort of passed mathematics at school. I had to rote-learn. I had to learn formulas and those sorts of concepts and I didn’t really understand them. For tests I just had to learn what we had to do but I never actually understood what we did.

Other participants indicated that their reasons for feeling not confident were related to concerns about teaching maths. For example, Karen felt her confidence in maths was:

> Basically okay, my main concern would be teaching the higher grades I think. With the younger grades, I think I would be O.K. but when it comes to teaching the higher grades, that’s where I’m anxious and not very confident

However, by the time of the post-enactment interview, significant changes had occurred to the participants’ maths-confidence. This can be seen in data presented in Table 1.

Table 1.

Maths-confidence

Category of responses.	Percentages %	
	Pre-interview	Post-interview
How confident are you about your own maths–skills?		
Not at all	**19**	**0**
Not very	**50**	**19**
Semi- confident	**31**	**44**
Quite confident	**0**	**31**
Confident	**0**	**6**

The increase in maths-confidence according to most participants did not necessarily mean that they felt maths-confident content-wise. Rather, it indicated that they now felt that they were not alone and that there were others who like themselves do not understand mathematics. More importantly, they had come to appreciate that there are many different ways of learning mathematics. For example Marge explained:

> I couldn’t say that content wise I am very confident yet. What it’s helped me with is seeing how many different ways people go about doing things… that was the best thing for me

Belinda in turn said:

> I’m not overly confident with my mathematics but I’m not as scared to give it a go… I will sit down and look at it for hours where as before I would have just said okay I don’t understand that … give up.. I just saw when we were doing our math groups there’s just more people that feel the same way as well so it’s not like I’m a dummy and I think just group work and having someone to talk about it helped.

Rose further elaborated on this confidence by noting:

> I think my skills still have something to be desired, but I think in learning as a group of people that have similar issues and frustration and worries, it's good to see that you're not alone and that you're not the only one… I feel a little more confident in asking people questions and letting people know when I don't understand… I feel confident in that even if I have a wrong answer it's not going to mean the end of the world or that people are going to think less of me. It's good to collaborate with a lot of different people.

There was an increase in participants' feeling semi-confident from 31% to 44%. Rose explained her feelings of semi-confidence by stating:

> Although I still find the subject area difficult and challenging I understand its place and worth and have developed new conceptions about what mathematics is and how it should be taught, especially number sense. I value the importance of discussion in mathematics, flexibility in teaching methods, incorporation of group work, developing and maintaining motivation and the use of technology in creating interest and understanding in this key learning area.

Belinda a highly maths-anxious participant explains how she challenged her maths-avoidant behaviour:

> I have always hated long division and still never learnt how to do it, but I went out and had someone teach me how to do it, that is a big achievement for me to overcome the first thing that turned me right off math. The praise for my accomplishments encouraged me to try and do better in my weakened areas, such as long division areas. I have learned that no matter how hard it looks, give it a go even if you can't do it at least you know you have tried it not just given up at first glance. Also, there is always going to be more than one way of working out a problem.

Feelings of being quite confident to feeling confident about mathematics were two new categories identified in the post-enactment interviews. Participants now feeling quite confident indicated that they no longer felt afraid about the different processes involved in mathematical problem solving and that it was acceptable to make mistakes. Participants also recognized the benefits of group work. Petra explained her feelings of confidence,

> Oh I feel a lot more confident even though I was very nervous about the program. I'm a lot more confident because I understand it [mathematics] a lot more – I've learnt with this program about how important it is not actually about getting the answer but it is the process – how you are doing it. I enjoyed the group work we all learn differently, it is quite amazing – we all have different processing skills

Carla felt,

> 100% more confident because what I've learnt in this project is that to embrace the freedom of making a mistake, means that it's a stepping stone to finding a solution where as prior to coming into this research program I felt shame I felt intimidated because a mistake meant a mark less and that classified me basically as a dummy. Today after being involve in this program I realised that mistakes are to be celebrated and it's like being able to say to the kids "okay that way didn't work, let's try something else.

However, the participants feeling quite confident had not as yet extended their levels of confidence to feeling confident about teaching mathematics with understanding to students in a classroom. Ron, the only male in the research study, was the only participant who felt confident in teaching mathematics for understanding. He stated that,

> I think I could now teach children these concepts and have them understand the concepts, which is the most important thing…

Summary and Conclusions

This study sought to effect positive changes towards mathematics amongst preservice student teachers with negative beliefs and lack of confidence in doing, learning, and teaching mathematics. The aim was to present mathematics as a discourse worthwhile and not about the *right answer* that so often is the reason for the lack of maths-confidence found in large number of preservice student teachers. The findings suggest that this study was successful in developing these preservice student teachers' confidence about expressing, thinking, and experimenting with mathematical ideas.

Much of the increase in the participants' maths-confidence and changes to their beliefs about mathematics can be attributed to a number of factors such as, the continuous support from their group members via the computer-mediated Knowledge Forum community, and the support they received from the researcher and facilitator within the non-intimidating workshop environments. Another important factor that played a crucial role in the increase of maths-confidence and positive changes to participants' beliefs that emerged during the course of the post-interviews was the time allowed to explore and engage in asynchronous computer-supported collaborative discourse. Data from the interviews clearly indicated that this played a crucial role not only in the increase of maths-confidence but also in the development of their understanding and conceptual knowledge about the specific mathematics that were subsumed within the mathematics problems (c.f., Brett et al., 2002). Also associated with this, the results suggest an increase in maths-confidence can be attributed to the participants not feeling alone and that there were others' who like themselves, did not understand mathematics. Indeed, participants came to value small-group work, individual effort and the power of the community of the group as a whole in resolving what to accept as valid in their growing repertoire of mathematical knowledge. This finding is in line with the research literature about the importance of the development of teaching and learning communities (Ball, 2001; Boaler, 2002; Lampert & Ball, 1999; Ma, 1999) and in the development of identities as mathematics teachers (Brett, et al. 2002). Hence, findings from this study clearly support and also in line with other research (c.f. Brett et al., 2002; Scardamalia & Bereiter, 1995) that participating in a CSCL environment increased the depth of participants learning as well as it fostered interactivity among the participants that in turn led to the development of their community.

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Appendix 1.

The four mathematical activities.

Syllabus Strand	Mathematical Activity
Number Operations - Mental Computation	*What are the best way(s) of working out problems such as 68 + 49 in your head?*
Space and Measurement	*Farmer Browns best sheep paddock fronts the river and he has 100 metres of fencing. He needs help to find out the largest rectangular area he can enclose using the 100 metres of fencing.*
Algebra	*In ancient times, people discovered that numbers have shapes. For example, they discovered that all odd numbers had the shape of an L or a gnoman (the L-shaped part of a sundial)* * * * For example: 3 * * and 5 * * * • *Using MipPad, see if you can generate a rule to work out the sum of the first 5 odd numbers.* • *Then try to develop a rule for the sum of the first 10 odd numbers.* • *Then try to develop a general rule.*
Number Operations	*a) How can 3 X 19 be generated from 3 X 20 and 3 X 15* *b) How can you model the following two notions about division:* *a. Partitioning (4 X ? = 24)* *b. Quotitioning (? X 4 = 24)*