KID04997 Reducing maths-anxiety: Results from an online anxiety survey.

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Abstract

Large numbers of primary preservice student teachers' experience maths-anxiety and negative beliefs when entering teacher education courses. This study investigated the reduction of maths-anxiety in sixteen self-identified maths-anxious preservice student teachers. These students were engaged in the development of 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 and teaching mathematics. A focus for this study will be the findings from the online anxiety survey that allowed participants to self-monitor their feelings as they engaged with the various mathematical activities. The findings suggest that a significant decrease in participant maths-anxiety occurred as they became aware of their emotional state and feelings in relation to each mathematical activity.

Introduction.

A large number of students entering primary teacher education programs have been found to have negative feelings about mathematics (Cohen & Green, 2002; Levine, 1996). These negative feelings about mathematics often manifest in a phenomenon known as maths-anxiety (Ingleton & O'Regan, 1998; Martinez & Martinez, 1996; Tobias, 1993). Maths-anxiety can be described as a learned emotional response to, for example, participating in a mathematics class, listening to a lecture, working through problems, and /or discussing mathematics (Le Moyne College, 1999). People who experience maths-anxiety can suffer from, all, or a combination of the following: feelings of panic, tension, helplessness, fear, shame, nervousness and loss of ability to concentrate (Trujillo, & Hadfield, 1999). Maths-anxiety surfaces most dramatically when the subject either perceives him or herself to be under evaluation (Tooke & Lindstrom, 1998; Wood, 1988).

An awareness of the learned negative belief[s] and affect[s] and then the ability to monitor these emotions are necessary components to overcome and control maths-anxiety (Martinez & Martinez, 1996; Pintrich, 2000). A number of researchers (e.g., Ainley & Hidi, 2002; Hickey, 1997; Jarvela & Niemivirta, 1999; Pintrich, 2000) support the need for the development of methodologies and measures that access the dynamics of students' subjective experiences or reactions whilst they are engaged in a learning activity. Ainley

and Hidi suggest that such methodologies and measures provide a new perspective from which to consider the relation between what the person brings to the learning task and what is generated by the task itself. The purpose of this paper is to report on the results of an Online Anxiety Survey (Uusimaki, Yeh, & Nason, 2003) used in a study that sought to address preservice student teachers negative beliefs and anxieties about mathematics (Uusimaki, 2004, Uusimaki & Kidman, 2004). The Online Anxiety Survey was designed to help maths-anxious preservice student teachers recognize and accept their feelings about specifically chosen and anxiety-causing mathematical activities, both before commencing and at the completion of each mathematical activity. The On-line Anxiety Survey was particularly useful in measuring trends in participants' negative or positive emotions about mathematics as their learning process was unfolding.

Methodology

Participants

The 16 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.

Procedure

The methodology used in the study incorporated three stages and can be seen in the diagrammatic representation (the Intervention Program) in Figure 1.

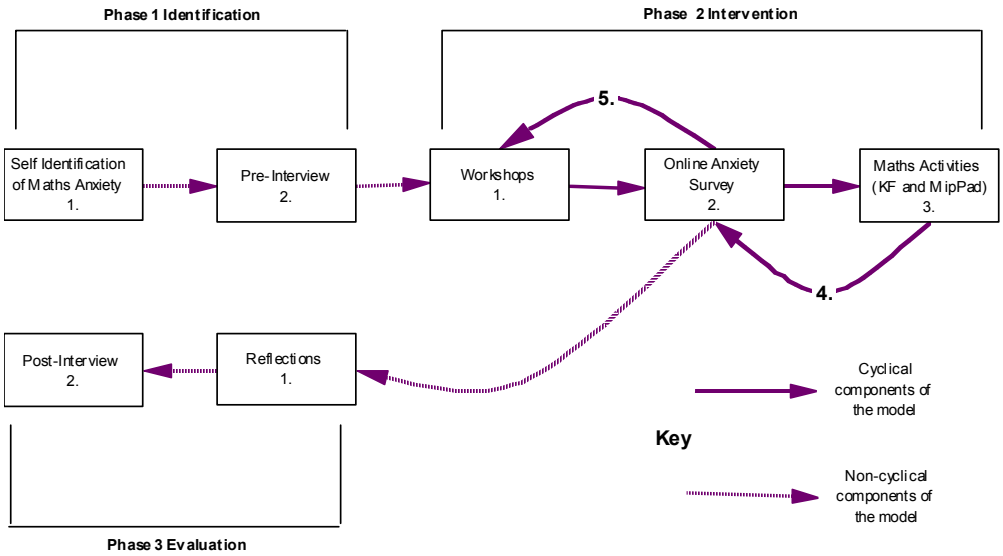

Figure 1. Intervention Program

Phase 1: The identification of origins of maths-anxiety.

In this initial phase individual 30 minute semi-structured interviews were conducted to ascertain the causes and negative feelings about mathematics held by the participants.

Phase 2: The enactment of the intervention program.

In this second phase, to ensure a conducive learning environment, the four 60 minute workshop situations were deliberately designed to establish a safe and supportive environment to help participants feel secure to take risks, and feel supported by each other. Participants were allocated into groups of three with whom they collaborated as a team throughout the study. Mathematical activities that focused on mathematical content areas which the participants had indicated were anxiety-causing were utilized in this phase (see appendix 1). Participants were then introduced to the Online Anxiety Survey (Uusimaki et al., 2004) (see Figure 2) to measure their subjective experiences prior to and after partaking in each of the four 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 (Brett, Nason & Woodruff, 2002) and Mathematics Ideas and Process Pad (MipPad) (Yeh & Nason, 2003).

Phase 3: The summative evaluation.

At the end of the study, all participants were required to produce a written reflection about their experiences in the project. These written reflections were analysed in order to identify potential relationships between perception of higher mathematical competence and lower levels of anxiety. Following the written reflections, semi-structured interviews were conducted to further investigate any changes to perceptions that may or may not have occurred.

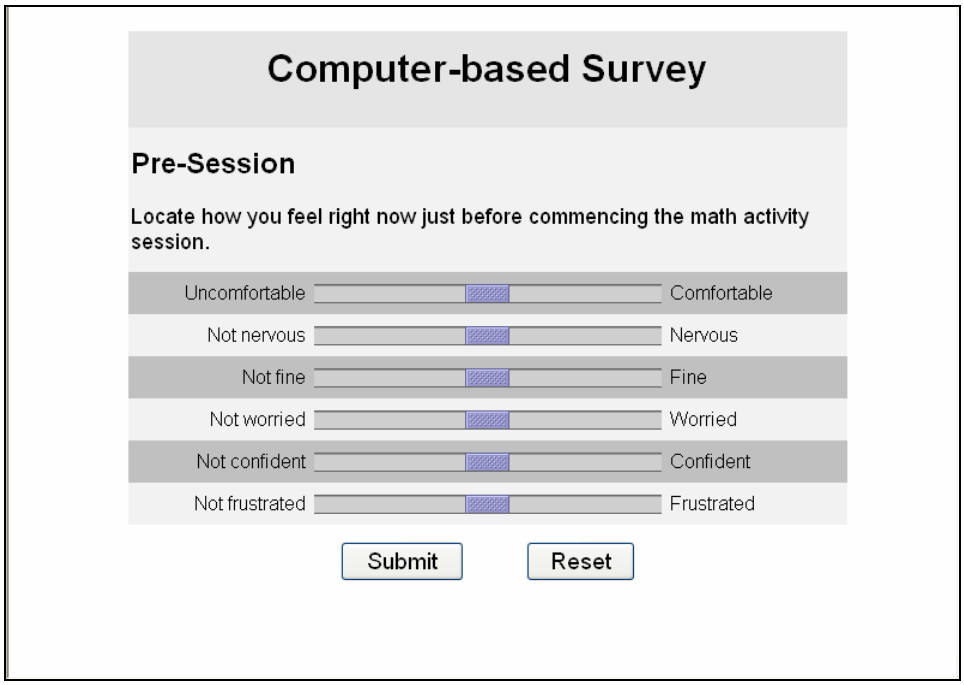

Figure.2. Online Anxiety Survey.

Figure 2 shows an example of the pre-session Online Anxiety Survey and the choices of the affective responses used in the study. It takes approximately thirty seconds to complete the online anxiety activity. To record the emotional response triggered by the mathematical activity the participant was required to slide a bar horizontally along a scale to indicate his or her feeling both prior to and at the completion of the mathematical activity. Once the participant had completed the activity, the program then recorded a numerical value (unknown to the participant) that was stored as a number between for example 0 for uncomfortable and 100 for comfortable.

Data Analysis

The Online Anxiety Survey measured three positive feeling responses as defined (perceived) by the participants: (a) comfortable (a sense of personal comfort), (b) confident (a sense of I can do this activity), and (c) fine (I feel good about this activity). The three negative feeling responses were as defined by the participants: (a) nervous (physical feelings such as for example, a nervous stomach), (b) worried (a sense of fear for activity), and (c) frustrated (a sense of anger and hopelessness towards the situation).

Descriptive statistics were produced using Box plots to determine overall trends and the distribution of data followed by inferential statistics. Quantitative data from the Online Anxiety Survey was analysed using multivariate analysis of variance (MANOVA) with repeated measures and graphical analysis. The analysis of this data facilitated the identification of key episodes or mathematical activities that led to the changes in perceptions. A comparison of pre- and post- scores was made in relation to each of the six affective/feeling responses via a graphical analysis in the form of a line graph. The Online Anxiety scale recorded an interval level of measurement (Levin, 1977) as the respondents indicated measures "which yield equal intervals between points on the scale" (Levin, 1977, p. 6). Parametric tests were used to analyse the data with the statistical data analysis used in this study first tested for overall significant differences between pre-intervention and post-intervention scores. This analysis was based on a multivariate analysis of variance (MANOVA) with repeated measures. The independent variable was the pre-and post- mathematical activity intervention whilst the six feeling responses (comfortable, fine, confident, worry, nervousness and frustrated) were the dependent variables or response categories. Pillai's Trace test was used due to small sample size (n=16) (Krus, 2004). Further analysis was made by means of pairwise comparison to determine whether there was significant change within each of the feeling responses.

Results and Discussion.

Box plots were used to give an overall visual record of participants' pre- and post anxiety distribution. The box represents the inter quartile range which contains the middle fifty percent of values in the sample, that is from the twenty-fifth percentile to the seventy-fifth percentile. The line across the box indicates the median. The whiskers extend respectively from the twenty-fifth and seventy-fifth percentiles to the lowest and highest scores. An outlier is shown as an open circle either above or below the upper or lower whisker and represent data outside the regular data distribution. A positive skew is determined by the mean being higher than the median and that the upper whisker is longer than the lower whisker (Lane, 2000).

The overall results of the study show the impact of the four mathematics activities on the participants' feelings. Figure 3, represents the three positive feelings – comfort,

confidence and feeling fine. As can be seen from Figure 3, there has been a positive shift in the feeling responses of comfortable and confident for most participants. However, the degree the bottom whiskers have not shifted in these two feeling responses, indicated at least one participant not feeling comfortable or confident with the activities. The degree to which the bottom whiskers move up in the positive feeling response "fine" suggests that all participants enjoyed the mathematical learning experiences.

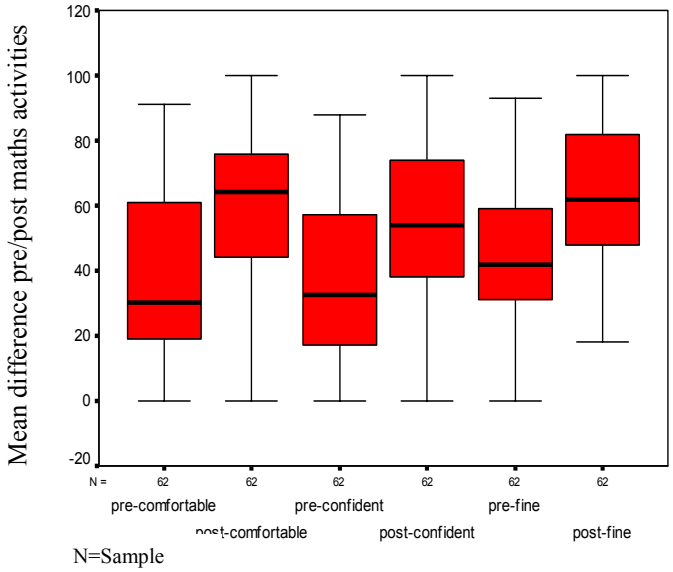

Figure 3. Box Plots Overall positive feelings

The overall impact of the intervention on participants' negative feelings showed a decrease in the negative feelings, worried and nervousness; this can be noted by the degree the top whiskers move down in these negative feeling responses (Figure 4). Only a slight decrease was noted in the feeling of frustration.

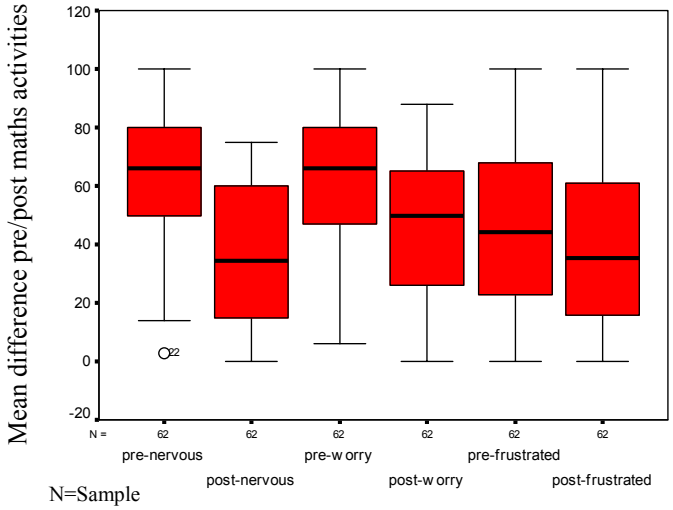

Figure 4. Box plots Overall negative feelings

Inferential statistics were used to test overall statistical significant differences' between pre-intervention and post-intervention scores of the Online Anxiety Survey. The analysis utilised a multivariate analysis of variance (MANOVA) with repeated measures and was found to be statistically significant (Pillai's Trace = .647, F (6,56) = 17.01, p = .000). Further analysis with the use of Pairwise comparison was used to determine the significance of the mean differences between the pre- and post-intervention score, as shown in Table 1.

Table. 1

Overall results. The mean difference on each of the value scales across the four mathematical activities.

Feeling	Mean difference Pre and Post activity	Std. Error	Sig. (a)
Comfortable	**23.097(*)**	**2.849**	**.000**
Confident	**19.032(*)**	**2.893**	**.000**
Fine	**20.935(*)**	**2.405**	**.000**
Nervous	**-27.661(*)**	**3.364**	**.000**
Worried	**-18.774(*)**	**3.828**	**.000**
Frustrated	**-6.694**	**4.064**	**.105**

Based on estimated marginal means
* The mean difference is significant at the .05 level.
(a) Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments)

The pairwise comparison test compared the differences between each pre – post feelings of the four mathematical activities. Comparisons were made on the individual means using the standard errors of each mean (Becker, 1999). As can be seen, the results show that there were significant mean differences in the positive feeling responses of comfortable, fine, and confidence as well as a decrease in the negative feeling responses of nervousness and worried. No statistically significant mean differences were found in the feeling response of frustration.

The findings from the Online Anxiety Survey about the participants' perception regarding each of the four mathematics activities saw statistically significant increases in most of the participants' levels of positive feelings (i.e., comfort, confidence and feeling fine). Significant reductions were also, noted in the negative feelings (i.e., nervousness and worry). However, the findings suggested no significant changes in participants' levels of frustration except for the last learning activity.

An analysis of post-enactment interview data indicated that qualitative changes occurred to the participants' feelings of frustration during the course of engagement in the mathematical problem solving activities. Whereas frustration at the beginning of an activity was related to concerns about the mathematical activity and being able to start the process of problem solving, by the end of the activities, feelings of frustration tended to be related to frustration with the computers (e.g. the server being down, or not being able to download the software program on the home computer) or frustration about the relevance/worth of a specific mathematical activity.

The insights into participants' subjective experiences as they navigated their way through the various mathematics activities suggested that their need and interest in overcoming their fear of mathematics and fear of failure in the task influenced their affective responses but not intended effort (c.f., Ainley & Hidi, 2002; Boekaerts, 2002). For instance, by the time the participants were engaged in the final mathematics activity, although they still experienced feelings of anxiety about mathematics, this was no longer manifested by avoidance behaviour. For example, one of the participants Belinda now felt comfortable enough to confront her phobia towards long division; she independently sought help outside the community to acquire knowledge necessary for her to be able to teach division with deep understanding. Further, these insights were helpful to the participants in their quest for effecting change (to overcome their negative beliefs and anxieties about mathematics), for they allowed reflection and awareness of their emotional state (Boekaerts, 2002; Martinez & Martinez, 1996).

Summary and Conclusions

The Online Anxiety Survey was effective in being able to record the emotional state of the participants before and after each of the four mathematical activities. However, one of the difficulties of the Online Anxiety Survey was that there were no "behavioural" anchors to the Likert scale. That is the scale did not focus on different aspect of comfortableness, nervousness, confidence, worry, frustration and feeling fine. Even so, and whilst the Online Anxiety Survey had no psychometric properties it has face validity. Hence, the results from the online anxiety activity must be treated with some caution.

The clear implications from this analysis for future research into challenging maths-anxiety suggest a deeper understanding the role emotion plays in learning mathematics. As has been noted to be comfortable or uncomfortable about mathematics is not dependent on ability, it is anxiety that interferes with the learning of mathematics. It is the fear of failure and worry that affects performance even when the mathematics is well within the skill level of, as in this study, the preservice student teacher.

Innovative intervention programs that seek to support and empower maths-anxious preservice student teachers to develop confidence as both learners and teachers of mathematics are crucial particularly in challenging persisting stereotypical ideas and myths associated with who can or can't do mathematics.

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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)*