An Online Survey to Assess Student Anxiety and Attitude Response to Six Different Mathematical Problems

Vincent Anderson
Launceston College and University of Tasmania
<Vincent.anderson@bigpond.com>

Survey results for anxiety responses and attitude responses to six particular mathematics problems are presented for 43 students from grades 4, 5, and 6. These data are analysed for a relationship between mathematics anxiety and attitude to mathematics. An online survey method is used and is found to be a valuable tool for use in a primary school setting. The six mathematics problems vary in type between traditional levelled tasks in the form of basic mathematical operations and rich tasks. Basic operations are varied amongst three levels of difficulty and rich tasks are varied amongst three degrees of complexity of context. A weak relationship is found between mathematics anxiety and attitude to the six mathematics problems presented to students. Some differences are observed between boys and girls for responses to rich tasks. Also, differences in both attitude and anxiety responses are found due to a variation of problem difficulty for traditional basic operations. Further research is suggested that promises to inform the pedagogies of practicing teachers.

Anxiety response to mathematics is a significant concern to educators in terms of the perception that high anxiety will relate to avoidance of mathematics. An internet search quickly shows the broad interest of many in this subject. This paper presents survey responses of a small sample of 43 upper primary school students. The context of the survey is an online survey environment, where students are asked to consider six particular mathematical problems. After each of the six problems, the students are asked to respond to six questions for anxiety response, based on the survey instrument used by Uusimaki and Kidman (2004), followed by a question of their familiarity with the question and then six questions for an attitude response, based on the survey instrument used by Ma and Kishor (1997).

In this study, anxiety response to mathematics is taken to mean an involuntary emotional response to mathematical problems and mathematical language. Attitude to mathematics is taken to refer to a qualitatively different phenomenon, where the nature of the response is considered and couched in thoughtful, cognitive language. Some explanations of attitude to mathematics treat the concept as synonymous with mathematics anxiety, such as a teacher of mathematical economics, Dr Alpha C. Chiang (Huenneke, 2005):

> Unfortunately, studying mathematics is, for many, something akin to taking bitter-tasting medicine, necessary and inescapable, but extremely tortuous. Such an attitude, referred to as math anxiety, has its roots, I believe, largely in the inauspicious manner in which mathematics is presented to students.

Unlike the position taken by Chiang, the present study interprets attitude response to mathematics as a cognitive response. This differentiation between attitude response as cognitive and anxiety as an emotional response is informed by Goleman (1996), Schlöglmann (2001), Hannula (2005), and Ritchhart (2001). This differentiation is adopted by Kabiri and Kiamanesh (2004). Particularly Goleman (1996) describes the anxiety phenomenon of involuntary emotional responses that operate too quickly for cognitive processing to filter them.

The phenomenon of attitude to mathematics is considered in this study as similar to the concepts of Intellectual Character (IC) and Thinking Disposition, as outlined by Ritchhart (2001). Ritchhart refers to the limitations of traditional concepts of intelligence, and proposes an alternative perspective, where the importance is placed on IC, rather than the traditional, fixed measure of IQ. Ritchhart summarises the various interpretations of Thinking Dispositions from the literature and relates these to the concept of IC. Ritchhart differentiates IC from IQ by claiming that ability is only part of performance, where IC is a demonstration of a will or inclination to use these abilities, and a sensitivity to know when particular abilities are appropriate. Thinking Dispositions proposed by Ritchhart are: openmindedness, a curious nature, metacognition, truth seeking, strategic planning, and a sceptical nature.

Measurement of anxiety response for this study is done through an online survey instrument only. Hanula (2005) identifies the difficulty of measuring affective responses, such as anxiety, to mathematics accurately outside of a psychology laboratory. Hanula favours observations of students to assess emotional response when researching in real life situations. The use of such techniques in a classroom environment was not feasible for this survey. The design of the survey is intended to allow the students to respond immediately to the anxiety survey questions after seeing each mathematics problem, augmented by the use of smiley faces and the immediacy of an online survey.

Unlike the research of Ma and Kishor (1997), as well as Uusimaki and Kidman (2004), this study considers student responses to six particular mathematics problems, rather than mathematics in general. Ma and Kishor suggest that their focus, and that of many researchers, on attitude responses to general mathematics could be too broad to show strong relationships that are meaningful and applicable to pedagogy development. They suggest the use of particular problems or fields of mathematics.

> Perhaps the best solution, before more advanced attitude measures are developed, is to measure specific attitudes toward certain mathematical areas or activities (e.g., arithmetic, problem solving) rather than generalized attitude toward mathematics as a whole. (p. 40)

Due to the use of particular mathematics problems, it is possible to survey the students' familiarity with each problem type. The role of familiarity with the problem type can then be considered in relation to students' anxiety and attitude responses. The use of particular mathematics problems also allows the effect of problem difficulty and problem type to be considered. The problems selected for this survey were conceived as three basic operations, ranging in difficulty from easy to difficult, followed by three rich tasks ranging from a familiar and simple context to an unfamiliar and complex context.

The purpose of this paper is not to elaborate on the difference between rich tasks and traditional basic operations. Ritchhart (2001) argues the merits and attributes of rich tasks. Anderson (2005) reviews literature on this topic.

Research Questions

The research questions posed for this study are:

- What is the typical anxiety versus attitude profile of upper primary school students in response to the three basic operations and three rich tasks selected?
- What effect does the difficulty of the selected basic operations have on student responses?

- What effect does the complexity of the selected rich tasks have on student responses?
- What trends are apparent between anxiety response and attitude response to each mathematics problem?
- Are there any implications for teaching practice in the results of this research?
- Does the method of online surveys support efficient and effective research in the environment of a primary school?

Methodology

The school that participated in this research is a primary school of approximately 300 students in a central suburb of a city with a population of about 250,000 people. The socio-economic background of the student population is modestly wealthy and very homogeneous. Nineteen girls and 24 boys in grades 4, 5, and 6 completed the survey.

An online survey is used to measure students' anxiety response, and then attitude response to six particular mathematics problems. Access to the survey is controlled with a password and a page that asks the students if they agree to participate in the survey. The design of the survey initially requests grade level and gender of the student. The structure of the remaining survey shows a sequence of mathematical problems to the student and asks them to *consider* solving each problem, but *not* to solve them. The online survey format reinforces this request by not allowing any area for an answer to be presented by the student and by stating repeatedly that students do not need to solve the problems. Immediately after the presentation of each problem, an anxiety survey instrument of six questions is presented to the students. Smiley face symbols are used to highlight the emotional nature of the response, as shown in Figure 1.

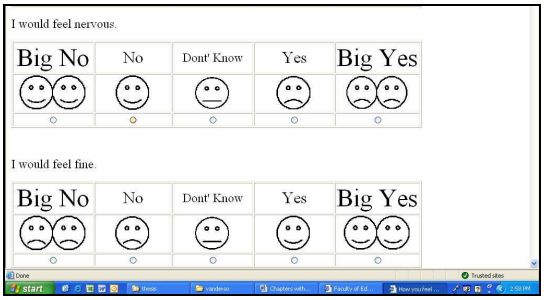


Figure 1. Screen capture of the online survey showing the appearance of radio buttons and formatting.

The anxiety survey instrument is based on that used by Uusimaki and Kidman (2004) and consists of graded responses as shown in Figure 1 to the following six statements:

- I would feel comfortable.
- I would feel nervous.
- I would feel fine.
- I would feel worried.
- I would feel confident.
- I would feel frustrated.

Uusimaki and Kidman (2004) also used an online survey, although with a different format, and they surveyed preservice teachers. The construction of this survey is modified to be more communicative to grade 4, 5, and 6 students through a selection of language, font size, and smiley faces.

To differentiate the attitude section of the survey, the students are specifically asked to respond to what they think about the problem they have seen, marking a deliberate shift to less emotive language. Smiley faces are not used for this reason. Immediately before the attitude survey statements, a familiarity question is posed as a statement, *I have seen problems like this before*, requesting a graded response.

The attitude survey statements that follow are based on those used by Ma and Kishor (1997) and request a graded response, but without use of smiley faces, to the following six statements. As with the survey instrument used for anxiety response, polarity of the questions are alternately reversed in an attempt to neutralize erroneous or random responses.

- I am not good at maths like this.
- I like this kind of maths problem.
- I would not try to answer this maths problem if I didn't have to.
- I think answers to problems like this might be useful in my life.
- I think this problem would not be easy to answer.
- I think maths like this is important in the world.

The six mathematical problems selected are shown respectively in Figure 2 to Figure 5. Problems 1 to 3 are basic operations (Figure 2), or traditional levelled tasks, intended to range from easy to difficult for the sample group. Questions 4 to 6, shown in Figures 3 to 5, are conceived as rich tasks. They demonstrate a broader use of language to describe context and present texts that the students might use in authentic contexts. The screen format in the actual survey for the fifth problem in Figure 4 is much larger than shown here.

Problem 1: $17-5=?$

Problem 2: $553+365=?$

Problem 3: $43\times17=?$

Figure 2. Three basic operation problems used in survey.

If 6 of your friends are coming to your house to share a pie, what shape would you make it so that it would be easy to cut into equal serves? How would you cut it? If one person does not turn up, how could you cut the cake into 5 equal portions?

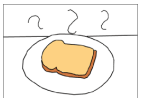
Figure 3. Fourth example problem, sharing a pie between 5 or 6 friends.

You have $6.30, and your best friend has $6.90. What items could you buy from the following advertisement?

Do you think that the food in this ad is healthy? How could you measure this?

Figure 4. Fifth example problem, shopping with a friend.

You have 45 friends coming around to your house to eat some French Toast with you. The cook says they have run out of eggs and that you need to run to the store and get enough for everyone. It's up to you to work out how many dozen eggs to get for the recipe shown here.



French Toast

Details.

2 eggs
1/2 cup milk
Pinch of cinnamon
3 to 4 bread slices (preferably stale challah or sourdough)
1 tbsp. butter
Maple syrup, powdered sugar, or orange/raspberry juice concentrate (optional)

What you do.

Crack the eggs into a bowl, add milk, put in pinch of cinnamon.
Whisk until well blended.
Pour the mixture into a pie pan, dip both sides of each slice of bread in the mixture until well soaked
Melt butter in a skillet over medium heat.
Cook the bread for five minutes or until brown underneath, both sides.
Transfer the bread to a clean plate and add the topping of your choice. You've made French toast!
Recipe and illustrations by Mollie Katzen, author of Pretend Soup

Do you think this food will be healthy for everyone who would be coming to share food? What are some reasons that a person might not be able to eat French Toast? How could you include them?

Figure 5. Sixth example problem, needing eggs for a recipe.

The use of an online survey allows the data to be transferred via email for collection and collation. The security of personal data is addressed by de-identifying all of the data, meaning that without the key of the survey, the data cannot be interpreted by third parties. Names are not requested for this reason. The survey is conducted within the classroom in small groups and interaction between the students is not discouraged.

The anxiety and attitude data are analysed using descriptive statistics, including box-and-whisker plots, to compare responses to the six questions for boys and girls. Familiarity data are considered in graphical form as positive, neutral, or negative, again for boys and girls. The relationship of anxiety and attitude responses is summarised in graphical form and the degree of association reported in *r*-squared values.

Results

Anxiety responses are shown in Figure 6 where the discrete data have been normalised between extremes of -1 to +1. The overlap of responses as problems varied was significant. As the sample size was only 43 students, apparent trends should be interpreted reservedly. The most significant feature is the apparent increase in anxiety response to the three basic operations as there level of difficulty increases for both boys and girls. Variation in anxiety between the three rich tasks is less apparent for either boys or girls although there is a suggestion of a slight increase as the problems become more complex.

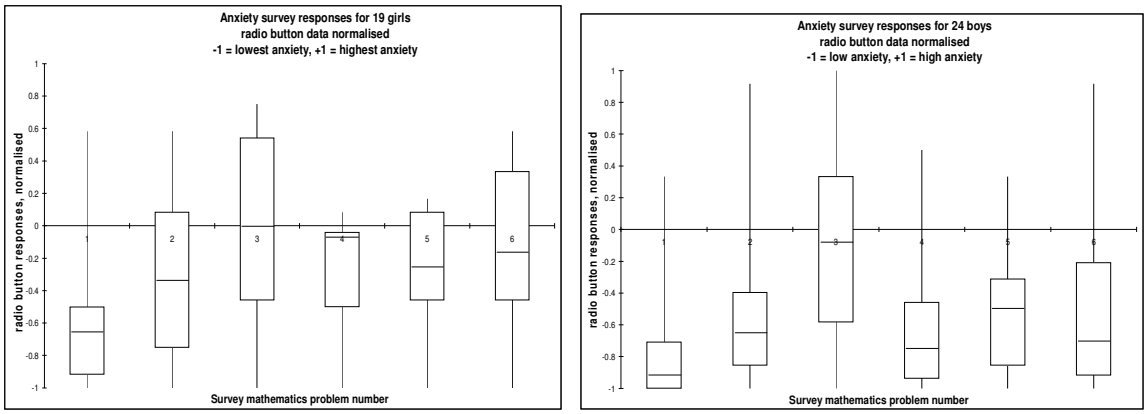


Figure 6. Anxiety survey data spread, 19 girls (left) and 24 boys (right).

The familiarity responses to the six problems are shown in Figure 7, for boys and girls. The responses are grouped as positive, neutral, or negative. Figure 7 shows that the girls familiarity steadily decreases as the problems progress and shows that boys responses are less regular. They show that boys show a potential increase in familiarity with more difficult problems, although a larger sample would be needed to support this interpretation. For five of the six problems, however, the girls express a higher level of familiarity.

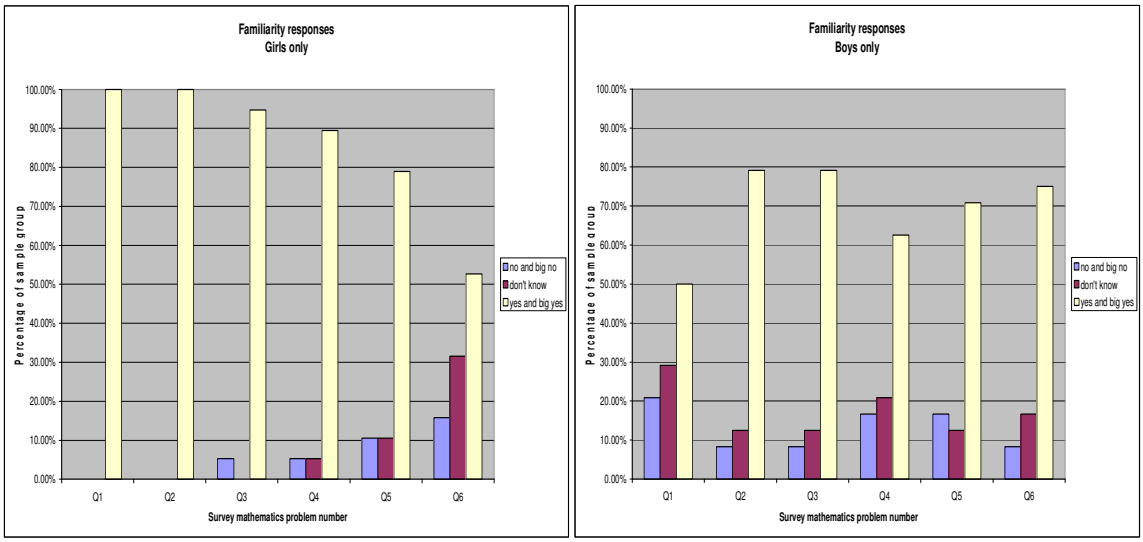


Figure 7. Familiarity responses, 19 girls and 24 boys.

Attitude responses are shown in Figure 8 for boys and girls. The most significant feature is the apparent decrease in attitude response to the three basic operations as the level of difficulty increases for both boys and girls. Variation in attitude between the three rich tasks is not apparent for either boys or girls.

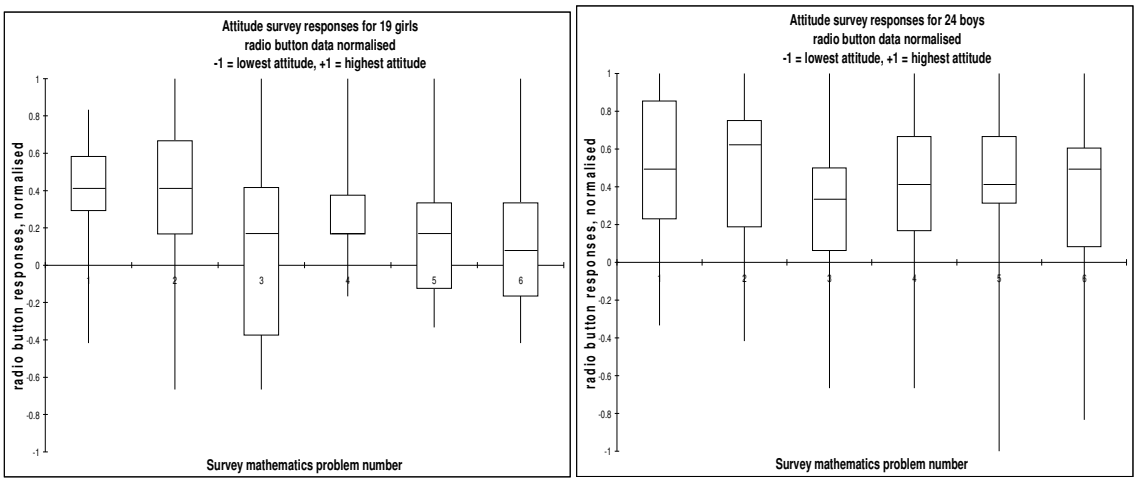


Figure 8. Attitude survey data spread, 19 girls and 24 boys.

An alternative representation of the anxiety and attitude data is shown in Figure 9 with average and standard deviation used instead of the quartiles represented by box-and-whisker plots. Figure 9 supports the apparent sensitivity of anxiety and attitude with relation to difficulty of basic operations for both boys and girls. A general trend of higher anxiety relating to lower attitude response is indicated by responses to the basic operations. Figure 9 shows a potential increase in anxiety for the most complex rich task for girls only. There does not appear to be any other discernable sensitivity of attitude and anxiety with relation to the three rich tasks selected for this survey, particularly for boys.

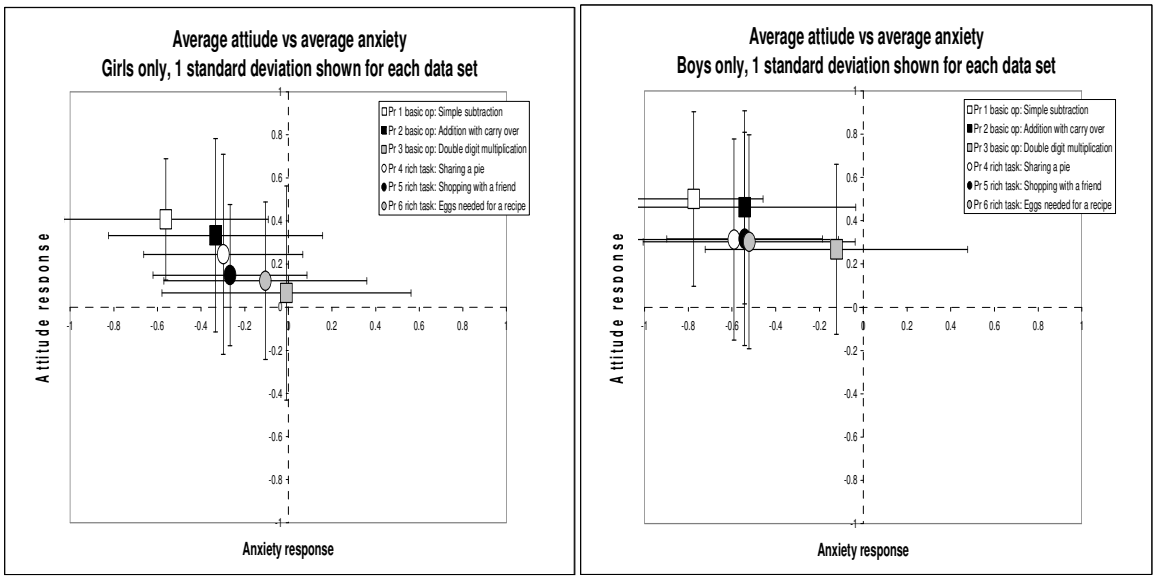


Figure 9. Average attitude versus anxiety for different mathematics problems, girls and boys.

The general trend of a reduction in attitude with an increase in anxiety response is also indicated by Figure 10 where attitude response and anxiety response to all six problems are shown together. Each data point represents one student's response to a particular problem.

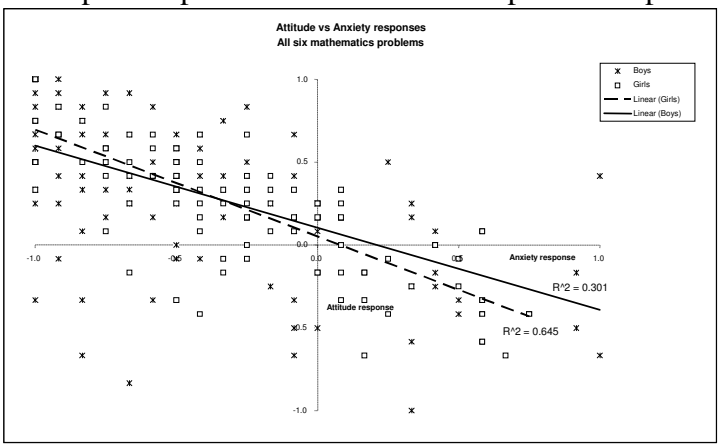


Figure 10. Attitude vs Anxiety responses for all six mathematics problems.

Although not shown in individual graphs here, the squared Pearson's correlation coefficient values for each of the six problems, showing the strength of the association for boys and girls is shown below in Table 1. The sign of all correlation coefficients is negative. For all problems except the first, the association of anxiety and attitude is stronger for girls than for boys.

Table 1
Summary of Pearson's r² Values for Variation of Data from Trendlines for Attitude Versus Anxiety

	Boys	*Girls*
Problem 1	0.339	0.336
Problem 2	0.390	0.678
Problem 3	0.302	0.756
Problem 4	0.451	0.672
Problem 5	0.236	0.507
Problem 6	0.231	0.704

Discussion

The role of anxiety response is assumed to be a powerful driver of decision making for students in discontinuing with mathematics or avoiding mathematics and further entrenching an innumerate self perception for those afflicted. Although this survey asks for responses to six particular problems whereas other research asks for responses to mathematics in general, if Figure 10 is considered as indicative of students' responses to mathematics in general, the results compare favourably with other research. Bowd and Brady (2003) cite Hembree (1990), from a meta-analysis of 151 pre-service teachers:

> Hembree also noted that preservice arithmetic teachers were especially prone to mathematics anxiety and that positive attitudes toward mathematics consistently related to lower mathematics anxiety.

Kabiri and Kiamanesh (2004) found a similar relationship with an r^2 coefficient of 0.4 from a survey of 366 Iranian eighth graders.

Answers to Research Questions

What is the typical anxiety versus attitude profile of upper primary school students in response to the three basic operations and three rich tasks selected? Students typically show a reduction in attitude to a mathematics problem that they also show an increase in anxiety response towards. Student responses range almost the full scale of attitude and anxiety with most responses lower than neutral anxiety and higher than neutral attitude. There are very few responses that show a high attitude associated with a high anxiety.

What effect does the difficulty of the selected basic operations have on student responses? The range of basic operations selected caused a surprisingly large difference in anxiety response and an apparent difference in attitude response.

What effect does the complexity of the selected rich tasks have on student responses? The range of rich tasks selected was not associated with significant variation of attitude or anxiety responses.

What trends are apparent between anxiety response and attitude response to each mathematics problem? A weak and negative correlation is found for all problems, where an increase in anxiety response is associated with a decrease in attitude. Squared Pearson's correlation coefficients are shown in Table 1.

Are there any implications for teaching practice in the results of this research? Teachers are invited to interpret these data in terms of their own practice. One feature worthy of note is the small number of responses showing high attitude and high anxiety response. This would indicate that anxiety is not an effective motivator for some students' performances. Knowledge of the potentially stronger association of anxiety and attitude for girls may assist teachers in planning classroom activities and the attitudes they themselves exhibit. Knowledge of increased anxiety with increasing difficulty of basic operations would not be a surprise to teachers but again may assist in planning support for students who struggle.

Does the method of online surveys support efficient and effective research in the environment of a primary school? The online survey method was observed to be engaging to the students. The value of receiving data in an electronic format made translation and analysis of the data easier. This ease of handling data meant that as a researcher in the classroom the researcher could focus on managing the flow of students and answering their technical questions. The format of the online survey was also well received by the three classroom teachers who generously allowed their classes to participate in the survey. There were a handful of students who opted not to participate in the survey of their own accord, whereas two parents responded with withdrawal of consent. Of three classes, the take up rate was very encouraging for the use of web based surveys in the future.

Limitations of the Study and Suggestions for Further Research

The sample size of this study is small. A larger sample group would allow stronger conclusions and invite more detailed analysis of data. A sample that also included a wider range of socioeconomic variation would also allow conclusions to be applicable more broadly to teaching practice.

Anxiety is understood to be an involuntary emotional response, best measured by involuntary responses such as perspiration, body language or twitching, as suggested by Hanulla (2005). Calibration of the anxiety survey instrument in relation to involuntary responses would establish the degree of validity of measuring anxiety response with a survey instrument only.

No deliberate attempt was made explicitly to link the particular skills required to solve the relative rich task and basic operation in this survey design although some similarity was intended. Future survey designs should align the skills required between relative problems of different kinds to allow stronger conclusions when comparing types of problems that teachers might set for students.

This study was not designed to investigate any potential causal relationship between attitude response and anxiety response. A longitudinal study to establish cause and effect between anxiety and attitude would be valuable in terms of informing teaching strategies that might address cause and not effect.

Acknowledgement. This study was conducted as part of the Bachelor of Teaching Honours Program at the University of Tasmania under the supervision of Jane Watson.

References

Anderson, V. (2005). *Investigation of the relationship between anxiety response and attitudinal response to six mathematics problems: upper primary students*. Unpublished Honours Thesis. Hobart: University of Tasmania.

Bowd, A. D., & Brady, P. H. (2003). Gender differences in mathematics anxiety among preservice teachers and perceptions of their elementary and secondary school experience with mathematics. *Alberta Journal of Educational Research, 49*(1). Available at http://proquest.umi.com.ezproxy.utas.edu.au/pqdweb?index=2&did=579671371&SrchMode=3&sid=1&Fmt=3&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1176534708&clientId=20931&aid=1

Goleman, D. (1996). *Emotional Intelligence: Why it can matter more than IQ*. London: Bloomsbury Publishing Plc.

Hannula, M. (2005). *Understanding affect towards mathematics in practice.* Abstract submitted to the Fourth Nordic Conference on Mathematics Education, Relating Practice and Research in Mathematics Education, Trondheim, Norway. Retrieved on 15/7/05 from http://norma05.hist.no/Abstracts/Hannula.pdf

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*, 33-46.

Huenneke, S. (2005). *Does Econ Answer Man have a way for us mortals to do better in economics?* Retrieved 16/9/2005 from: http://warp6.cs.misu.nodak.edu/econ/econanswerman/econans1.html.

Kabiri, M., & Kiamanesh, R. (2004). *The role of self-efficacy, anxiety, attitudes and previous math achievement in students' math performance*. Unpublished paper. Tehran: Institute for Educational Research, Teacher Training University, Tehran, Iran.

Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education, 28*, 26-27.

Ritchhart, R. (2001). From IQ to IC: A dispositional view of intelligence. *Roeper Review, 23*, 143-150.

Schlöglmann, W. (2001). Affect and cognition: Two poles of a learning process. *Proceedings of the 3rd Nordic Conference on Mathematics Education, Kristianstad, Sweden*. Retrieved 9/9/05 from http://www.education.monash.edu.au/centres/sciencemte/docs/vamp/schloglmann2001.pdf

Uusimaki, L., & Kidman, G. (2004, November*). Reducing maths-anxiety: Results from an online anxiety survey.* Paper presented at the Australian Association for Education Research Annual Conference, Melbourne. Available at http://www.aare.edu.au/04pap/kid04997.pdf