

Changing attitudes: undergraduate perceptions of learning mathematics

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The purpose of my research is to explore first year undergraduate perceptions in learning mathematics and their identification of strategies to support them in this area. I work as a senior lecturer in mathematics education on a BA Applied Education Studies course where students consistently identify the mathematics education units as a source of anxiety. Having established a potential link between mathematics anxiety in teachers and trainee teachers, and the potential that this anxiety could be passed on to children in classrooms, my aim is to identify whether there may be strategies that could support adults in learning mathematics. To explore this area, I tracked a sample of first year undergraduate students through their initial mathematics education unit, establishing their perceptions before and after the teaching of this unit. Initial findings demonstrated that the students had negative perceptions about learning mathematics (twice as many negative as positive) and that this was reversed following the completion of the first mathematics education unit. A range of factors were identified as affecting how they felt about learning mathematics, including the role of the teacher, personal perceptions regarding learning mathematics and the role of discussion.

Keywords: mathematics; attitudes; perceptions; confidence; understanding

Introduction

This research stems from my experiences of working with undergraduates on a BA Applied Education Studies course at a university in the UK, where I have been a senior lecturer since 2006. The discussion is based on the initial findings of a doctoral research project exploring the views of 75 first year undergraduates, with the aim of identifying strategies that might support them in learning mathematics. The students attending the course study part-time, and are required to work or volunteer within a school based setting for at least one day a week, although many of the students work full time as teaching assistants and unqualified teachers. Over half of the students who graduate go on to train as primary teachers. The course consists of a range of units focussing on education within primary settings, and includes the development of personal subject knowledge and pedagogical understanding in learning mathematics. On commencement of the course, students complete audits in mathematics, science and English, and from these audits it has been possible to identify a trend where students express anxiety regarding the learning of mathematics, hence leading me to explore this issue in more depth.

Perceptions regarding learning mathematics

In terms of adult perceptions, there are those who suggest that anxiety in learning mathematics is an issue that exists for many individuals who exhibit symptoms such as tension, fear and panic when faced with carrying out mathematical problems (Buxton, 1981; Tobias, 1993; Boaler, 2009). Both Crook and Briggs (1991) and Tobias (1993) suggest that adults bring their past experiences with them when

learning mathematics and that when these experiences are negative ones, their disposition towards the subject is affected. Additional concerns are raised regarding the potential effect of mathematics anxiety on those who are working within primary settings, including those who are training to teach as well as those who are fully qualified (Hembree, 1990; Relich, 1996). There is the suggestion that those who are anxious about mathematics themselves may pass this onto their pupils, creating a cycle of anxiety (Ashcraft and Moore, 2009; Haylock, 2010).

A range of influences in regards to how adults feel about learning mathematics have been identified, with the most consistent influence being that of the role of the teacher (Hodgen and Askew, 2006; Ashcraft and Krause, 2007; Bekdemir, 2010). Other factors for consideration include the effect of parents and peers (Evans, 2002; Ashcraft and Moore, 2009) and the lack of perceived connections between mathematics and reality (Tobias, 1993; Boaler, 2009). Others suggest that the cause of mathematics anxiety is related to personal perceptions limiting a person's ability to carry out mathematics (Buxton, 1981; Dweck, 2007; Bekdemir, 2010).

Coben (2006) identifies that the teaching of mathematics to adults is an area that needs further consideration. A number of approaches have been explored that might support adults in learning mathematics, including the need to make such learning relevant to real life (Lindeman, 1926; Knowles, Holton III and Swanson, 2005). Others suggest that the development of a range of pedagogical approaches could support understanding, to include collaboration and group work (Gresham, 2007; Ashun and Reinink, 2009; Johnston-Wilder and Lee, 2010), alongside the need to support adults in making connections between one aspect of mathematics and another (Klinger, 2011). It is also suggested that the role of the teacher in the learning of mathematics remains a consistent influencing factor, with the teacher needing to be knowledgeable, approachable and able to use a range of teaching approaches (Tobias, 1993; Johnston-Wilder and Lee, 2010; Welder and Champion, 2011).

Based on the concerns raised by undergraduates in learning mathematics at the start of their degree course, and the potential link between their perceptions and the effect on the children they may work with, I decided to explore this area further. The purpose of my research is therefore, to explore first year undergraduate perceptions in learning mathematics and their identification of strategies that may support them.

Methodology

The sample of students chosen for the study was 75 first year undergraduate students enrolled on the BA Applied Education Studies course in 2011. The mean age of these students was 30 (SD 9.5) and there were just nine males (13%). My aims were to examine the students' perceptions of learning mathematics before and after their first undergraduate mathematics education unit to see if there were any changes in their perceptions; if there were any such changes I wanted to identify what strategies may have contributed to this. In order to explore these aims I took a pragmatic approach to my research, whereby I aimed to identify the most appropriate tools to explore my issue (Feilzer, 2009; Denscombe, 2010). In this case I wanted to be able to utilise a combination of quantitative methods to establish students' perceptions regarding learning mathematics and qualitative methods to probe into the reasons behind such perceptions.

To establish greater detail regarding the context and background of the students prior to starting the course, my initial method utilised an existing dataset comprising two strands. Strand 1 contained the group statistics collected by the

University administration team and Strand 2 was the data collected from an initial audit of the students' mathematical skills on entry to the degree course. This audit included a number of mathematical questions and a confidence rating scale, where the students were asked to rate their perceived confidence in learning mathematics. Students were also given the opportunity to identify anything they wished to be known about their mathematical capabilities. This data was collected in May/June 2011.

I used survey research to explore my research issue further, comprising of two anonymous questionnaires and a series of focus group discussions. Questionnaire 1 (November 2011) was a pre-teaching questionnaire designed to explore the students' perceptions of learning mathematics prior to embarking on their first mathematics education unit. The questionnaire consisted of a range of closed questions about the students' feelings towards learning mathematics, their perceived levels of understanding and confidence, and their past experiences. Alongside this they were asked to describe an experience which had affected their feelings towards learning mathematics.

Questionnaire 2 (February 2012) was a post teaching questionnaire designed to explore the students' perceptions of learning mathematics once they had completed their first mathematics education unit. The questionnaire followed a similar structure to that of the pre-teaching questionnaire, using a range of closed questions to explore their feeling towards mathematics, perceptions of levels of understanding and confidence, any changes in these levels and factors that may have affected their views. They were also asked to provide a narrative account expanding on their views regarding factors affecting their learning of mathematics over their first unit.

Due to the limitations of a paper of this length, detailed discussion regarding validity and reliability is not appropriate here. However, in terms of triangulating the data this was achieved by using two or more methods to examine the research aims (Cohen et al., 2007). I acknowledge my own role as practitioner-researcher, as I was the teacher of the first undergraduate mathematics education unit, this was disclosed this role to the participants at the start of the research. Through triangulation I planned to minimise my personal bias, but I could not discount the fact that some participants may have responded in order to please me as their teacher (BERA, 2011).

Results

Audit Data

Using Pearson's r correlation coefficient, the audit data demonstrated a moderate to strong correlation between the students' audit percentage score and their perceived level of confidence (positive correlation coefficient 0.620, $p < 0.01$). 55 chose to provide additional comments and these were analysed for the use of positive, negative and aspirational language. The ten most commonly used words (five positive and five negative) formed the first part of the pre-teaching questionnaire to allow for a comparative analysis. When analysing the narrative comments, some students chose to make both positive and negative comments. Over half of these comments were negative (43 negative comments compared to 17 positive comments) and 14 of the students related their negativity to past experiences affected by others. This was reflected in comments such as "I felt a failure in school and this was backed up by home when I asked for help and was made to feel stupid and terrified". As the audit data was originally designed to gain background information for the purposes of

teaching, further detail in regards to the research aims was gained from the pre-teaching questionnaire.

Pre-teaching questionnaire

Of the total sample of 75, 68 students completed the pre-teaching questionnaire and were first asked to identify as many of the following words that they associated with mathematics:

Strong, interest, easy, confident, enjoy, weak, fear, unconfident, struggle, difficult

Of the 247 words identified, the ratio of positive to negative vocabulary chosen was 87 to 160. In terms of understanding mathematics, 17 (25%) students perceived they had a good, or very good level of understanding and 24 (35%) students identified themselves as being confident or very confident in learning mathematics. Using Spearman's rho correlation, a strong correlation between perceived understanding and perceived confidence was identified, with a positive correlation coefficient of 0.707, $p < 0.01$. It was the narrative accounts of students' past experiences that provided an insight into what might have shaped these perceptions. 65 of the 68 students provided such an account, and these were analysed using a thematic coding system. A range of themes were identified that are shared in Table 1, with the top two influences being the effect of the teacher and students' personal perceptions, both identified by over half of the sample. A point to note here is that there were almost twice as many negative comments as positive comments, consistent with the earlier proportions identified within the questionnaire.

Table 1: Thematic Analysis of Pre-Teaching Questionnaire

	Positive comments	Negative comments	Total number of comments	Percentage of students commenting
Attendance	0	2	2	3
Behaviour	1	6	7	11
Effect of the teacher	14	28	42	65
Personal influences outside school	0	6	6	9
Tests and exams	2	3	5	8
Public nature of doing mathematics	0	5	5	8
Personal perceptions	22	16	38	58
Setting arrangements	2	17	19	29
Current role	5	0	5	8
Specific aspects of mathematics	3	4	7	11
Support	1	4	5	8
Total comments	50	91	141	

The effect of the teacher was the highest rated influence on learning mathematics (42 students, i.e. 65%), where fourteen students identified the teacher as a positive influence and twenty-eight as a negative influence. Where the teacher was seen as a positive influence, the comments were related to the supportive nature of the teacher who was described as encouraging, enthusiastic and helpful, demonstrated by one student who stated that she felt the change in her attitude at school was, "... due to an understanding teacher who supported the class well." Where the teacher was seen as a negative influence, comments related to the unsupportive nature of the teacher and being made to feel humiliated and scared.

Students' perceptions of their ability to carry out mathematics emerged as the second highest rated influence (38 students, i.e. 58%). Twenty-two students said that their enjoyment and willingness to work hard in learning mathematics had a positive effect on how they viewed the subject. Sixteen students perceived mathematics as a difficult subject and not within their capacity to learn, demonstrated in comments such as "I find maths a struggle because it has never been simple or easy for me to understand it".

Together, the audit data and the pre-teaching questionnaire demonstrated that a greater proportion of students had a negative rather than positive perception of learning mathematics and that two key themes emerged as having influenced these perceptions.

Post-teaching questionnaire

The post teaching questionnaire aimed to explore the students' perceptions having completed their first mathematics education unit as undergraduates. Of the total sample of 75, 64 students completed the post-teaching questionnaire and as for the pre-teaching questionnaire, they were first asked to identify words that they associated with mathematics. Of the 314 words identified the ratio of positive to negative vocabulary was 211 to 103, a reversal of the ratio identified in the pre-teaching questionnaire. 33 (52%) students perceived that they had a good or very good level of understanding of mathematics, in comparison with 17 (25%) students on the pre-teaching questionnaire, and 37 (59%) students identified themselves as being confident or very confident in learning mathematics with a strong positive correlation maintained between these two variables (Spearman's rho positive correlation coefficient 0.643, $p < 0.01$). Students were also asked to rate their comparative levels of understanding and confidence, with 53 (83%) identifying themselves as having a higher or much higher level of confidence and 55 (86%) as having a higher, or much higher, level of understanding. A point to note here is my concern about the students wanting to please me, so I compared the initial audit scores with the scores from the tests the students took as part of their assessment. 64 of the 75 students (86%) students had an increased score, suggesting that these perceptions regarding confidence and understanding may not be invalid.

In terms of what may lie behind this increase in positive perceptions, I turned to the narrative accounts, where the students were asked identify any factors that may have influenced how they felt about the learning of mathematics. 59 of the 64 respondents chose to respond, and as for the post-teaching questionnaire, these comments were analysed using a thematic coding system and the range of themes identified is summarised in Table 2. The ratio of positive to negative comments in this instance is 9 to 1, maintaining a consistency in students' increase in positive perceptions regarding learning mathematics.

Table 2: Thematic Analysis of the Post-Teaching Questionnaire

	Positive comments	Negative comments	Total number of comments	Percentage of students commenting
Online materials	9	0	9	15
Teaching	34	2	36	61
Teacher characteristics	7	0	7	12
Discussion/working with others	12	1	13	22
Practice	10	0	10	17
Tests and exams	0	3	3	5
Personal perceptions	11	3	14	24
Total comments	83	9	92	

The effect of teaching as an influencing factor was identified by over half of the students (36, i.e. 61%). 25 respondents made specific reference to the process of teaching mathematics, referring to the step by step break-down of methods, clear explanations and modelling techniques, reflected in responses such as “The teaching has been broken down and this has made me have a clearer understanding of areas of mathematics that I have previously worried about.” Where students commented on the pace of the teaching sessions, this was either in reference to an appropriate pace, or in the case of two students, too slow a pace in areas where they already felt confident. Alongside reference to the teaching, seven students commented on the characteristics of the teacher in supporting them, including a sense of humour, and not being made to feel ‘silly’.

Personal perceptions remained the second highest rated influence, identified by 14 (24%) students. As in the pre-teaching questionnaire, the positive perceptions (11 students, 18%) related to those students who found mathematics enjoyable and who were motivated by such enjoyment. Three students felt limited by their perceptions, with one student commenting, “I feel overwhelmed by the amount I have to learn, due to my lack of understanding in the first place.”

The third rated theme was the role of discussion and working with others identified as a positive influence by 12 (20%) students.

Summary and next steps

This paper aimed to explore first year undergraduate perceptions of learning mathematics. I wanted to identify if there were any changes in the way the students perceived mathematics during their first year as undergraduates, and if so, what may have contributed to these changes.

The audit and the pre-teaching questionnaire showed that prior to their first mathematics education unit about two thirds of the students had a negative view of learning mathematics. Key themes contributing to this view included the role of the teacher, personal perceptions regarding mathematics and setting arrangements.

In exploring whether or not there had been a change in perceptions of learning mathematics, the post-teaching questionnaire provided data that identified that the ratio of negative to positive perceptions about learning mathematics had been

reversed. Alongside this, the perceptions of understanding and confidence had increased in both categories and approximately four in five students believed that they had an improved level of understanding and confidence. This was supported by data demonstrating that almost all the students (64, 86%) showed an increase in attainment between their audit data and post unit tests. These combined factors demonstrate that there had been a change in the students' perceptions in learning mathematics in that they felt more positive, more confident and had a higher level of understanding in the subject.

As there had been a change in the students' perceptions following the completion of their mathematics unit, the final aim was to identify any strategies that might have contributed to these changes. The students' narrative accounts demonstrated that teaching was rated as the highest positive influence in learning mathematics, consistent with those who also identify this as a key influence (Tobias, 1993; Hodgen and Askew, 2006; Johnston-Wilder and Lee, 2010). In terms of the role of personal perceptions as the second rated influence on learning mathematics, this might be compared to the views of those who suggest that learning is affected by self-perception (Tobias, 1993; Dweck, 2007). Finally, the third theme linked to the role discussion and working with others could be considered alongside those who suggest that group work and discussion is an important factor in supporting learning (Askew et al., 1997; Gresham, 2007; Ashun and Reinink, 2009).

It is possible to infer from this research so far, that for some students there has been a change from a negative to positive view of learning mathematics. These students may have been affected by the factors discussed in the initial analysis of data; however, focus group discussions have been designed to probe more deeply into the themes identified and also to give consideration to any additional influences that may have not yet been identified. These discussions form the next steps of this project and once fully analysed will be shared within the full presentation of my thesis.

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