Lower secondary school students' attitudes to mathematics: Evidence from a large-scale survey in England

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In this paper we present some preliminary data from the ESRC funded ICCAMS project about current student attitudes to mathematics at Key Stage 3 in England. We compare attitudes by sex and by attainment. Whilst the data largely confirms existing findings, an unexpected result was that a very high proportion of students responded that, for mathematical success, effort was more important than ability. We also present some interview data concerning student attitudes.

Keywords: Attitudes, attainment, gender

Background

Increasing Student Competence and Confidence in Algebra and Multiplicative Structures (ICCAMS) is a 4-year research project funded by the Economic and Social Research Council in the UK (Hodgen et al. 2008, 2009). In this paper, we report and discuss early findings of the study regarding students' attitudes drawing on both survey and interview data.

Methods and theoretical framework

Phase 1 of the ICCAMS project consists of a large-scale survey of 11-14 years olds' understandings of algebra and multiplicative reasoning in England using three tests of mathematical understanding and an attitudes questionnaire. The three mathematics tests, covering algebra, decimals and ratio, were originally used in the late-1970s as part of the Concepts in Secondary Mathematics and Science (CSMS) study. (See Hart 1981, for a discussion of the test development.) The attitudes test is adapted from previous work (Boaler, Wiliam, and Brown 2000). In Phase 2 of the study we are conducting a collaborative research study with eight teachers extending the investigation to classroom / group settings and examining how assessment can be used to improve attainment and attitudes.

Participants

In June and July 2008, tests were administered to a sample of approximately 3000 students across Key Stage 3 (KS3) from 10 schools and approximately 90 classes. In England, KS3 refers to the first three years of secondary school: Years 7 (ages 11-12), Year 8 (ages 12-13) and Year 9 (ages 13-14). Since the survey was conducted at the end of the school year, the vast majority of these students were at the older end of these age ranges: 12, 13 and 14 years old, respectively. We report here on the attitudes of a sub-sample of 1422 students for whom we have linked data on attitudes and attainment on the Ratio test, enabling us to report on the relationship between students' attitudes and attainment. The sub-sample consisted of 494 Year 7 students, 524 Year 8 students and 394 Year 9 students. Of the total, 748 were boys and 674 were girls.

The Ratio test reports students' mathematical attainment using a hierarchy of levels from Level 0 up to Level 4 (Hart 1981; Brown, Küchemann, and Hodgen Forthcoming). In the sub-sample, the attainment of boys was slightly higher than girls (see Table 1).

	Ratio Level	Year 7 [12]	Year 8 [13]	Year 9 [14]
Boys	0	24%	16%	10%
	1	49%	49%	41%
	2	16%	14%	15%
	3	8%	16%	19%
	4	4%	6%	15%
Girls	0	23%	20%	9%
	1	56%	52%	48%
	2	13%	15%	19%
	3	6%	9%	16%
	4	2%	5%	9%

Table 1: Comparison of the attainment of boys and girls on the Ratio test by Year group [age] for the sub-sample.

We note that these early results should be treated with caution. In particular, we note that this sub-sample of students appears to be slightly higher attaining than the general KS3 population in England. A further sample of approximately 3000 students took part on the survey in Summer 2009 and these results are currently being analysed. When this process is complete, the sample will be representative of schools and students in England. The full sample was randomised and drawn from MidYIS, the Middle Years Information System. MidYIS is a value added reporting system provided by Durham University, which is widely used across England (Tymms and Coe 2003).

Research background: Attitudes, attainment and participation

In England, in common with many other countries, too few students choose to continue studying mathematics once it ceases to be compulsory. There is considerable research in England addressing reasons for non-participation in mathematics - students stop studying mathematics because they experience it as difficult, abstract, boring and irrelevant (Osborne et al. 1997). The most recent findings relating to 16 year-olds (Matthews and Pepper 2007; Brown, Brown, and Bibby 2008) suggest that students' attainment and attitudes are strongly inter-related. A major factor is that even relatively successful students perceive that they have failed at the subject and lack confidence in their ability to cope with it at more advanced levels, especially in comparison to the perceived 'clever core' of fellow-students. When pressed about the reasons for their feelings of failure, students suggest that they do not understand parts of what they have been taught and point to the predominance of routine and formal work on algebra and multiplicative reasoning (Nardi and Steward 2003). These perceptions of failure appear to be strongly linked to ideologies of 'ability stereotyping' (Ruthven 1987) and ability grouping (Boaler, Wiliam, and Brown 2000). Girls' attitudes to mathematics tend to be more negative than boys. Boaler and Greeno (2000) link these more negative attitudes to mathematical teaching practices that do not emphasise understanding.

However, the nature of the relationship between attitudes and attainment is poorly understood. In common with other highly and relatively highly attaining countries in TIMSS 2007, English students' attitudes fell in comparison to TIMSS 1999, the last comparable data (Sturman et al. 2008). The fall in England at Grade 9, 25 percentage points, was greater than for other comparable countries, despite an increase in attainment elative to previous TIMSS surveys. One puzzling result is that, although within countries higher attainment is associated with more positive attitudes, the between country effect is in the opposite direction – countries with higher mathematical attainment tend to have more negative attitudes (Askew et al. 2010).

Early analysis of survey data: Student attitudes to mathematics

This early analysis of the survey largely confirms existing findings. For example, students' attitudes dropped as they got older. 63% of 12 year olds responded that they enjoyed mathematics lessons, but this had fallen to 54% of 14 year olds. (See Table 2.) However, the drop was greater for girls than for boys. Although a similar proportion of 12 year-old boys and girls said that they enjoyed mathematics lessons (64% and 62%, respectively), by age 14 the proportions were 59% of boys compared to 50% of girls. This reflects the TIMSS 2007 finding of greater levels of self-confidence amongst Grade 9 boys than girls in England (Sturman et al. 2008). Similarly, although boys' perceptions of their own ability were largely stable and positive across the age range, girls' perceptions of their ability had dropped to about half the sub-sample by age 14. (See Table 3.)

Year Group [Age]	Boys	Girls	Total
Year 7 [12]	64%	62%	63%
Year 8 [13]	61%	61%	62%
Year 9 [14]	59%	50%	54%

Table 2: Positive responses to 'Do you enjoy maths lessons?' by age and gender.

	Year 7 [12]	Year 8 [13]	Year 9 [14]
Boys	78%	80%	81%
Girls	67%	66%	52%

Table 3: Positive responses to 'Do you think you are good at maths?' by age and gender.

Across the age range, more boys than girls thought that they would study mathematics after GCSE and for both boys and girls this dropped. However the drop was greater for girls with only a quarter of the sub-sample of 14 year olds saying that they would continue post-16. One potentially positive finding is the relatively high proportion of students of both sexes who were undecided. (See Table 4.)

	Year [Age]	Yes	No	Don't know
Boys	Year 7 [12]	38%	15%	46%
	Year 8 [13]	34%	15%	51%
	Year 9 [14]	35%	22%	44%
Girls	Year 7 [12]	30%	16%	54%
	Year 8 [13]	28%	19%	53%
	Year 9 [14]	26%	32%	43%

Table 4: Responses to 'Do you think you will continue to study maths after GCSE?' by age and gender.

One surprising result was that a very high proportion of students responded that working hard was more important for success in mathematics than natural ability: 89% of 12 year olds and 85% of 14 year olds, with the drop being almost wholly due to a change in boys attitudes. (See Table 5.) This result appears to contradict previous findings.

Year Group [Age]	Boys	Girls	Total
Year 7 [12]	88%	89%	89%
Year 8 [13]	81%	89%	85%
Year 9 [14]	82%	87%	85%

Table 5: 'Working hard' responses to 'Which do you think is more important for success in maths? Working hard or Being naturally clever' by age and gender.

The relationship between attitudes and attainment

We now turn to examine the relationship between attainment and attitudes. Unsurprisingly, a greater proportion of the highest attaining students said that they enjoyed maths and, in contrast to other students, this proportion did not fall for older students. (See Table 6.)

	Year 7	Year 9
~ Bottom 75%	62%	52%
~ Top 25%	64%	59%
~ Top 10%	71%	69%

Table 6: Comparison of positive responses to 'Do you enjoy maths lessons?' between Year 7 [age 12] and Year 9 [age 14] by attainment. Rough attainment proportions calculated as follows: for bottom 75% by aggregating Levels 0 and 1 for Year 7 [75%] and Levels 0, 1 and 2 for Year 9 [71%]; for Top 25% by aggregating Levels 2, 3 and 4 for Year 7 [25%] and Levels 3 and 4 for Year 9 [29%]; for Top 10% by aggregating Levels 3 and 4 for Year 7 [10%] and taking Level 4 for Year 9 [12%].

Again, unsurprisingly, a greater proportion of high attaining students were intending to continue to study mathematics after GCSE. However, the proportion of the highest attaining 10% intending to continue studying post-16 was only 57%. It is worth noting that 24% of the bottom 75% said that they intended to continue with mathematics post-16. This figure is relatively high in comparison to the limited options in English education for this group of students post-16. (See Table 7.)

	Year 7	Year 9
~ Bottom 75%	32%	24%
~ Top 25%	43%	46%
~ Top 10%	59%	57%

Table 7: Comparison of students intending to continue to study mathematics post-GCSE at Year 7 [age 12] and Year 9 [age 14] and by attainment. See Table 6 for how rough attainment proportions calculated.

It is also noteworthy that the proportion of students who felt that the working hard was more important than natural ability was high at all attainment levels. (See Table 8.)

	Attainment (as measured by Ratio Level)				
Year Group [Age]	0	1	2	3	4
Year 7 [12]	89%	89%	89%	91%	86%
Year 8 [13]	81%	87%	87%	82%	82%
Year 9 [14]	86%	86%	86%	81%	85%

Table #: Proportions of 'working hard' responses to 'Which do you think is more important for success in maths? Working hard or Being naturally clever' by age and attainment.

Findings from interviews

We have conducted several group interviews with students from Phase 2 schools. These interviews have followed a semi-structured format. Here, for reasons of space, we discuss just one interview. This interview is of particular interest because it sheds light on the issue of

'working hard' and success at mathematics referred to in the analysis of survey data above. The interview was with three Year 8 students from the second set of a relatively high attaining state comprehensive school. The students were typical in disliking algebra and describing it as "bad". Similarly, when asked whether they themselves were "good at maths", they referred to their test results and levels from the end of Year 7 (Hodgen and Marks 2009).

The following is an extract about what it takes to be good at mathematics:

> Researcher: What's it take to be good at maths?
>
> Student K: - dedication...
>
> Student M: -knowing your numbers...
>
> Student C: I think it just comes normal to you... with some people, like you might not be good at many subjects, but when it comes to maths you could just be brilliant...
>
> Researcher: And is that what those three were...
>
> Student C: I reckon one them was... J, when it came to him, because he... I don't think he's that great, like superb at all the others but when it comes to maths he's superb, he gets every answer first, so...
>
> Researcher: So what has he got...? What's it take to be good at maths?
>
> Student M: -study...
>
> Researcher: Do you think he worked hard, this boy...?
>
> Student K: ...um, I think yeh, he worked hard.. I think ... if he didn't know what he had to do in class, if he didn't understand it, then he would go home and like get hold of a maths book or something which would explain it better and also give him questions that he could do to make sure he actually knew what he was doing when he came back to class the next day, so he could understand it

An interesting feature of this discussion was the way in which the student referred to J as "great" and "superb" but also as someone with "dedication" who "worked hard".

Conclusion

As we have already noted, the analysis is at an early stage. The next stage of analysis will further investigate the relationship between students' attitudes and attainment.

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