

Students' participation in post-16 mathematics: a perspective from students in Wales

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Abstract

This paper considers the results of an investigation into the factors influencing students' participation in AS-Level (Advanced Subsidiary) mathematics in Wales. National statistics for Wales illustrate that considerably fewer females choose to study mathematics at AS-Level. This is despite a similar proportion of females and males achieving A-C grades at GCSE (General Certificate of Secondary Education) mathematics. This paper considers evidence from pupils which helps to identify some of the main influences on students', and in particular girls', mathematical participation. Supported by considerable statistical data, this paper suggests that anxiety about, confidence in and enjoyment of mathematics are all significant factors on students' mathematics AS-Level choices, with gender stereotypical career aspirations also being a determining influence on students' subject preferences.*

Introduction

The non-participation of girls in mathematics has become a concern over a number of years and, as a result, there have been a number of research studies considering reasons behind this (see Boaler, 1997a; Walkerdine, 1998). However, rather surprisingly, there appears to be no work to date that looks at this within the Welsh context and, whilst considering Wales, Jones and Morris state:

Particularly in education and training, there is a dearth of information pertaining to the relationship between language, gender and variables such as qualifications, subject choice, examination choices and results and so on. (1997: 1)

This paper will therefore consider influential factors relating to students' participation in mathematics within the Welsh secondary schooling system. A number of the findings, however, may also be useful to educationalists and researchers further afield.

Research studies, as shown below, suggest that the competitive environment often found within the mathematics classroom can deter some pupils, and in particular girls, from studying the subject. Isaacson (1992), for example, suggests that mathematics classes would benefit from becoming more 'co-operative' rather than 'competitive'. He suggests that this would not only help to promote the vital skills of team work but would also have the potential benefit of encouraging girls to study the subject after compulsory schooling.

This issue of 'competitive' environments is often associated as a contributory factor to girls' apparent 'fear' of mathematics. Paechter (2001: 58) states that "many pupils find the mathematics classroom an anxiety-provoking place" and this anxiety is more often linked to

girls than boys. However, Walkerdine (1998) explains that studies of anxiety do not report consistent findings. Only in studies of “extreme” anxiety does there appear to be evidence to support the claim that girls are more “maths anxious” (ibid: 21).

Along with anxiety, the issue of ‘confidence’ or ‘lack of it’ is frequently cited. Burton (2001) asserts that research concerning gender and education shows that, due to different expectations by teachers, girls have lower self-esteem than boys. Seliktar and Malik (1998) found that there was a great difference in the perceptions of males and females towards their own mathematical ability. They state that “women are more likely than men to rate their mathematical ability as good or fair and less likely to rate their mathematical ability as excellent” (ibid: 88).

Anxiety, confidence and fear in mathematics classrooms would seem to be significant factors that influence students’ participation in mathematics. Combined with these attitudinal factors, it appears that girls and boys are still inclined to follow gender stereotyped careers and, as a result, a number of schools have initiatives to address these gender preferences (see Salisbury, 1996, for example). It is not unreasonable to assume that if there is a tendency for girls and boys to have different career aspirations then the subjects they opt to study at AS-Level are likely to differ. This issue of career goals is also visited later as part of this research study.

Based upon the findings of the literature and research data this paper considers tendencies in girls’ and boys’ attitudes towards mathematics in Wales which may affect their participation in the subject.

The Research Study

Closed questionnaires were used to gather data from three hundred and seventy five Year 12 (age 16/17) students from fourteen schools in Wales. The questionnaires were administered to and completed by both AS mathematics and non-AS mathematics students. Table 1 illustrates the numbers of male and female participants who took part.

Participants	Number
Males	179
Female	185
Not identified	11
Total	375

Table 1 Participants by gender

The returned questionnaires were analysed using SPSS (Statistical Package for Social Sciences) and tendencies between girls’ and boys’ attitudes towards mathematics sought.

Research Results and Discussion

The first result to be considered in this study relates to mathematical anxiety and was derived by analysing the responses to question 5 of the questionnaire. In an analysis of mathematical anxiety of students in Wales, more girls (55.1%) stated that they felt anxious during mathematics lessons compared to the boys.

	Yes	No
Male*	25.7% (n=46)	73.2% (n=131)
Female	55.1% (n=102)	44.9% (n=83)

Table 2 Did you feel anxious when you studied maths?
(*Two males did not answer this question.)

Such a finding mirrors other research studies which suggest girls are more anxious during mathematics than boys (see Paechter, 2001 for example). This therefore leads to the conclusion that in Wales generally girls seem to be more “maths anxious” than boys. Such anxiety could account for the decline in female participation in AS mathematics as mathematical anxiety is more often linked to girls than boys (Sturge, 1996).

Boaler (1997b) questioned the girls in her study about anxiety towards mathematics and found that they were anxious as a result of the system of school mathematics that they had experienced. Walkerdine (1998) supports and explains this point by suggesting that previous explanations of anxiety had been located within girls themselves. Boaler (1997b) illustrates that there has been a change in position with girls locating their anxiety to the school system rather than towards their own failings.

Question 15 of the administered questionnaire asked the students to indicate whether they enjoyed mathematics or not. Table 3 illustrates that 57.5% of the male participants answered yes to this question with 43.2% of females being of a similar opinion.

	Enjoyable	Not enjoyable
Male*	57.5% (n=103)	40.2% (n=72)
Female	43.2% (n=80)	56.8% (n=105)

Table 3 Do you think maths is enjoyable or not?
(*Four males did not answer this question.)

Given the findings of the literature presented earlier it is perhaps not surprising that girls appear to lack enjoyment during mathematics. It is probable that if the girls experience more anxiety than boys during mathematics, as the first result appears to illustrate, then they are less likely to enjoy the subject. Darmain (2000: 75) suggests another perspective on this issue of enjoyment by advocating that in schools and in the media those who seem to enjoy mathematics are often marked as “nerds or geeks”. She goes on to propose that “most often nerds and geeks are considered to be male” (ibid: 75). Such a proposition, if correct, could lead to the suggestion that girls are less likely to admit that they enjoy mathematics as this could lead to a negative view of their gender identity.

The third finding to be considered relates to mathematical confidence. The results presented for this issue are derived from question 29 of the questionnaire and was answered only by students studying mathematics AS-Level. When asked to predict their mathematics AS-Level grade, 36.4% of males stated a grade A compared to 19.3% of females, as shown in Table 4.

	A	B	C	D	E
Male*	36.4% (n=30)	38.3% (n=32)	17.8% (n=15)	1.9% (n=2)	0.9% (n=1)
Female	19.3% (n=17)	56.1% (n=49)	22.8% (n=20)	0.0% (n=0)	1.8% (n=2)

Table 4 What grade do you think you will achieve at the end of your maths course?
(*Three males did not answer this question.)

Using Meyer & Koehler' s (1990) explanation that confidence relates to how certain a student is of his or her mathematical ability, the table suggests that there is a tendency for boys to be more confident about their mathematical ability compared to girls in Wales.

As explained earlier, Burton (2001) proposes that girls have a lower self-esteem than boys due to varying teacher expectations. This is supported by Myers (2000) who cites a survey conducted in 1998 of nine thousand Year Nine students by the National Foundation for Educational Research. The survey found that girls' self-report of their work, not necessarily just mathematics, was lower than the boys. However, Seliktar and Malik (1998) report challenging evidence to that presented by Myers. They found, in a study of university students' self concept of ability, that there was no difference between girls' and boys' perceptions of their own general academic abilities. What is interesting, however, is that they discovered that there was a great difference in the perceptions of males and females towards their mathematical ability. They state "women are more likely than men to rate their mathematical ability as good or fair and less likely to rate their mathematical ability as excellent" (ibid: 88).

Ireson, Hallam & Plewis (2001) also found that boys have a higher self-concept than girls in mathematics, even when their academic attainment is similar. In fact they go on to suggest that this low self-concept may be the reason for many girls opting out of mathematics at 16. Jones & Smart (1995) suggest an interesting frame of thought by explaining that one possibility for the large proportions of girls opting out of mathematics is not due to their lack of confidence in their mathematical ability but in their confidence and enjoyment of other areas of study.

Moving on, the two subsequent results to be considered relate specifically to determining if this lack of female participation in mathematics would take effect prior to 16 if allowed. Mathematics GCSE is a compulsory 'core' subject for all students and therefore pupils are required to continue studying it throughout their compulsory secondary schooling. A number of other subjects become optional at Year 9 (third year of secondary schooling). During this time, pupils are required to indicate the optional subjects they wish to continue studying and the subjects they no longer want to continue with. Therefore, question 17 of the questionnaire employed for this study asked the students if they would have continued with mathematics if it had been an 'optional' rather than 'compulsory' subject. Table 5 illustrates the findings.

	Yes	No
Male*	15.1% (n=27)	83.8% (n=150)
Female	41.1% (n=76)	58.9% (n=109)

Table 5 If the choice had been available, would you have dropped maths at Year 9?
(*Two males did not answer this question.)

This research therefore demonstrates that girls are more inclined to want to opt out of mathematics at Year 9 compared to the boys. The answers to this question consequently demonstrate that a lack of female participation could be witnessed if mathematics was not compulsory after Year 9. Myers (2000) explains that by Year 9, girls and boys are aiming for vastly different occupations and this could be the reason for this finding. It could also be that the gendered tendencies (for example, an increase in girls' anxiety and lack of enjoyment) presented in this paper play a part in this result.

Despite this gender tendency, however, similar high proportions of the AS-Level mathematics students indicated that they wished to proceed to mathematics A-Level (Advanced Level). However, only 35.1% of these females stated that they would continue to study a mathematics based course at university, as shown in Table 6.

	Yes	No
Male	67.3% (n=56)	32.7% (n=27)
Female	35.1% (n=31)	64.9% (n=57)

Table 6 Do you think you will go to university to study a maths-based course?

Despite these results, QCA (Qualifications and Curriculum Authority) point out that mathematics and physics students are more likely not to continue with full A-Levels after AS-levels than other subjects (QCA, 2005). They also suggest that, "in both physics and mathematics there is a persistently, but slightly higher, proportion of females doing AS than A level, indicating proportionately higher drop-out by females after AS" (ibid: 28). This result given by QCA does not seem to be supported in this study as similar proportions of boys and girls indicated that they wished to continue with A-Level mathematics perhaps illustrating a difference in attitudes between students in Wales and England.

A further distinction between the QCA study and this study is also evident when questioning students about their university subject choices. 50% (n=86) of the students in this research stated that they would like to study a mathematics based course at university but only 9% reported that they would like to study mathematics at university in the QCA project (QCA, 2005). Of course, the difference here may lie in the wording of the question. In this study students were asked about 'maths-based' courses so these could include, for example, engineering or physics whereas in the QCA study the students were asked explicitly about mathematics degrees. It is promising to see, however, that students are still considering mathematics based courses even if they are reluctant to embark upon straight mathematics degrees but it is still evident that mathematics courses are more appealing to males than females.

It has been mentioned throughout this paper that a contributing factor to the lack of female participation in post-16 mathematics is likely to be girls' and boys' different career choices. In order to determine whether this does play a part the questionnaire included a question on this. Considering just the questionnaires completed by the mathematics students, 36.4% (n=30) of the boys indicated that they wanted to be engineers compared with 1.8% (n=16) of the girls. Further to this, by combining the responses from mathematics and non-mathematics students, more girls indicated that that they wanted to be nurses, social workers and teachers. Such a finding therefore suggests that students' intended career choices are likely to be an important factor in their decision whether to study mathematics AS-Level, given that the apparent career aspirations of girls would not require an AS mathematics qualification.

Such a result seems to mirror 'gendered' trends and suggest that girls and boys are still inclined to follow gender typical careers. Perhaps further projects such as 'Girls into Science and Technology' are required to encourage girls, and indeed boys, into less stereotypical careers. This result supports Myers (2000) who illustrates that through 1997 to 2000, there had been little change in the types of work that girls and boys move into.

Conclusion

Prior to suggesting some conclusions from the research it is perhaps necessary to highlight some of the limitations of the study. This study is part of an ongoing investigation and the researcher is aware of the limitations of using questionnaires in this type of study. However, the aim of this paper is to highlight some broad trends ready for future more specific investigation.

It should also be acknowledged that the researcher is aware of the issues surrounding the theorising of gender difference as one could contribute to the binary construction of gender. Such a construction of gender has been shown to be out-dated and even damaging to either due to an exaggeration of psychological differences between men and women (Hayes, 2000). Despite this, however, national school examination results are published on a male/female basis and it is the differences which arise from these statistics which are of concern to policymakers in particular. Therefore, it is important, as far as practitioners and policymakers are concerned, to identify any factors which may result in gender tendencies. This paper has therefore aimed to highlight some of these factors in the Welsh context but it should be remembered that these are only tendencies rather than fixed differences.

In conclusion, the evidence gathered as part of this study resonates with that identified in other research articles but the findings focus on pupils in Wales, an area that has not been explored. To reiterate, the aim of this paper was to highlight tendencies in girls' and boys' attitudes towards mathematics in Wales, which may affect their participation in mathematics. In answer to this aim, girls are more likely to feel anxious during mathematics compared to boys and appear to have a lower self-esteem in regard to their mathematical ability. As far as enjoyment of mathematics is concerned, once again boys are more likely than girls to report enjoyment of mathematics.

The results of this study also demonstrate that girls are more inclined to want to opt out of mathematics at Year 9 compared to the boys. Despite this however, similar proportions of boys and girls studying AS-Level mathematics plan to proceed to A-Level. Such a finding differs, however, after A-Level mathematics where more boys suggest that they will study a mathematics course at university compared to the girls. It appears that students' career choices are a deciding factor in whether students will continue to study post-16 mathematics. As girls appear to shy away from mathematical or science orientated careers so they choose not to study mathematics AS-Level.

One final point, this study has considered gender tendencies in mathematics, but there appears to be much scope to expand this area of research to consider other subjects in order to determine whether the results are mathematics specific or not. To clarify this, for example, it could be that girls are more anxious in all subjects and not just mathematics. Therefore there is an avenue for a comparative study to explore Welsh students' attitudes across subjects. At present, however, this study has begun to address the lack of research concerning gender tendencies in Wales.

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