

Girls' Participation in A level Mathematics and Further Mathematics

A briefing document summarising recent research relating to girls' participation in Advanced level Mathematics and providing recommendations for schools and colleges for increasing girls' participation.



*Rhaglen Gymorth Mathemateg Bellach Cymru
Further Mathematics Support Programme Wales
Gadewch i fathemateg fynd â chi ymhellach
Let mathematics take you further*

Girls' participation in A level Mathematics and Further Mathematics



Girls taking A levels in Business Studies, Economics, Geography, Psychology and Sociology would all benefit from studying mathematics as a supporting subject because of the mathematical content of these courses.

F MSP/IOE Gender Literature Review

The number of students taking A levels in Mathematics and Further Mathematics in the UK has risen considerably over the last ten years.

In 2016, Mathematics was the fifth most popular A level amongst girls, behind English, Biology, History and Art whilst it was the most popular subject taken by boys. The participation rates at AS level were the same with Mathematics being the most popular subject taken by both boys and girls. The proportion of students taking Mathematics (AS/A level) who are girls is around 40% with the corresponding figure being 30% for Further Mathematics (AS/A level).

The Further Mathematics Support Programmes (FMSP) in England and Wales promotes participation in Advanced level Mathematics to all students who would benefit from taking the qualifications, especially girls. This document summarises the key findings from the recent research in England and Wales, which aim to identify

and share good practice in promoting participation in Advanced level Mathematics by girls. More reports can be downloaded from: www.furthermaths.org.uk/encouraging-girls-maths

We hope that the guidance provided in this document will be a stimulus for reflection by colleagues in schools and colleges on the issue of girls' participation. It is hoped that the recommendations listed at the end of the document will help to initiate practical action to increase the proportion of girls who progress to study A levels in Mathematics and Further Mathematics.

It is an important time for all stakeholders to consider the role they will play in promoting post-16 mathematics, particularly to girls.



...the unequal participation of women in STEM identifies a potential source for recruiting more mathematicians.

F MSP/IOE Gender Literature Review

Research evidence into factors affecting girls' participation in Advanced level Mathematics

The UCL Institute of Education (IOE) produced a literature review of recent national and international findings on gender participation and performance in post-compulsory mathematics.

Prior attainment in mathematics was found to be the most significant factor in progressing to A level, but boys were more likely to continue to A level than girls with the same GCSE grade. This disparity becomes much more pronounced for students with A or B grades, suggesting that girls may see good, but not excellent, grades as a barrier to progress.

Students were more likely to choose mathematics if it was their highest grade at GCSE. With girls attaining more A/A* grades across the full range of GCSE subjects, their positioning as 'all-rounders' may negatively affect their uptake of A level Mathematics. Enjoyment was more likely to be cited by girls than boys as a reason for STEM related choices.

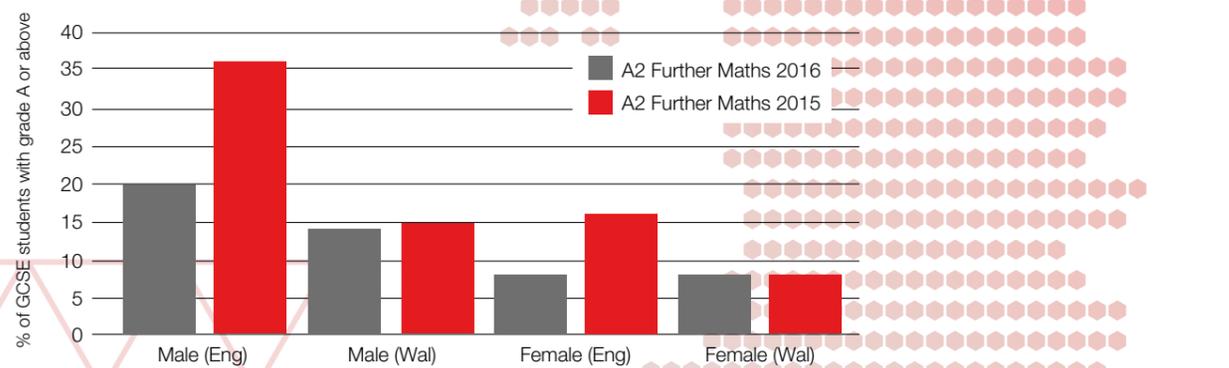
Girls have been found to have a lower mathematics self-concept than boys of the same ability; this is of concern because

research shows the degree of match between task performance and self-concept is linked to intention to continue with mathematics. Students were found to be aware of the stereotypical images of mathematicians, but they still used them. Female students were also sometimes distanced by presentation of images of highly successful, attractive female mathematicians, meaning the images had the reverse effect to that intended.

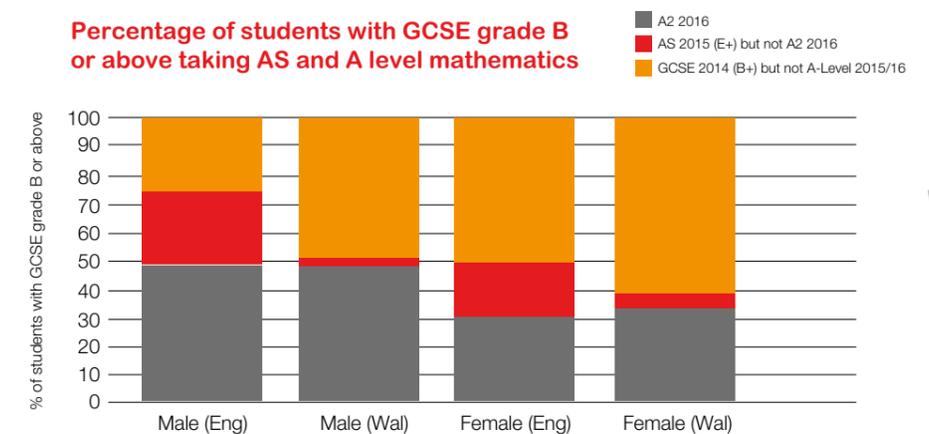
A lack of awareness of the utility of mathematics affected students of both genders.

Advice and encouragement to continue with mathematics from a teacher or family member was found to be important; and this could mediate the effect of lower mathematics self-concept for girls in particular. Research evidence acknowledges the importance of socio-economic factors and the impact of 'science capital'. Students who had formed an opinion against pursuing mathematics and science in the future by age 10 were highly unlikely to change their minds by the age of 14.

Percentage of students with GCSE A or above taking AS and A level Further Mathematics



Percentage of students with GCSE grade B or above taking AS and A level mathematics



Successful strategies for girls' participation in mathematics: Case Studies



The case study schools had not been involved in specific initiatives to attract girls to study mathematics; instead there was a strong culture of encouraging girls to aspire to take mathematics at A level.

FMSPI/OE Gender Literature Review



SLTs should identify ... a gender champion whose role includes bringing together the whole school in a coherent campaign to challenge gender stereotypes.

'Opening Doors: A guide to good practice in countering gender stereotyping in schools', IOP, 2015

From October 2014, the UCL Institute of Education has been working with the FMSPI in England to produce five case studies of schools and colleges that are making an impact on improving girls' participation in Advanced level Mathematics.

Through analysis of data, teacher and student focus groups and lesson observations, researchers have examined strategies that have contributed to effective change in the take-up of A level Mathematics and Further Mathematics.

Senior leaders: The support of senior leaders is seen as crucial in guiding the development of a clear whole-school culture which promotes participation in post-16 mathematics by girls and supporting an **appropriate curriculum** within the mathematics department. For example, three of the case study schools prepare students for Level 2 qualification in Additional Mathematics, which offers students an insight into what is involved in A level Mathematics. This is beneficial to girls who report that they feel more confident in progressing to A level having been exposed to more challenging mathematics during Key Stage 4.

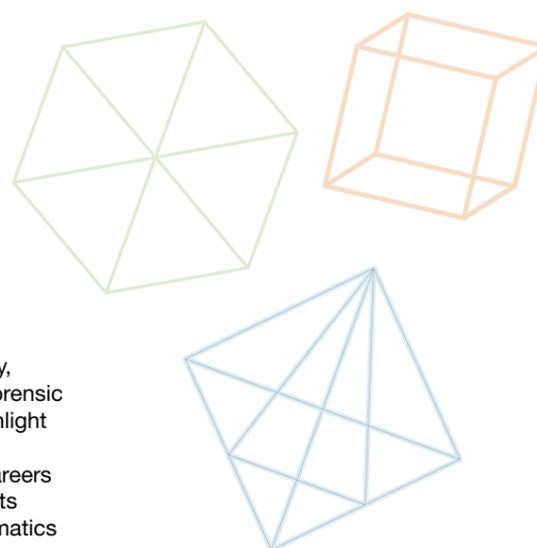
Careers advice should start early and illustrate the utility of mathematics across a range of disciplines. At one school, students have researched possible university courses by Year 11 and noted that mathematics was necessary for a range of careers including the armed forces and sports science. At one College, mathematics is valued as a currency that keeps options open and is a gateway

to specific careers, including optometry, medicine, food nutrition, youth work, forensic science and physics. Wall displays highlight the importance of mathematics. At a Further Education College, personal careers advice for new and prospective students emphasises pathways in which mathematics is an essential companion or a central subject.

Teachers: The role of **mathematics teachers** in supporting girls and getting to know them individually is valued by female students. They like teaching strategies that provide opportunities for checking understanding with friends and quiet conversations with the teacher. Teachers in the three mixed schools described the importance of directing questions to girls in class. In several of the schools, the mathematics department's 'open door' policy was seen as crucial in building girls' confidence.

Influence of family: In the case study girls' participation is seen to be assisted by strong **family appreciation** of the value of mathematics and the role of hard work. Family support for the study of mathematics was particularly high in non-white British ethnic groups. Students in the Further Education College were dismissive of negative cultural messages amongst some young people, such as it being 'smart to dumb down'.

Motivation: The messages about participation in Further Mathematics focused on **motivation** rather than simply focusing on the cleverest group of students in the year group.



Recommended strategies for promoting greater gender balance in Advanced level Mathematics

Strategies that senior leaders and heads of mathematics departments could implement to promote greater gender balance in the uptake of A level Mathematics and Further Mathematics:

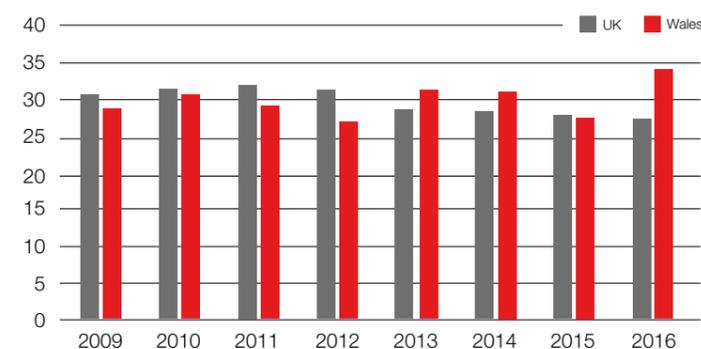
Consider the gender balance in previous A level cohorts. Use the JCQ data to identify the relative participation rate of girls against the national picture, in Wales and the UK and similar schools in Wales if the data is available. Look for trends in progression from Year 11 classes and/or feeder schools.

Identify and support girls in Year 10/11 who show the potential and/or interest in mathematics to progress to post-16 study. Analyse the proportion of girls and boys with an A or A* in GCSE Mathematics who progress to study mathematics to at least AS level.

Introduce more mathematics topics and qualifications alongside GCSE for students expected to get a grade B or above. Girls value the opportunity to evaluate their interest in the topics they might meet at A level and how they might cope with the more demanding material.

Throughout years 7 to 11, develop a school-wide culture in which girls aspire to study mathematics to A level.

Proportion of A-level Further Mathematics female students in Wales and the UK since 2009



Teachers should embed advice about how mathematics is used in real life contexts into lessons to make students aware of the utility of the subject.

Teachers should provide students, especially female students, with regular positive feedback on their progress and ability. Praise resilience, discussion and careful work, and support female students in developing a more accurate match between task performance and mathematics self-concept.

Avoid presenting A level Mathematics as a 'specialist' subject – emphasise the general benefits of studying the subject.

Present a clear message to staff interviewing and enrolling students to A level courses about the possible barriers that may need to be broken down when recruiting girls to post-16 mathematics courses and provide clear information about the importance of A level Mathematics and Further Mathematics qualifications.

Engage with parents/carers about the importance of promoting a positive message to both boys and girls about progressing to study mathematics post-16.

Provide clear messages to students, and girls in particular, about the wide range of careers and degree courses for which post-16 study of mathematics would be beneficial. Invite current or previous female A level Mathematics students to speak to younger students about the importance of mathematics in their degree course or future employment, both in STEM and non-STEM fields.

Further Mathematics Support Programme in Wales



Further Mathematics Support Programme Wales

Room 283a, Talbot
Swansea University,
Singleton Park
Swansea SA2 8PP

T: +44 (0)1792 602793
www.furthermaths.org.uk

Further Details

www.furthermaths.org.uk/
encouraging-girls-maths

www.furthermaths.org.uk/
girls-maths

www.furthermaths.org.uk/
wales

If you have any queries relating to this publication, please contact Dr. Sofya Lyakova:

E: s.lyakhova@swansea.ac.uk

The Further Mathematics Support Programme Wales is a Welsh Government funded initiative. It is managed by the Wales Institute of Mathematical and Computational Sciences (WIMCS), a collaborative partnership of the universities of Aberystwyth, Bangor, Cardiff, Swansea and the University of South Wales, and is supported by Mathematics in Education and Industry (MEI).

Our main aim is to provide Further Mathematics GCE AS/A2 level tuition to all students who cannot access Further Mathematics through their local 11-18 schools or colleges in Wales. For more information about The FMSP Wales please see our leaflet.

Extracts from two recently published reports addressing these issues in Wales:

'Science, Technology, Engineering and Mathematics (STEM) in education and training: A delivery plan for Wales' 2016

<http://gov.wales/docs/dcells/publications/160311-stem-delivery-plan-en-v2.pdf>

This highlights the increasing skills shortage in STEM related jobs in Wales. It identifies the responsibility of schools and teachers in nurturing talent in pupils who are 'lost' to mathematics and science at all stages after GCSE.

'In 2015 we saw the publication of key documents setting out radical new proposals for changes to our education system in Wales. Professor Graham Donaldson's report, 'Successful Futures', presents a vision for the future of education in our schools. It is telling that it sets the development of STEM skills from age 3 to 16 front and centre, recognising their importance in an increasingly science and technology driven world.

Successful Futures also highlights the essential nature of pedagogical development and that Wales' education practitioners need the skills and knowledge necessary to be able to deliver a new curriculum. This is no more important than in the STEM field, where we know from global research that the subject knowledge of teachers (in areas such as mathematics and science) is a direct factor in learner attainment.' Page 14

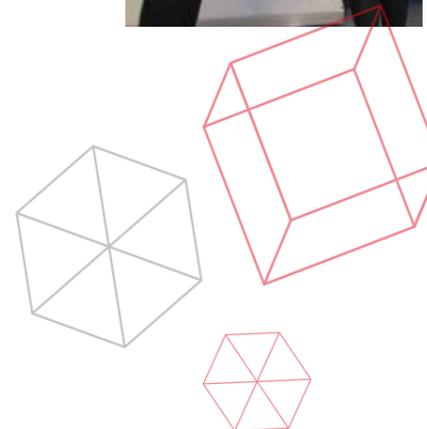
'Our priority is to increase interest and participation in STEM learning, particularly among girls' Page 30.

'Talented Women for a Successful Wales: A report on the education, recruitment, retention and promotion of women in STEM-related study and careers' June 2016

<http://gov.wales/docs/det/report/160308-women-in-science-en.pdf>

Wales has a chronic shortage of research scientists across a wide range of STEM disciplines, which impedes the success of our research community. This is why educating, recruiting, retaining and promoting women in STEM careers is crucial to the health of our science base and to the performance of the economy as a whole, as well as the life chances of individual women. Currently, less than 10 per cent of engineering employees and STEM professionals overall in the UK are female, compared with three times this proportion in Sweden.

The problem in the UK is that, every year, thousands of women who would make excellent engineers and scientists go into different careers instead. Reasons include tired old stereotypes, such as that science is 'not for girls'; the paucity of famous female scientists and engineers, to act as role models; the absence of flexible working opportunities and assisted paths to return from career breaks and a lack of focused, engaging information and advice about career options.



Research evidence into factors affecting students' choice of Further Mathematics.

Choosing Further Mathematics study by UWTSU and Swansea University (to appear in the Wales Journal of Education November 2016)

In 2014 UWTSU, FMSP Wales and Swansea University formed a research group to explore the reasons behind student choices in studying Further Mathematics at post-16. The study among the other things found out that:

- **A false perception that Further Mathematics is harder than Mathematics** and thus is only suitable to the most talented Mathematicians is still persistent. The existing models of delivery involving additional lessons and self-study outside the normal curriculum unfortunately add to this misconception. **Therefore efforts should be made to facilitate the return of the subject as a fully timetabled option.**

- **Teachers** influence student choice by encouraging participation but also through their teaching. **Thus given the advanced nature of some of the material included into Further Mathematics it is imperative that schools have access to subject focused professional learning programmes.**

- **Offering Additional Mathematics helps both promoting Further Maths and the transition between GCSE and A-level.** There was a clear feeling amongst the students that there is a **step up in the difficulty** from GCSE to AS-level Maths and a further step up from Mathematics to Further Mathematics. However, the students who took Additional Maths felt a clear benefit particularly in terms of their improved skills in algebra, manipulating indices, simultaneous equations and factorising quadratics as well as having been exposed to basic calculus of integration and differentiation prior to A-level. The Additional Maths qualification also makes students aware "there is more than one A-level in Maths".

- Given the small numbers of students involved in Further Maths compared with other A-level subjects it was no surprise that many students did not encounter anyone amongst their **peers** who had studied Further Maths. In addition to this, whilst **parents** appear to influence

students' decisions to study Maths, this is not apparent with Further Maths. **Thus wider promotion of the benefits of Further Maths is needed.** Perhaps it can be achieved by better informing parents of the benefits of Further Mathematics and encouraging existing Further Mathematics students to become Further Mathematics champions.

- **There is a pool of students who clearly felt they could have taken Further Mathematics.** In students opinion taking Further Maths could have opened up more options for courses at highly selective universities. The courses mentioned by the students included STEM as well as economics based degrees.

- **Gender differences** were statistically insignificant in the sample of students who already decided to study Maths at A-level. In other words, once girls have decided to study mathematics their attitudes are very similar to those of boys. This together with the above bullet point stresses the advice given in the UCL study on **approaching students, and girls in particular, early on.**

How can FMSP Wales help your school to improve uptake for A-level Mathematics and Further Mathematics?

- ✓ Teacher Professional Learning Programmes in Further Mathematics. Increased knowledge and confidence will help teachers deliver Further Maths as a fully time-tabled subject, not an extra.
- ✓ Partially timetabled Further Mathematics can be supported by online learning or to groups of pupils organised in consortia.
- ✓ Study Days and Revision Sessions are organised in local universities to support students.
- ✓ Student conferences broaden student perspective on how mathematics is used in the real world.
- ✓ Careers in Maths talks for Y9/10/11 students showcase a wide range of opportunities including non-STEM subjects.

Rhaglen Gymorth Mathemateg Bellach Cymru Further Mathematics Support Programme Wales

Sefydliad Gwyddorau Mathemategol a Chyfrifiadurol Cymru Wales Institute of Mathematical and Computational Sciences

Swansea University Prifysgol Abertawe

Room 284
Talbot Building
Swansea University
Singleton Park
Swansea SA2 8PP

Ystafell 284
Adeilad Talbot
Prifysgol Abertawe
Parc Singleton
Abertawe SA2 8PP

Tel/Ffôn 01792 606845 / 01792 602793

Cardiff University Prifysgol Caerdydd

Room E/2.16
School of Mathematics
Cardiff University
Senghennydd Road
Cardiff CF244AG

Ystafell E/2.16
Ysgol Mathemateg
Prifysgol Caerdydd
Senghennydd Road
Caerdydd CF24 4AG

Tel/Ffôn 02920 875554

Aberystwyth University Prifysgol Aberystwyth

Room 4.03
Physical Sciences
Aberystwyth University
Penglais
Aberystwyth
SY23 3BZ

Ystafell 4.03
Gwyddorau Ffisegol
Prifysgol Aberystwyth
Penglais
Aberystwyth
SY23 3BZ

Tel/Ffôn 01970 622763

Bangor University Prifysgol Bangor

Room 114
School of Computer Science
Bangor University
Dean Street
Bangor
LL57 1UT

Ystafell 114
Ysgol Cyfrifiadureg
Prifysgol Bangor
Stryd y Deon
Bangor
LL57 1UT

Tel/Ffôn 01248 382279

Email/Ebost: infofmspwailes@wimcs.ac.uk
www.furthermaths.org.uk/Wales

Email/Ebost: infofmspwailes@wimcs.ac.uk
www.furthermaths.org.uk/Wales

