Gender Differences in Mathematics Ability at an Undergraduate Level

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Abstract

The existence and causes behind the perceived differences between genders in mathematics is the purpose of this research project. An in depth look at previously undertaken research on the matter defines the layout and approach of the investigation, taking into careful consideration ethical issues, ensuring all ethical procedures are thoroughly considered. This leads to an interview process involving 20 undergraduate mathematics students (10 male, 10 female). During this interview, the GCSE and A level grades are obtained to scrutinise any differences in achievement. The interview questions are organised into themes such as attitudes, self-assessment, experiences with failure and knowledge of existing stereotypes. No tangible evidence was found to suggest any differences in ability in terms of grades obtained. However, there were noticeable differences when it came to the effects of failure and stereotypes.

Introduction

Gender differences in mathematics ability have become a matter of general belief. Regardless of the ever evolving educational systems, this idea seems to have burrowed itself in as a fact. However, in the past decade, the desire to re-evaluate such issues has dwindled to the point where very few theorists are interested in understanding if or why this problem still exists. The purpose of this research project is therefore to answer these questions in an up to date context.

Gender differences within mathematics education was once a huge area of study. However, over the past decade it seems that the level of interest has decreased. This could be due to a number of factors. The first is that the previously witnessed differences between males and females have decreased to the point where they are no longer worth investigating. Another may be that there is no definitive cause for any discrepancy, and that the problem is something that will always be there. The importance of tackling this issue, however, cannot be dismissed. If, in fact, the differences do still exist, it is imperative to define the underlying causes to create a more realistic view on how to resolve them. The following literature review will look into previous theories of why such differences manifest, and whether or not the preconceived ‘gap’ between gender and ability is significant enough to play a role in today’s educational systems.

The idea that women underachieve in mathematics is one that has been thoroughly investigated throughout the years. Although the stereotypes about women’s capabilities have changed vastly over the last 30 years, the concepts of female inferiority are still evident today. A survey by Ernest (1976) found that, when questioning teachers, 63% believed that boys had better natural capabilities when it came to performance in mathematics. None of the questioned teachers thought that

females were the better mathematicians. A study that supports this negative stereotype is from Yee and Eccles (1988), who interviewed parents rather than educational officials. The results show that parents generally thought mathematics to be more challenging for their daughters. With these two very important figures within a child's educational growth fuelling such negative stereotypes, it is easy to understand the lack of confidence females have in their own mathematical capabilities. These attitudes are well documented in a study by Catsambis (1994) who found that all female maths students tended to have very little interest and confidence when it came to maths. The consequences were that fewer young females took maths courses at a higher level, as documented in the previously mentioned investigation by Yee and Eccles (1988).

Halpern (1992) cited statistics from the National Education Association stating that these stereotypes are supported by test scores. She shows that boys did better than girls by over half a standard deviation, explaining that these results are fairly consistent over the past 20 years. She surmises that any perceived improvements in female mathematics results are not apparent. However Feingold's research (1988) reaches a completely different conclusion. He used aptitude tests between the years of 1947 and 1980 to compare with the same test applied again between 1960 and 1983. He found that there were significant decreases in differences between the years studied, including the complete absence of gender differences in the arithmetic section of the test.

Feingold does acknowledge the consistent differences apparent in formal educational facilities, however, stating that gender differences there have been consistently negative for the past 27 years. This is supported yet again by Sells (1973) who reported that only 8% of a random sample of Berkley students that were female had taken four years of mathematics in high school, whereas 57% of the males in the sample had. However, Caplan (2010) suggests that all these studies are biased, with the already determined conclusion that females do underachieve, and that all the data used was collected from countries that were already known to have gender differences. Cherian & Siweya (1996) used South Africa as a perfect example of an unbiased test. Their results found that there were no cases of ability differences in university maths majors. In fact, there were profound indicators to suggest that females' achievement was higher than that of males.

Back to Halpern (1992) and her study. She supplied a thorough summary of completed research into sex differences at a cognitive level as well as research on mathematic differences. She describes the nature of such differences through the perspective of biological and psychological theories. Halpern acknowledges the importance of sex stereotypes in performance, yet laments that the insufficiency of causational investigation is a major factor of the lack of understanding into why women perform poorly in standardised tests, especially since they outperform males in class grades.

The idea of "stereotype threat" is proposed by Steel and Aronson (1995) in which a study was carried out to measure the effect that stereotypes have on standardised testing. Focusing mainly on the stereotype surrounding black students' underachievement, the study showed the impact that stereotypes can have on results. When the black participants thought the test was not to measure intelligence,

they performed much better than when they believed it was diagnostic. This self-fulfilling prophecy is fuelled by self-doubt creating substantial self-evaluative anxiety. All of this ultimately results in a huge negative effect on test scores.

This evaluation apprehension is completely applicable to women in mathematics. Steel (1997) verifies this and goes on to state that even without such performance expectations, women will still suffer when it comes to documented performance. It seems that negative attitudes surrounding females and mathematics ability have created a vicious cycle of self-doubt, anxiety and, ultimately, underperformance.

Another perspective is offered by Brunstein and Gollowitzer (1996) who suggest that it is not stereotypes, but one's previous negative outcomes that fuel future academic performance. Repeated failures, they explain, act as training tasks which negatively affect the mental confidence of an individual, resulting in weak future performances. Atkinson (1964) builds on this with the classic expectancy-value theory. This reiterates the idea that failure causes a negative domino effect on future endeavours. However, Bandura (1991) considered that not only outcome expectations but the individual's sense of ability defines performance. He explains that an individual's self-efficacy is directly proportionate to the expenditure of effort said individual is willing to apply to any given task. It is suggested that only if the negative outcome has an effect on the individual's self-worth would it have an undesirable effect. Similar conclusions are reached by Vroom (1964) where the link between action and outcome expectation is transformed into general expectancy-focused motivation.

On the other side of this theory, Wortman and Brehm (1975) suggest that such responses in terms of repeated failure need to be put into a time context. They state that certain individuals may fight back against initial failures in an attempt to regain and maintain control. Only when frequent failures occur does an individual seem to give up and lose motivation. Ford and Brehm (1987) argued that failure leads to the task in hand being considered as significantly harder than originally believed. This ultimately results in more effort and consequently a better result. Another effect this can have is illustrated by Carver and Scheier (1991) where the individual, when faced with failure will lower their previously high expectations to accommodate the previous unsuccessful result.

Hyde et al (1990) gives an alternative perspective, by offering the concept of "autonomous learning". This suggests that the problem is due to a drastic difference in learning approaches between men and women. The idea is that women, especially in mathematics, do not take the time to understand and rationalise the things they are learning but simply memorise the techniques. This, theoretically, would definitely limit an individual's learning capacity and restrict them to a lower level of understanding.

Methodology

The sample of 20 undergraduates (10 male 10 female) was chosen for consistency and reliability. The 10 questions asked in the interview are broken down into questions that investigate, specifically, the theories experienced within the relevant literature (see appendix 3). Before the interview questions begin, GCSE and A level grades obtained are collected from the participants. The quantitative aspect of the

data collection will allow for an impartial inquiry into the possible trends and patterns that may exist. Muijs (2011) describes quantitative data as a tool to answer specific questions within research. For this project, that question is “Is there reasonable evidence to suggest differences in ability between males and females at GCSE and A Level mathematics?”

The first couple of questions ask about personal attitudes toward the subject. These are followed by questions about the effect failure has had on their outlook, so as to understand the different repercussions self-assessed underachievement can have. Next, the theme turns to effort levels, in comparison to other subjects, at GCSE. Asking the participant to rate his or her own abilities in mathematics reinforces this, enabling an analysis of their self-view. The final question determines the individual’s experience and knowledge of any gender biases that exist within the mathematical community. This is to understand the concept of stereotype threat and the negative effects it can have on an individual’s intellectual development. Overall, this will allow a focused look at which theories may be playing a significant role in the problem.

One section of the interview is dedicated to understanding the degrees of effort expended for mathematics. A downfall of such questions is the threat that participants may feel inclined to lie, suggesting they found mathematics a lot easier than they actually did, to avoid embarrassment. To overcome this, I will be stating my own difficulties matter-of-factly, to put them at ease about any potentially sensitive information. The mixed use of both quantitative and qualitative data collection is to ensure that a thorough look at all aspects of this area of study is undertaken. Qualitative research is explained by Weitzman (2000) as a crucial tool for extractting deeper, more delicate information. This is imperative in this research as the focus is personal attitudes and experiences. For this reason, this delicate yet thorough approach is necessary.

Although the sample size is not great for statistical analysis, it is sufficient to understand any trends in attitudes that may exist. However, if more time was available, the sample size could have been a lot larger, to enable a more in depth investigation, statistically. This is why the questions are focused on the participants’ own experience within mathematics, why they chose to study at degree level and how well they rate their own effort levels, in comparison to other subjects. A comparison of other subjects is imperative as it allows a focus point to determine effort levels in context. For example, a participant may have found maths very easy yet had to put a lot more effort in other subjects. Alternatively, maths may have been one of the subjects in which an increased level of effort was made, which would increase understanding of gender differences in ability. Another question in the interview would be to find out if they were aware of any stereotypes that existed. If high achieving females are aware that there is a negative stereotype surrounding them and yet they have achieved very well in mathematics, this could dismiss the most common theory in literature: stereotype threat.

The data collection will take place as a semi structured informal interview. Semi structured interviews are perfect for this type of research as it is imperative to get a deep understanding, one which cannot be achieved with the likes of a Likert scale. The questions being asked concern attitudes, experiences etc. The need for qualitative information is greater than the need for a lot of information. Thus, the job

of the interviewer becomes to delve deep into the true nature of the participants' experiences. The interview will take place in a café. The casual setting allows for an informal atmosphere, creating a relative ease for the participants when answering questions. This has the advantage of comfort. If the interview were conducted more formally, it would be cold and uncaring. Especially when asking the female candidates, it is important that they feel they can express their opinions honestly. A reinforcement of this informality is the planned seating arrangement. The interviewer and the candidate will both be on the same side of the table, further eradicating the intimidating interview feeling. Cohen & Crabtree (2006) warn that the downfall of such interviews can be the note taker; the presence of a third party can hugely affect the participants' responses. Therefore it will be the interviewer who will take notes throughout. The seating arrangement, however, may have a downside. If the participant is able to see what I am writing down, it may negatively affect the casual atmosphere. Therefore, note taking will be kept at an angle where it is not visible, to ensure that any notes taken do not affect the candidate's answers.

Throughout the interview, a back and forth discussion will be implemented to not only reinforce the familiarity atmosphere with the candidate but to also ensure that as much information is gathered as possible. This will ensure a high level of quality data is gathered, ready for data analysis. Another technique that will be implemented with the semi structured interview is the freedom for a degree of flexibility regarding the question order. For example, if during the discussion of one question, the candidate answers one of the other questions, I will be able to skip the question unintentionally answered, rather than getting the participant to repeat themselves. This will allow the overall interview to flow seamlessly, taking the form of a simple informal discussion. Overall, the interview should last approximately 10 minutes, which will be explained to the participants at the start of the interview, to ensure they have no prior commitments.

Firstly, before any data can be collected, it is imperative that the participant is fully aware of their rights throughout the research. For this research, an information page is supplied on which the research outline is explained, along with aims and how they can contact me if needed (see appendix 1). As well as this, a different sheet is provided, on which is the check list of rights the candidates have. One of these rights is the right to withdraw from the research, either before, during or after the interview has taken place. Candidates are fully aware that no reason for a withdrawal is needed and there would be no negative effects as the result of a withdrawal. Along with this information, they will be assured that any information they trust me with will be held confidentially and anonymously.

One crucial factor that candidates need to be aware of is the right for disclosure. As the interviewer, any illegal behaviour witnessed throughout the research will be reported to the appropriate authorities. Another important factor to consider is the risk of having participants recall information from the past. This can create unwanted remembrance of unpleasant experiences. To overcome this, I will ensure that each individual is fully aware of potential risks and remind them that there is the option of withdrawal, if they feel they cannot continue with the interview.

Once the participant has read the necessary information, confirmed that they understand and signed the consent sheet (see appendix 2), then and only then can

the interview take place. I will be there during the reading of information to ensure that if any confusion occurs, I can answer any questions they have. All of these procedures are necessary to ensure that the data collected is completely useable.

For long term security, all data collected will be transferred onto a secure digital platform where it will remain for 3 years before being completely deleted. This will ensure that the only person who has contact with the data is the interviewer. By transferring it into a digital medium, the long term secure containment of the information is assured, and the original hard data collected will be shredded as soon as the digital copy is secure.

The initial data analysis will consist of grades obtained from GCSE and A Level mathematics. Due to the nature of this information, there are 5 possible categories in which a participant can fall into (A*-D). These results will be converted into a numerical form ranging from 1 (A*) to 5 (D) allowing for a quantitative interpretation of trends and patterns within the information.

As well as this, there will be a qualitative data analysis stage. This data refers to the answers given in the interviews, which will be much more difficult to group. Therefore, the questions will be grouped into themes emerging from the literature, to allow for an overall look at any recurring trends in answers given between participants.

Results

Now that all the data has been collected, the information collected can be carefully analysed to look at any emerging patterns or themes that may exist. There are both quantitative and qualitative aspects to the data collected during the interviews. Therefore, the analysis of the information collected will take place via two different mediums, in response to the varied data types. These will consist of a numerical analysis of the grades achieved at GCSE and A level. By converting the grades into numerical form, a comprehensive look at the similarities and differences can be made. Secondly, for the qualitative data collected during the interviews, common themes and ideas will be analysed to either confirm or disprove the theories suggested in the literature. As only 20 candidates were used, the sample size of the data analysis will consist of all participants' information.

Table 1: Numerical conversion of GCSE and A Level grades collected during interviews

Gender	GCSE obtained	A level obtained	Numerical conversion GCSE	Numerical conversion A level	Grade difference
M	A*	B	1	3	-2
M	A	A	2	2	0
M	A	A	2	2	0
M	A	B	2	3	-1
M	B	B	3	3	0
M	B	B	3	3	0
M	B	D	3	5	-2
M	B	C	3	4	-1
M	C	C	4	4	0
M	C	C	4	4	0
F	A*	B	1	3	-2
F	A*	A	1	2	-1
F	A	D	2	5	-3
F	A	B	2	3	-1
F	A	C	2	4	-2
F	A	B	2	3	-1
F	A	B	2	3	-1
F	B	B	3	3	0
F	B	B	3	3	0
F	C	C	4	4	0

Table 2: Data analysis of GCSE and A level grades collected

	Male GCSE Grades	Male A Level Grades	Female GCSE Grades	Female A Level Grades
Mean	2.7	3.3	2.2	3.3
Median	3	3	2	3
Range	3	3	3	3
Mode	3	3	2	3
	Average Male Grade Difference -0.6		Average Female Grade Difference -1.1	

Firstly, during the interview, GCSE and A level mathematics grades were obtained. This was to identify if there is a noticeable difference between the attainments of males and females. The numerical conversion was a simple method of assigning each grade obtained to a number; A*=1 A=2 etc. (see table 1). This data conversion enables a quantitative look at trends in the data. Once done, the mean medium and mode of the grades obtained can be calculated (see table 2) allowing a clearer view of any significant differences that may be evident. As shown in the table, the information collected in the data is very similar. The only apparent difference in grades obtained was the slightly lower average GCSE grade achieved by the female candidates. However, when examining the grade difference between GCSE and A level, males' average difference was -0.6 where females' was almost twice that, at -

1.1. This could suggest that whilst there are no significant differences in grades achieved, the jump between the two different educational stages is better handled by the male participant. One theory that could support this idea is the theory of autonomous learning offered by Hyde et al (1990). However to safely state this theory, a more in depth investigation of grade differences would need to be made, and this study is insufficient for the reasons given above. Overall, in terms of the numerical side of the study, there is no strong evidence to suggest that there is a significant difference in ability between males and females in mathematics.

The second section of the data analysis process is the interpretation of the qualitative information collected during the interview process. As previously mentioned, the major themes in the questions asked were proportional to the theories understood in the relevant literature. These themes provide the structural layout of the analysis process and can be narrowed down into 6 main sections: attitudes, encouragement, effects of failure, self-accessed ability, learning strategy and experience with stereotypes. By grouping the research results like this, a more in depth and consistent look at the results can be achieved. The results will be referred to the literature from which the main themes came, to enable a strong and supported conclusion to the data that has been collected.

Starting with the attitudes of candidates, these answers were all relatively similar across the two genders, with very little variation between the two. All of the 20 candidates interviewed stated that their attitude towards the subject was nothing short of positive and enthusiastic. There were no variations in answers in terms of gender, with words such as "*interesting*" and "*satisfying*" used frequently throughout several interviews. However, 4 of the 10 males asked about their attitudes stated they enjoyed the subject simply because they were good at maths. Although this has no relevance to the themes found in the literature, it is an interesting aspect of attitudes of students and their reasons for choosing particular subjects at a higher level. All in all, there seems to be no reason to assume that there are any significant differences in attitudes between males and females. However this is to be expected when asking undergraduates who are studying mathematics. The enthusiasm and dedication required to study a subject at an undergraduate level would be consistent with the commonalities seen when participants were responding to this particular part of the interview. To perform a more reliable and fair investigation into attitudes of maths, there would need to be a wider demographic of participants. This would enable a wider spread of data for comparison.

Next, the encouragement section of the study is considered. This section stems from the idea of parent and teacher attitudes having an exponential effect on individuals' intellectual growth and development. Interestingly, when asked about the encouragement received to continue maths at a further level, there were some noticeable differences in answers given. For the males, 6 of the 10 asked were very certain about the positivity surrounding their encouragement. Words such as "*definitely*" and "*absolutely*" were commonly used and indicate that both their teachers and their parents were very supportive. One participant stated "*ever since I took a liking to maths, everyone suggested to take it further" (male participant 9).* The other 4 male candidates simply stated that it was either their parents or teachers that were the encouraging bodies. None of the males asked described any lack of encouragement. However, with the female candidates, 3 explained how they felt they

were "*not particularly*" encouraged by anyone to continue the subject. The other 7 individuals followed the same pattern as the males, some stating it was teachers (3/10) and some parents (4/10). Interestingly, only 1 female indicated an enthusiastic positive result as clearly as the males had, saying "*At school my maths teacher told everyone to do maths at college" (female participant 1*. These findings could very easily suggest a strong correlation with the theories supplies by Rosenthal and Jacobson (1968) and Yee and Eccles (1988) whose studies showed that both parents' and teachers' attitudes are more negative towards females than males regarding the study of mathematics. However, to suggest that this has had a negative effect on any of the participants would be illogical as they are all undergraduates who, regardless of encouragement, chose to study at a higher level.

The next section is on the effect that failure has on individuals' approach and confidence. This theme was chosen due to the contrasting ideas presented by Brunstein and Gollowitzer (1996) and Wortman and Brehm (1975). These theories illustrate the repercussions that failure has on a person's self-worth and motivation. Interestingly, a huge 90% of male candidates stated that whenever they have not done as well as anticipated, they have responded by working harder, as suggested in Wortman and Brehm's (1975) study. The other male candidate stated "*I have never failed*" (male participant 2) meaning that 0 of the 10 male participants felt negative effects when it came to failure. The reactions of the females on the other hand were completely different. 70% of the females that were interviewed stated that they experienced negative effects from not doing as well as they had hoped, with phrases such as "*knocked confidence*" and "*inadequate*" used throughout. One participant said "*I feel terrible whenever I fail, it really knocks my confidence" (*female participant 10). This shows an extremely significant difference in how males and females cope with failure and definitely coincides with the theories that were discovered in the literature, such as Vroom (1964) who suggested the positive link between failure and motivation and Atkinson (1964) who stated the idea of the negative domino effect failure has on future endeavours. However, again it seems that the negative effects this might have on grades are not evident here. Although there seem to be huge repercussions on the female participants' mental state, there is still no evidence to suggest that this has any effect on the future grades achieved.

Moving on to the theme of self-assessed ability, this aspect of the investigation came from the theory of self-fulfilling prophecy. The idea that one's belief in one's own personal ability shapes the outcome is interesting and could potentially be a big factor in gender differences. The information collected during this section of the interview was relatively similar across the two genders. Nearly all the candidates asked stated that they thought of themselves as good at maths. However, there was one exception from the female interviewees. This individual was very critical about her abilities and stated her skills in mathematics as "very *average*" (female participant 4). This individual also claimed that the effort levels required for maths were a lot higher than for her other subjects at GCSE level, saying "*I tried harder in maths than I did any other subject"*. This candidate seems to be anomalous in this aspect as all other candidates, both female and male, explained that effort levels in this particular subject were a lot lower than the others they studied at school. For example, one participant said "*I didn't have to try at all, it was easy"* (male participant 2). As with the attitudes section above, this trend is to be expected as to succeed in A level and progress to a degree course would imply good capabilities in

mathematics. Once again, it would require a more varied group of people to establish a true distinction between perceived skill level and actual achievement as undergraduates need a certain amount of mathematical skill to be at the educational level at which they are currently operating.

Learning strategy is the next phase of the interview process to analyse. This theme came from the idea of autonomous learning, a theory offered by Hyde et al (1990). The theory suggests that females are less likely to try and understand the underlying principals and lean more towards simply memorising methods. When asked, 70% of the males stated that they put precedence on the underlying logic. One candidate went on to say "*it helps me remember if I understand why we use certain methods*" (male participant 2) and another said "*I memorise the equations, I have no idea why we differentiate or anything like that but it doesn't stop me knowing how to do it"* (male participant 5). Similarly with the female candidates, 6 out of 10 explained the importance that understanding has to their learning style. Conversely, 4 out of the 10 interviewed said the opposite. There are no significant differences between genders to suggest any strong correlation with the existing theories and the results of this study.

The final section of the data analysis section is the experiences with gender bias that the individuals interviewed have had. This is fuelled by the idea of stereotype threat, a theme consistent throughout the literature. The male side of the participants were relatively oblivious to the existence of stereotypes against females in mathematics with only 2 out of 10 being aware that such stereotypes exist. One of those 2 stated "*men are always better than women at maths"* (male participant 2). With the female participants, however, there was much more awareness. Only 1 of the 10 women asked was totally unaware of the stigma surrounding females, but did state "*very few women were doing maths at A level"* (female participant 8). A huge 90% of females asked were fully aware of the negative stereotypes surrounding them. Although this is a significant difference, it is understandable that the female mathematicians would be aware of such stigmas. The important thing to note here is that as shown in the numerical analysis of grades, it has clearly done no damage to the grades obtained. Therefore it would be difficult to suggest that the data collected in this study supports the theory of stereotype threat.

Discussion

The findings of the study both contradict and support the theories examined in the literature. Whilst attitudes and self-confidence were found to be insignificant, there is strong reason to suggest that the idea of stereotype is a negative factor in the mathematical education of females. Similarly, encouragement and the effort levels exerted by candidates seemed to be similar between genders, whereas there were noticeable differences in learning strategy and the effect that failure has. Overall, the findings show that the main differences are the effects that the experience of failure has. Failure seems to have a markedly more negative impact on women than men. Another noticeable difference is with the learning strategy, as the literature suggests; it seems that the female candidates put a lesser importance on understanding the underlying reasons behind methodology. It was found that the males preferred to understand fully. The final difference was in the awareness that candidates had of the stigmas and stereotypes surrounding females in mathematics.

Conclusions and Recommendations

All in all, the differences are significant enough to acknowledge the effects they may have on a female's learning experience. However, it is not reasonable to state that these differences have any negative effects on the educational outcome. This is due to the limited number of people that were interviewed. One qualification is that the undergraduates are successful in their mathematical education and therefore cannot be used to understand any negative effects of these findings. One thing that would be necessary to alter if the investigation were to be continued would be the demographic of individuals interviewed. With a wider spread of people to ask, a more comprehensive look at the negative effects could be made.

In terms of the individual growth of the interviewer, this experience has been extremely educational and beneficial. As a female in the mathematics field, it is fascinating to look at all the struggles that an individual (especially a female, it would seem) has to go through whilst in the educational system. As a prospective teacher, it has moulded the future approaches to teaching individuals who are in precisely the same position at the individuals interviewed in this study.

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Appendix 1: Information Sheet

Outline of the research: This is an investigation into the possible causes of differences in the mathematical ability between males and females at an undergraduate level. A study of the extent to which the differences occur and possible interventions that can be put in place to try and resolve such differences.

Who is the researcher?
Name: Laura Payne
Institution: Liverpool Hope University
Contact details: 11010356@hope.ac.uk

What will my participation in the research involve?
Your participation will involve taking part in an interview. The questions will be open so feel free to elaborate where you think is necessary. The questions will revolve around your Mathematical ability, confidence, motivations for study and your overall attitudes towards to the subject.

Will there be any benefits in taking part?
If the study is successful, you could take pleasure in the knowledge that you helped understand the differences in mathematics ability when it comes to gender.

Will there be any risks in taking part?
As you will be thinking back to your time as a secondary level student, you are advised that if there is any chance of negative emotions being evoked as consequence, you have no obligation to take part.

What happens if I decide I don't want to take part during the actual research study, or decide I don't want the information I've given to be used?
Your participation is completely voluntary; you may withdraw at any given time throughout the study. However, if the results are published, it will be very unlikely that any provided information will be removed.

How will you ensure that my contribution is anonymous?
The availability of your information will be only to the researcher. All data given by you will remain anonymous to the general audience.

Appendix 2: Consent Form

Title of research project: Gender differences in mathematics ability
Name of researcher: Laura Payne

1. I confirm that I have read and understand the information sheet for the above research project and have had the opportunity to ask questions.	Yes	No

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.	Yes	No

3. I agree to take part in this research project.	Yes	No

Name of participant
Signature
Date:

Name of researcher
Signature:
Date:

Appendix 3: Interview Questions

Gender: Male Female

1. What grade did you achieve at GCSE? A-Level? (if applicable)
2. Why did you choose to do Mathematics at degree level?
3. Do you feel you were encouraged to study Mathematics at a higher level?
4. Do you enjoy maths? What aspects of mathematics in particular do you enjoy?
5. In the past, when you have failed a maths exam, what effect has it had on you? (make you try harder/lose confidence)
6. Do you find you have to put a lot of effort in studying for tests? I.e. a lot of revision time put into preparing for exams.
7. At what point in education do you think you began to enjoy Maths?
8. How would you describe your mathematical ability? For example, does understanding mathematics come easy to you?
9. Which do you find you do more: Try to understand the underlying logic in Maths, or do you mostly just memorise rules?
10. What gender biases have you experienced in Mathematics? What do you think the causes of these are?

Additional Notes: