A small-scale action research project examining the gender differences in confidence and enjoyment of mathematics.

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Abstract

This study looks into the gender differences in mathematics, specifically focusing on the differences of confidence and enjoyment of maths. Students in the sample were asked to predict their scores for assessments, which were then compared to their actual results, to examine confidence.

There have been many conflicting results regarding the gender differences in mathematics performance, confidence and beliefs. Else-Quest et al (2010) discovered females reported lower self-efficacy in maths than males, although there was little difference in their mathematics achievement. This has the potential to increase as students move through school, with the largest difference being amongst the highest performing students (Ganley et al, 2013). Foyn, Solomon and Braathe (2018) found that the females, particularly the high achievers, do not want to be seen as 'clever' and therefore do not like to participate in lessons or continue to study mathematics after the compulsory age. The inconsistencies in the literature available influenced the choice of this research. Despite there being little gender differences in achievement, why are there larger differences in student's perception of the subject?

Literature Discussion

When researchers first started examining the gender differences in mathematics they found that boys outperformed girls on tests, girls dropped maths as a subject at school as soon as possible and that the stereotype 'girls do not do maths' was widely known (Hyde and Mertz 2009; Maccoby and Jacklin 1975; Walkerdine 1998). Sells (1980) describes maths as the 'critical filter' as basic maths knowledge is required for jobs at all levels, not just those at

graduate level. When girls drop maths at high school they are then unable to access higher paying and prestigious occupations (Hyde, Fennema and Lamon, 1900). This then triggered many other researches to be conducted aiming to understand *why* girls under participate in maths. Maccoby and Jacklin (1975) quote that “boys excel in mathematical ability” and their skills in the subject increase faster than girls from age 12 (p352).

One of the first meta-analysis studies into gender differences in mathematics performance was by Hyde, Fennema and Lamon (1990). They compared 100 previous studies with over 3,000,000 participants altogether. They found that there were little to no gender differences in maths achievement, with the only difference being on problem solving tasks. This did not support previous findings, such as those above, which suggests that within the 10/20 years between the research, the gender gap had practically closed. If this pattern has continued, now nearly 50 years after the research in this area began, the difference should be unrecognisable.

In the UK females achieve higher total GCSE scores, are entered into more full GCSEs than males and are more likely to achieve the Department for Education’s benchmark of at least 5 A*-C grades including maths and English (now grades 4 and above) (Sammons et al, 2014). This Department for Education study also found no significant gender differences in maths GCSE, females made more progress in maths than males and girls had higher science and maths outcomes in primary school (Sammons et al, 2014).

Despite this gender differences are more obvious in subject choice than achievement (Bramley, Vidal Rodeiro and Vitello, 2015). In 2018 girls accounted for 39% of mathematics A levels and only 28% of further mathematics (Cassidy, Cattan and Crawford, 2018). An under-representation of females in maths at A level leads to under-representation of females

in maths-based careers (STEM Women, 2019). This reflects Sells' 'critical filter' from 1980, showing that this idea is still apparent, although achievement gaps and society's expectations have since changed, girls are still filtering out of maths career paths (Watt, Eccles and Durik, 2006; Blickenstaff, 2005; Watt, 2007). A recent study showed that female graduates with maths degrees earn 13.4% more 5 years after graduating than females with other degrees (Belfield et al, 2018; Cassidy, Cattan and Crawford, 2018). In 2009 43% of girls who scored grade A in maths GCSE went on to study maths at AS/A level, compared to 65% for boys (Noyes, 2009). In 2014 maths A level was the most popular subject taken by boys, but the 4th most popular among girls (Baldwin, 2016). This difference in participation (choosing to study maths after GCSE) raises the questions *why* are girls opting out of study maths after it is compulsory?

One of the reasons girls shy away from maths and other STEM subjects is due to the stereotype threat effects (Brown and Josephs, 1999), however there are many different results from research in this area. Stereotype threat is defined as the unconscious anxiety of confirming a negative stereotype, even ones that are not necessarily true, such as that males are better at maths (Ganley et al. 2013). Some studies found stereotype threat effects in girls from when they first start school and others found none of these effects up until the end of high school and results differ in mixed sex and single sex schools (Ganley et al. 2013). Another suggestion is that the stereotype threat effect has more of an impact on girls if they are outnumbered by boys when taking a test (Hargreaves, Homer and Swinnerton, 2008). Their study compared the attitudes and performance in maths amongst 500 gifted and talented students and found more boys were identified as 'gifted' by their teachers than girls were. However, when comparing samples with more boys to those with equal amounts of boys and girls, they found the girls achieved the same or better results than the boys. This shows the stereotype threat was not apparent in this situation of higher achieving girls.

Maths has previously been seen as a male domain, which has discouraged girls from participating in the subject. As girls filter out of the pipeline, the male dominance in the subject increases as you progress through the levels of education (A level to postgraduate) (Mendick, 2006). In Brandell and Staberg's 2008 study, they found that their research sample of year 9s and 11s in Sweden perceived maths as a male domain. Positive aspects of maths were associated more with boys whereas negative aspects were associated more with girls. Among the older students, maths was seen as more easy, interesting and enjoyable for boys, whilst it also was seen as more important for their future careers.

One-way maths could be perceived as a male domain by children is due to the lack of female role models and representations in mathematics picture books (Trakulphadetkrai, 2017). This could lead to girls subconsciously growing up observing that maths has a greater association with males. Trakulphadetkrai then goes on to suggest this could lead to girls being less able to relate to maths themselves and could even affect the subjects they choose to study post16. Although more research is needed into this factor, and the study was small, only looking at 64 mathematics picture books. There are now also maths books geared to girls of all ages, from primary up until high school age (Green, 2019),

Although stereotypes are slowly changing, due to girls and boys' abilities being at the same level, it still has an impact on how girls view maths. Even if girls do not personally believe that maths is "just for boys", if they have people in their immediate environment, such as family and friends, who hold such beliefs, this can result in girls undermining their confidence, which can then impact their performance and achievement (Hastedt 2019; UNESCO 2017).

Foyn, Solomon and Braathe (2018) found that females in their Norwegian study did not want to be seen as, or identify themselves as 'clever' and are embarrassed to be seen studying higher level maths. If the girls are seen as clever, they risk being perceived as a 'nerd' by their peers. This can be seen as a reflection on Mendicks (2005) findings. She interviewed 43 A level mathematics students in the UK, of which only 4 identified themselves as 'good at maths', all of whom were male. 2 of the girls she interviewed identified themselves as 'not good at maths', despite taking both mathematics and further mathematics at A level, taking their GCSE maths in year 10 and receiving A* in these.

> "*For the students in this paper, 'real mathematics' is different from other subjects; it is certain and rational; 'real mathematicians' are different from other people; they combine the flattering character of geniuses and heroes with the unflattering character of 'nerds'.*" (Mendick, 2005. pp.217).

These students also do not want the reputation of being a 'nerd' and therefore do not identify themselves as clever at maths, despite their evidence of academic talent in the subject. However, this was a reflection upon both boys and girls, suggesting this idea of not wanting to be seen *too* good at maths applies not just to girls. Piper (2008) conducted a study into the attitudes, confidence and achievement of higher ability fifth grade students. He found that these gifted and high achieving students were more confident to begin with, with the boys being more confident on the research scales. Within this group, "boys confidence tended to match or exceed their achievements while girls' achievement tended to match or exceed their confidence" (Piper, 2008, pp.36).

Attitudes towards mathematics, by both boys and girls at any age, have an important influence on whether pupils will continue to study maths after it is compulsory (Hargreaves,

Homer and Swinnerton, 2008). These researchers studied mathematics attitudes among gifted and talented students. They found that 40% of the boys thought they were better at maths than girls (as shown by answering the question 'who do you think are better at maths? With the choice of answers being boys, girls or same) 55% of boys answered same and only 4% thought girls were better.

> "*In other words, boys more frequently think that as a group they are better at mathematics whilst the same is true, though less so, of English for the girls. Therefore it is not that girls have no confidence in their general ability, but that they have a lack of confidence in their mathematical ability*." (Hargreaves, Homer and Swinnerton, 2008. pp.30).

This shows that despite there being no difference in their performance, boys are significantly more confident in their abilities than girls. The comparison with English suggests that girls do have confidence in themselves, just not within mathematics.

Girls perceptions of their mathematical abilities can originate from primary school age. Dowker, Bennett and Smith (2012) found that boys as young as 8 years old, rated their mathematics significantly higher than the girls did, despite there being no gender differences in performance (Trakulphadetkrai, 2017). Previously researchers have found boys have rated their self-concept of maths higher than girls (Ireson, Hallam and Plewis 2001; Manger and Eikeland 1998). Manger and Eikeland also found that when the differences in self-concept were controlled there were no longer differences in achievement, therefore suggesting the difference in mathematical confidence is a social construct and this difference in confidence affects achievement (Hargreaves, Homer and Swinnerton, 2008). This suggests if boys are more confident in the subject, they will believe they can achieve high grades and continue to study it past GCSE. However, this is an old paper, from 1998, so this may have changed in the past 20 years.

Hodgen et al (2010) looked into the attitudes of 12 and 14-year olds towards maths in England. When asking students if they enjoyed maths lessons, the 12-year olds enjoyed it more than the 14-year olds. Among 12-year olds, 64% of boys and 62% of girls said they enjoyed the subject compared to 59% of 14-year old boys and 50% of 14 year old girls. This suggests that attitudes towards maths decline for both genders, but more so for females. Jo Boaler worked with PISA (Programme for International Student Assessment) and found the UK came last compared to the other countries for gender equity in mathematical and mindset beliefs (Boaler, 2015). In the mindset questionnaire the beliefs of students were measured through questions such as can you learn maths to a high level. The results showed the UK had larger differences between boys and girls in their beliefs about maths than any other country. This indicates boys have a much more positive attitude/mindset towards maths than girls, and this gap is bigger than in other countries. Although it can be difficult to compare mathematics education to other countries as the education systems are all so different.

From the literature available, it seems that there are no recognisable differences in achievement in maths between boys and girls, but there is a difference in the confidence and self-concept boys and girls have of their abilities, which could explain why fewer girls appear to enjoy maths. The purpose of this study is to examine whether there are any differences in the confidence and enjoyment of girls and boys in mathematics. Do boys over estimate themselves or are their estimations correct? Do boys enjoy mathematics more than girls, if so could this be due to a difference in confidence?

Methods

To investigate whether boys overestimate their mathematical ability mixed method of data collections were used. When the sample of students took assessments, the results students predicted they would achieve were compared to their actual results. A questionnaire was then given, to ask students about their attitudes towards maths and if they feel confident in the subject.

School context.

The school this research took place in was a mixed secondary school academy in outer London. There were 1080 pupils on roll at the time of research (4 February 2020), taken from Classcharts, the schools online data system. There were 677 males and 403 females in total, including the sixth form. This shows the school is very 'boy heavy', which is, in part, due to many Ofsted graded 'outstanding' all-girls schools within the same borough. This could negatively impact girls' self-confidence, as Gilbert and Gilbert (1998) found that the potential harassment towards girls in boy heavy subjects/classes made them less willing to choose these. One of the targets for the mathematics department is to encourage more girls to study maths post-16. This shows there is already a gender difference in girls feeling confident enough to study mathematics A level, at this school.

217 pupils on roll were pupil premium, 98 females and 119 males. With this equating to 20.1% of the students, this is above the national average of 13.6% in 2018 (Department for Education, 2018). Pupil premium students are more likely to lack confidence and have lower attendance than others, which could both effect their confidence and attitude towards school in general, as well as in mathematics (Bishopshalt School, 2016; Graham, 2019). This could impact the research as there is a much higher percentage of boys in the school, but little difference in the number of pupil premium. These figures show 24% of females in the school are pupil premium, compared to 17% of males. Girls from working class backgrounds have previously been found to be the group most at risk of failure in mathematics (Gilbert and Gilbert, 1998). More recent research suggests boys from working class families are the

lowest attaining group in all subjects, including maths (Kuper and Jacobs, 2018; Waterman-Smith, 2020).

Sample

Convenience sampling was use to select the classes and participants who would take part in the study. Convenience sampling is a type of non-random sampling, where members of the target population meet a certain practical criterion (Etikan, Musa and Alkassim, 2016). In this case, the classes chosen were easily accessible to the researcher and available at the times needed. This consisted of two top set year 7 classes, one of which the researcher taught. Sample 1 consisted of 11 girls and 21 boys and sample 2 consisted of 5 females and 23 males.

After these classes had been selected, assent was then collected from individual students in the samples and consent was given by the school. All students gave their assent to be included in the study, with most keen to see if they could predict their score, or see how close they were. The research was explained to the students prior to them giving their assent, and again before the assessment and questionnaire were administered. At both points students were asked if they would like to continue.

The main disadvantage of convenience sampling is that it has the chance of being biased, so should not be taken to be representative of the whole population (Etikan, Musa and Alkassim, 2016). In this study, it meant the samples ended up only including high ability students in their first year of secondary school, which may have had an impact on their confidence, knowing they are high ability.

Assessment predictions

The first method used was comparing assessment results students achieved, to what they predicted they would achieve in the school's half termly assessments in February. This

would have been repeated with the end of term assessments in April, however due to COVID-19 this was not possible. The assessment was on the topic's students had learnt during that half term, and at the end of the previous term. Both classes had the same assessment and these were conducted in their usual school assessment environment. Before the test, students wrote on the front of their paper a 'predicted score before test'. This was a number out of 36, based on how confident they felt from the revision list they had been given and should have revised from. Then after the assessment students were given another opportunity to estimate their scores, this time it was broken into the questions, purely for students to remember each question, and then a total was calculated the end. Students were allowed to look back through their papers to see how well they answered the question before writing down their predicted score after the assessment.

To keep this anonymous, students only wrote their number, which had been randomly allocated to them by another teacher, on their assessment and prediction sheets. This allowed their assessments to be marked and to input their prediction data anonymously. When assessments were handed back to students and the data was put onto the system, their class teacher matched the numbers to students' names and handed these back. With students aware their information would be kept anonymous, they were more likely to be honest in their opinions, with anonymity being found to encourage greater disclosure by participants, therefore giving a more accurate picture (Murdoch et al., 2014).

Questionnaire

After their assessment, students were given an online questionnaire to complete regarding their attitude, confidence and enjoyment of mathematics. Out of the 32 pupils in sample one, 29 answered the questionnaire, this was lower than the sample as some students were absent at the time consisting of 11 females and 18 males.

To look at the gender differences in confidence and interest/enjoyment, participants in sample 1 also completed an online questionnaire. The second sample were due to complete

the same questionnaire, but due to COVID-19 this was unable to occur. Some statements were taken from the Fennema-Sherman Mathematics Attitude Scale, or adapted from the Modified Fennema-Sherman Mathematics Attitude Scale (Doepken, Lawsky, and Padwa, 1993). These were carefully selected and adapted/reworded to best suit the class completing the questionnaire. Answers were on a 4-point Likert scale to select how much the agreed with each statement. These 4 points were 'not at all true', 'slightly true', 'mostly true' and 'true', with 1 being 'not at all true'. With no 'neutral' option available on this 4 part Likert scale, students had to give an answer that reflected their confidence/feelings towards maths and could not choose a safe option to shy away if they felt less confident. This allowed students to give a degree of opinon to reflect their answer, rather than a yes or no (McLeod, 2008). This was of benefit to the current research, allowing a more accurate picture of how confident students feel towards maths. This scale replicated that used by Ganley and Lubienski (2016) to look into the mathematical confidence of students. Although this means they are 'forced' to choose an opinion, this supported the research, with students having to give honest answers to reflect their opinions. This reflects Ganley and Lubienski's (2016) research methods to examine maths confidence and interest. A number of questions in the questionnaire were also based around their study.

The questionnaire was split into two sections both containing 5 questions, on confidence and enjoyment (see appendix A). The third part of the questionnaire was regarding student's confidence about the grades they *think* they will receive and the grades they *would like* to receive at the end of year. When answering the questionnaire, students entered their research number, so this could be matched to their assessment data. This allowed participants predicted scores on assessment to be compared to the actual scores, as well as the confidence they had about their abilities in maths from the questionnaire. This allows for multiple areas to be looked into once examining the data collected by both methods.

Findings and Analysis

Confidence regarding predicted scores.

When taking the half termly assessment, students were asked to predict the score they thought they would achieve on two occasions, before they took the assessment and after. This would allow for any differences in confidence to be shown, for example, results could have shown boys were more confident before the test than girls. Based on the sample of 60 students, made up of 16 girls and 44 boys, the tables below show the number of students who over estimated (predicted they would get a higher mark than they did), underestimated (predicted they would get a lower mark than they did), or predicted the correct score. The table in figure 2.1 shows the results of the predictions students made both before and after their assessment.

Figure 2.1: test predictions for all students

	Pre-test predictions	Post-test predictions
Overestimated score	66.7%	70%
Underestimated score	28.3%	25%
Correct score	5%	5%

From this table, there are little differences in the change of prediction before and after the assessment was taken. 9 students went from underestimating their result before the assessment, to overestimating it once they had taken the assessment, whilst 6 students went from underestimating their score before the assessment to overestimating it after. Looking at the predictions of scores after the assessment had taken place may give a clearer indication to student's confidence, as the predictions prior were based on their revision rather than their ability to answer the questions they were given. Once students had

seen the questions and completed them to the best of their ability, they would have been in a better position to predict their scores. This allowed students to identify the areas they felt less confident in themselves. I replicated this method by breaking down the post-test review sheet into each question on the paper (see appendix B). This allowed students to go back and reflect on each question and their answers before giving their predicted mark, in turn creating a more accurate result than an estimate based purely on the number of marks available. The pre-test prediction grade, was just the score out of 37 students predicted they would get prior to the assessment and seeing the questions, so purely based on their confidence form revision. This method of assessment compliments Barker's (2019) findings on his study regarding confidence testing. His method of confidence testing revealed the students reflected on the questions in the assessment and thought about them in more depth before then answering his confidence assessment. The greater thought that went into the confidence assessment resulted in a more accurate picture of student's confidence. This also allowed students to focus on their own performance and hoe 'hard' they found each question.

From the data prior to taking the test, 72.7% of the boys predicted they would score higher than they did, whilst the same was true for 50% of the girls (see figures 2.2 and 2.3). Out of the total number of students, 66% predicted their score to be higher than it was. The predictions post-test showed the same percentage of boys overestimating their score, although as there was some movement in individuals' predictions, this percentage does not represent the same participants. For girls, the percentage of overestimating their ability rose to 62.5%. When looking at the results, boys slightly outperformed girls, with their average score being 62.1%, whereas the average score for girls was 55.7%. Due to the sample only containing students of high abilities, their confidence may have been higher than other classes. Parsons, Croft and Harrison (2009) found that those who are 'better mathematically qualified' were more confident in their mathematics and also more successful. The small

difference shown in the percentages of girls and boys *overestimating* their abilities shows a small gender difference. These results suggest that whilst girls in these top sets are confident, boys are more so.

Figure 2.2: Prediction results for boys

	Pre-test	Post-test
Overestimated score	72.7%	72.7%
Underestimated score	25%	20.5%
Correct score	2.3%	6.8%

Figure 2.3: Prediction results for girls

	Pre-test	Post-test
Overestimated score	50%	62.5%
Underestimated score	37.5%	37.5%
Correct score	12.5%	

The evidence in literature supports the finding that boys appear to be more confident in mathematics than girls. In previous studies, girls have been found to lack confidence in mathematics, be more anxious about the subject, have less interest in maths and had lower self-confidence even when they achieved higher than boys (Mubeen, Sayeed and Arif, 2013, Ganley and Lubienski, 2016, Else-Quest, Hyde and Marcia, 2010). Piper (2008) found that among fifth grade high ability students, boys were typically more confident than girls in mathematics, particularly on computation of decimals and fractions and whole numbers. The boys in this sample were also more willing to share and discuss their mathematics and answers, suggesting they were more confident to be vocal about their methods, even if they were not confident in the answers themselves. This is also supported by Parsons, Croft and

Harrison (2009), finding those with higher GCSE grades, reported higher levels of confidence in their mathematical ability post-16. This study, conducted on engineering university, involved a sample containing higher ability students, those studding engineering at university would have needed good grades in mathematics GCSE and A-Level. The sample in the present study were similar to the research mentioned above, all containing high ability students, which leaves room for the question 'would students of lower abilities be as confident in their mathematics as those of higher ability?'

Bench et al (2015) conducted a similar study into gender differences in overestimation of mathematics performance, discovering in both of the studies they conducted boys overestimated the number of questions they thought they got correct, perceiving they had attained a higher score than they actually achieved. Again, this study was on college students, all of whom would have needed good levels of maths to be able to get into the college and course.

Questionnaire - enjoyment

The questionnaire was broken into 3 parts; confidence, enjoyment and futures. This allowed the questions to be similar, but slightly re-worded to compare confidence and enjoyment. For example, a statement in the confidence section was 'maths is one of my *best* subjects' asking students to reflect on whether it is one of the subjects they are 'best' at and achieve well in, compared to other subjects. The similar statement in the enjoyment section, read 'maths is one of my *favourite* subjects'. From comparing these two questions, 36.7% of students answered 'very true' to the statement 'maths is one of my *best* subjects', whereas only 26.7% of students agreed that maths was their *favourite* subject. This shows a 10% drop in the number of students who recognise they are good a maths, but do not view the subject as one of their favourites, suggesting that although they are confident in their abilities, they do not enjoy the subject as much. 13.3% of students selected to agree with

‘not at all true’ to the statement ‘maths is one of my best subjects’, however 23.3% of students felt the same way about maths being their *favourite* subject. Again, this shows a significant difference, with a lower percentage of students who perceive themselves as *bad* at maths, but a high percentage admitting they do not like maths as a subject. These 2 comparisons suggest that although the majority of students perceive maths as one of their best subjects, with 66.7% of students agreeing with mostly or very true, these percentages drop when looking at those who agree very true or mostly true to the statement maths is their favourite subject. Although this may be affected by this particular sample, as participants are all in a top set and are aware of this, they know their mathematics is substantially above average. The findings regarding enjoyment could also be affected due to staffing issues. The class in the study had various different short-term supply teachers during this academic year as their permanent teacher was on long term sick leave. This meant the class had no stability in their learning environment, they had never met their official teacher and within the autumn term alone had 6 different supply teachers. This could impact their attitude towards the subject as there was no consistent attitude from a permanent teacher to support their learning and be able to build a rapport with students to boost their confidence, if it was found to be low.

Lee and Kung (2017) found that the girls most likely to feel less confident, were those who felt less accepted in their learning environment, especially if surrounded by boys who associated themselves with maths and therefore had a more positive self-concept. This could be the case in the present research, the girls are surrounded by boys of high ability, who, from the previous results, show they overestimate their abilities. The large number of boys in this class could also impact the girls feelings and attitudes. Only 34.4% of the students in the class were female, showing they are largely outnumbered their male counterparts. However, this is a true representation of the school as a whole, from the 1080 students on roll, only 37.3% were female. This suggests that the girl’s confidence found

here, could be replicated in other subjects where they also feel overwhelmed and undermined by boys. Girls can also be aware of the difference in self-confidence and the higher levels boys perceive themselves to have. During interviews, Foyn, Solomon and Braathe (2018) found that girls discussed and recognised boys' levels of confidence. One participant stated "I think boys seem a bit more confident in what they do" (Foyn, Solomon and Braathe, 2018, pp.84) with the other girl in the interview agreeing.

When looking at the statement 'I enjoy maths', no females related to this statement as 'very true'. 54.5% of girls said this statement was mostly true to them, but 36.4% said this statement was not at all true. When looking at the boy's responses, 16.7% agreed the statement was very true, 38.9% said it was mostly true however still a relatively high percentage (22.2%) said this was not at all true.

Figure 2.4: Enjoyment of maths questionnaire

'I enjoy maths'	**1.Not at all true**	**2.Slightly true**	**3.Mostly true**	**4.Very true**
Boys responses	22.2%	22.2%	38.9%	16.7%
Girls responses	36.4%	9%	54.5%	

Again, enjoyment in maths can be related and emphasised by the class teacher, and due to the situation, this class was in, the lack of a stable teacher could impact their enjoyment. Teachers have been found to describe boys as more talented than girls and interacted more with the boys (Heyder, Steinmayr and Kessels, 2019; Li, 1999). Li (1999) also found a small difference in teachers own paradigms, finding female teachers were more likely to promote collaborative and engaging learning environments, encourages all students to participate. With the lack of a constant teacher, students' belief regarding their abilities and self-

confidence may be lower than other classes, due to the unstable learning environment they found themselves in. Foyn, Solomon and Braathe (2018) also found that girls do not like admitting they enjoy maths, especially if their social status could be damaged by this and the reputation of being a nerd. The current research supports these finding, with no girls thinking the statement 'I enjoy maths' is very true to them. A study into the enjoyment of maths in key stage 2, found that boys enjoyed maths more than girls in every year group, years 4-6 (NCETM, 2009). This suggests pupil's enjoyment in maths in year 7, could stem from their attitudes in primary school.

Conclusion

This research project found there are small gender differences in the over-estimation of grades in maths, with boys being more likely to overestimate their scores, suggesting a higher level of confidence. This particular study found that girls in top set maths classes, who are therefore talented in the subject, had lower expectations of themselves than their male classmates. Although the boys did outperform the girls on their assessments on average (by 6.4%), there was a much greater difference in the predicted scores.

Confidence

This study found there was a small difference in the confidence between boys and girls in maths. Boys were found to be more likely to over predict their scores and overestimate their abilities in maths. This supports the findings of Bench et al (2015) that males overestimated their performance in maths, whereas females had more accurate predictions. This coincided with females also having less enjoyment of maths than males. Mendick (2005) found a similar relationship between confidence and enjoyment of maths in school, with it being more difficult for females to feel talented at and comfortable with mathematics so less chose to pursue the subject and this can have a negative effect on their achievement. This study

reflects Mendick's findings, the large difference in confidence found from over-estimating scores, could be a reflection on the small difference in the boys outperforming the girls. A limitation to this study was that the sample group of students were all in the top sets of their year group. Therefore, they knew their ability in maths was good and above average and their peers in other classes. The view of maths as a male domain (Brandell and Staberg, 2008; Hyde et al. 1990; Kloosterman et al. 2001) could also influence girls' confidence in the subject. Although in some countries, including Australia, some students have been found to perceive maths as a female domain (Brandell, Nyström and Sundqvist, 2004), whereas other research suggests there is a neutral domain (Forgasz, 2001).

The boy heavy classes could also be a cause for limitation in girl's self-confidence. If girls sense that boys feel more confident they may shy away, also with the risk of losing thier feminine identity if they show they enjoy maths (Foyn, Solomon and Braathe, 2018). When in societies where there are less female role models in STEM, particularly maths, female students underestimated their abilities (Niepel, Stadler and Greiff, 2019). Girls may also be less likely to be vocally proud of their achievements in case they are labelled as boastful (Riley, 2019). With this being said, Lindberg et al. (2010) conducted a meta-analysis into gender trends in mathematics, found no evidence to support previous claims that girl's performance suffers in gender-integrated classrooms. In this study, the school as a whole is heavily male (62.7% of students). Therefore, this could influence the attitudes of female students in other subjects across the school, especially those with masculine associations. Girls have described top set classes as full of loud and confident boys, who did not fear shouting out incorrect answers and were chosen to demonstrate work more by the teacher (Geilinger, 2017). This could be the case in the present school and sample, especially as they are outnumbered by boys.

Enjoyment and attitude

The results to the statement ‘I enjoy maths’ show that there are gender differences between enjoyment. With no girls agreeing to the ‘very true’ statement, their enjoyment is clearly less than the boys. This could be a reflection on their confidence, if students are less confident in a subject, they are less likely to enjoy it and have negative attitudes towards maths. Some classroom environments, including those with old-fashioned stereotype attitudes, contribute to the low interest and participation in maths by girls (Boaler, 2015). There is also room for the attitudes of both boys and girls to drop even more as they get older. Hodgen et al. (2010) found that attitudes of boys and girls dropped between the ages of 12 and 14. As this study involved year 7s, who were either 11 or 12, there is the possibility even more negative attitudes could form in the future. Post-16 there is even an even bigger drop for attitudes towards STEM subjects (UNESCO, 2017). There is also evidence to suggest gender differences in attitudes towards maths stem from primary school (NCETM, 2009; Rodríguez et al, 2020). With a big jump between the level of mathematics from primary to secondary schools, a difference in maths confidence and anxiety in younger years (Van Mier, Schleepen and Van den Berg, 2019) has the potential to increase even more in secondary school and beyond. In coeducational settings, girls can have significantly more negative attitudes towards maths than their male peers (Lee and Anderson, 2015), which could have been the case in the present study, especially as the girls were heavily outnumbered by the boys.

Changing the attitude of girls in maths

Due to the sample class having multiple substitute teachers, the attitude of all students in the class may have been more negative than others due to the inconsistencies. Teachers should instil mathematical confidence to all students, by holding the attitude ‘everyone can do maths’ (Durham University, 2016). This may have been unable to happen in the sample, as

they had many supply teachers. This meant they did not have one stable maths teacher, whom they could build a rapport with. As there was no teacher present for long enough to identify those students with lower levels of confidence or those with negative attitudes, no support was in place to change these. Previous studies have found positive correlations between the attitudes of students and their achievements in maths, especially for girls (Mubeen, Sayeed and Arif, 2013). Therefore, it is key to ensure students have a positive attitude towards maths, enjoy the subject, become more confident in their abilities and this will have a positive impact on their achievements. Discovering the gender dynamics in the classroom can help identify any differences students may have, but again with no long-term teacher, this would have been difficult to discover in the sample class used. UNESCO (2017) identified 4 tiers to the factors influencing girls' attitudes in STEM subjects; the learner, their family/peers, school and society, with the learner themselves having the biggest influence. They also found enjoyment of STEM subjects is linked to girls' self-efficacy and confidence. The school-level factors included teachers perceptions, teaching strategies, teacher interactions, learning materials and assessment, adaptions can be made to change these influences in a school environment.

Recommendations

It has previously been found that the key to unlocking the full potential of girls in maths is by fostering confidence in their mathematical abilities (Deal, 2003). This can be done in a variety of different ways in the classroom such as encouraging discussions, having positive role models, and ensuring the teacher gives off a positive attitude themselves. When a teacher displays enthusiasm towards their subject, they begin to foster meaningful learning and more effective teaching (Keller, Neumann and Fischer, 2013).

Strategies to increase the confidence of girls should be researched further and implemented by teachers where possible, especially in boy orientated classes. “A pupil’s self-confidence predicts largely the development of self- confidence in the future, but also the development of success orientation and achievement” (Hannula, Maijala and Pehkonen, 2004. pp.23). Stimulating learning environments, which promote the ways girls learn through collaborative discussions and group work, has the chance to impact their attitudes towards the subject (Foley, 2016; Foyn, Solomon, and Braathe, 2018; Boaler, 2015). Asking questions that encourage discussions and deeper thinking, rather than a simple answer can foster girl’s confidence (Lopez, 2020). These teaching techniques will enhance girls learning, through using techniques girls benefit from, they will slowly begin to feel more confident within the subject. Support at home can also act as a barrier to attitudes in maths, with girls previous reporting to receive less support at home with maths work (Burton,1990), although this may have changed over recent times.

Female maths teachers can be excellent mathematical role models, having a positive influence over their students’ capabilities (Seagull, 2019). The maths department within the school in the research, consists of 5 female and 2 male teachers. These female teachers are role models to their students, with the teacher mentioned as an example in Seagull’s (2019) article, being one of the teachers in the department and the teacher one of the sample groups. Training teachers, of both genders, to be more effective in increasing students’ self-efficacy and interest in maths is also a way to change the attitudes of all students (Sansone, 2017). Female teachers have also been found to be more sensitive and have more positive attitudes to gender equality in STEM subjects than male teachers (UNESCO, 2017).

More up to date research is needed into *why* girls are less confident in maths than their male peers and solutions as to how these inequalities can be resolved. Much research into the

gender differences in education are outdated and with changing times, opinions have adapted to suggest there is a smaller gap in confidence differences than previously. This research itself may not be an accurate picture, as it only includes 60 top set students and was significantly impacted by the situation around COVID-19. The plan to repeat the assessment predictions was unable to happen, due to the school closing, which could make the results less reliable. Results collected were analysed over an Excel document, rather than SPSS, as there was no access to university software.

As confidence and enjoyment levels can drop even more with age, it is important to recognise and support these differences at the earliest stages possible. These differences can begin to establish during primary school, but drop significantly as students' progress through secondary school and into sixth form. As soon as gender differences become noticeable, teachers should do what they can to close this gap. These need to be targeted as quickly as possible, even if this is in primary school, to ensure girls become as confident in their maths abilities as their male counterparts (Lopez, 2020). More research is there for needed into when the differences begin to appear in primary school settings. Girls have a growth mindset towards maths, believing their mathematical ability can grow and enhance, especially in inclusive maths classrooms, with the support around them (Foley, 2016).

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Appendix A: Questionnaire

Confidence questions				
	Not at all true	**Slightly true**	**Mostly true**	**Very true**
I am good at maths.	6.7%	13.3%	53.3%	26.7%
I get good grades in maths.	6.7%	10%	53.3%	30%
I find maths easy.	10%	33.3%	26.7%	30%
I can do difficult problems in maths.	6.7%	30%	40%	23.3%
Maths is one of my best subjects.	13.3%	20%	30%	36.7%
Enjoyment questions				
I like maths	20%	16.7%	36.7%	26.7%
I enjoy doing work in maths	26.7%	16.7%	46.7%	10%
I am interested in maths	13.3%	26.7%	46.7%	13.3%
I enjoy when I learn something new in maths	13.3%	20%	46.7%	20%
Maths is one of my favourite subjects	23.3%	30%	20%	26.7%

Appendix B: Post-test assessment sheet

Question number	Topic	Total marks available	Predicted score	Actual score
Q1	Ordering decimals	1		
Q2	Decimal to percentage	1		
Q3	Decimal to fraction	1		
Q4	Fraction to percentage	1		
Q5	Comparing fractions	3		
Q6	Equivalent fractions	1		
Q7	a) Fraction of an amount	1		
	b) Dividing whole numbers by fractions (reasoning)	1		
Q8	a) Subtracting fractions	2		
	b) Multiplying fractions	2		
Q9	a) Adding mixed fractions	2		
	b) Dividing mixed fractions	2		
Q10	Fractions of amounts (£s)	5		
Q11	a. Missing angles	2		
	b. i)Angles in parallel lines ii)Reasoning	2 1		
Q12	Angles in parallel lines and triangles	5		
Q13	Angles in parallelogram and triangles	4		
TOTAL		37		

Application for Ethical Approval: For all applications for ethical approval (staff/PGR/Masters/UG)

This form should be used by ALL members of the University including undergraduate students, postgraduate research and postgraduate taught students, staff and those in visiting or emeritus roles who wish to undertake research involving human participants under the name of the University of Chichester. You do not need to complete this form if your research does not involve human participants directly or indirectly (e.g. observation studies) (see section 4.1 of the Research Ethics Policy (REP) for more information), however, you are expected to work within the Research Ethics Policy and Researcher Code of Conduct. The University does not conduct research on animals. If your proposed project involves animals in any way please seek advice from the Research Office before proceeding. Researchers wishing to use tissue cultures in their research should contact the Research Office in the first instance. Researchers should consider the provenance of tissue samples/cultures/cell-lines and associated growth media (or similar) and whether immortalised and/or animal-free alternatives are available.

THIS FORM MUST BE COMPLETED AND APPROVED by the relevant person(s) and if categorised as Category B it must be approved by the Research Ethics Committee (REC) prior to commencement of research. Full guidance on the Application process can be found in the body and appendices of the Research Ethics Policy.

REQUIRED DOCUMENTATION Each Application must be submitted alongside relevant consent forms, information letters/sheets, and debriefing sheets. This documentation should be version numbered and dated.

Categorisation of applications for ethical approval

Category A projects are less likely to involve participants from vulnerable groups (e.g. children, or persons with disabilities) and/or involve sensitive issues or areas/activities that entail a level of risk of distress or harm to participants or researchers. They only need to be approved by your supervisor and do not need to be considered by the Research Ethics Committee. The Research Ethics Policy provides further guidance on categorisation and areas of risk.

Category A+ for specific cases of withholding information / intentional deceit as occurs in single blind or double blind trials (as described above), where the only reason for identifying the project as a Category B is the withholding of information / intentional deceit. If there is any other aspect of the study that would lead to a Category B categorisation (e.g. the study involves a vulnerable group such as children, people with a disability, or those with a mental health problem, who are not persons with whom the applicant normally works: see clause 10.1.5 of Research Ethics Policy) then the exception does not apply and the application for ethical approval is classified as Category B and treated accordingly. The application would be approved by the line manager/supervisor (as with Category A applications) and also by an independent scrutiniser drawn from a pool of experienced researchers within the Institute/Department approved by its Head/Director. They do not need to be considered by the Research Ethics Committee. This would apply to category A+ applications from undergraduate students as well as staff and postgraduates.

Category B projects need to be considered by the Research Ethics Committee. The process of approval can take several weeks or longer depending on the number of applications being considered at any one time and the resolution of any issues that are raised by the Committee. It is

fairly common for applications to be returned for further amendments prior to approval. The Committee expects applications from students to be of the same quality as those from staff. A helpful way to consider this position is to consider the research project from the point of view of the research participant.

Undergraduate or taught postgraduate student applicants: Your tutors and programme team will be able to advise you on how and when to complete this form. Your project supervisor is responsible for categorising your application as Category A, A+ or Category B and for authorising it.
Communications relating to Category B applications should be between the supervisor and the clerk to the Research Ethics Committee. The student should not contact the clerk directly.

The completed form will be kept for a period of five years after approval.

Postgraduate research students: Your PhD supervisor is responsible for categorising your application as Category A, A+ or Category B and for authorising it.
Academic Staff: Your line manager is responsible for categorising your application as Category A, A+ or Category B and for authorising it.
Emeritus or Visiting roles: The Head of Department of the area to which you are linked is responsible for categorising your application as Category A, A+ or Category B and for authorising it.

[*this is a detachable front sheet, the form begins on the next page*]

Section A: Basic Information

A1: Title of study:	A small-scale action research project examining the gender differences in confidence and enjoyment of mathematics.
A2: Name of Applicant: (in collaborative projects, just name the lead applicant)	Emily Wellstead
A3: Position of Applicant (e.g. UG/Masters/PGR student, academic)	Undergraduate student
A4: Programme of study: (for UG or taught Masters students only)	BSc Hons, Mathematics and Teaching for KS2/3
A5: Department of Applicant:	Institute of Education, Health and Social Science

A6: Checklist to ensure application is complete. Have you prepared the following documents to accompany your application for ethical approval, please tick the appropriate column for each of the following:

Document	**Yes**	**No**	**N/A**
Confirmation of Ethical Approval of any other organisation (e.g. NHS, MoD, National Offender Management Service)			/
Recruitment information / advertisement (e.g. draft text for email/ poster/social media/letter)			/
Information sheet for participants	/		
Information sheet for carers/guardians	/		
Information sheet/letter for gatekeepers e.g. Head teacher, teacher, coach	/		
Consent form for participants	/		
Assent form for younger children			/
Documentation relating to the permission of third parties other than the participant, guardian, carer or gatekeeper (e.g. external body whose permission is required)			/
Medical questionnaire / Health screening questionnaire			/
Secondary information sheet for projects involving intentional deceit/withholding information			/
Secondary consent form for projects involving intentional deceit/withholding information			/
Debrief sheet to give to participants after they have participated	/		
Statements about completeness of the application	**Yes**	**No**	**N/A**
For research involving under 18s or vulnerable groups, where necessary, a statement has been included on all information sheets that the investigators have passed appropriate ***Disclosure and Barring Service***[1] checks	**/**		
I can confirm that the relevant documents listed above make use of document references including date and version number	/		
I can confirm that I have proof read my application for ethical approval and associated documents to minimise typographical and grammatical errors	/		

Declaration of the applicant:

I confirm my responsibility to deliver the research project in accordance with the University of Chichester's policies and procedures, which include the University's '*Financial Regulations*',

[1] *Working with under 18's or other vulnerable groups may require a Disclosure and Barring Service Check. Contact HR@chi.ac.uk if you are not sure whether you have an up to date and relevant DBS check or if you require more information. Do note that a DBS check may take several weeks to obtain.*

'*Research Ethics Policy', 'Electronic Information Security Policy'* and *'Privacy Standard'* and, where externally funded, with the terms and conditions of the research funder.

In signing this research ethics application form I am also confirming that:

- The research study must not begin until ethical approval has been granted.
- The form is accurate to the best of my knowledge and belief.
- There is no potential material interest that may, or may appear to, impair the independence and objectivity of researchers conducting this project.
- Subject to the research being approved, I undertake to adhere to the project protocol without deviation (unless by specific and prior agreement) and to comply with any conditions set out in the letter from the University ethics reviewers notifying me of this.
- I undertake to inform the ethics reviewers of significant changes to the protocol (by contacting the clerk to the Research Ethics Committee (research@chi.ac.uk) in the first instance).
- I understand that the project, including research records and data, may be subject to inspection for audit purposes, if required in future, in keeping with the University's Privacy Standard.
- I understand that personal data about me as a researcher in this form will be held by those involved in the ethics review procedure (e.g. the Research Ethics Committee and its officers and/or ethics reviewers) for five years after approval and that this will be managed according to Data Protection Act principles.
- I understand that all conditions apply to any co-applicants and researchers involved in the study, and that it is my responsibility to ensure that they abide by them.
- For the Student Investigator: I understand my responsibilities to work within a set of safety, ethical and other guidelines as agreed in advance with my supervisor and understand that I must comply with the University's regulations and any other applicable code of ethics at all times.

Title of study : A small-scale action research project examining the gender differences in confidence and enjoyment of mathematics.

Name of applicant: Emily Wellstead

Signature of Applicant: Emily Wellstead

Date: 29/5/2020

Section B: Authoriser assessment and approval

Where Applicants are students (undergraduate or postgraduate) supervisors should authorise this form; where applicants are staff members their line manager (or nominated signatory) should authorise this form.

B1: Name of Authoriser:	Karen Nanson
B2: Position of Authoriser: (e.g. supervisor, line manager)	Programme coordinatior

AUTHORISER:
Please categorise the application (A, A+ or B) ensure that the application form and all of the required documentation are complete before signing this application.
Authoriser assessment: (**tick as appropriate** – *see Section 10 of the Research Ethics Policy)*

Category A: Proceed with the research project. ***Undergraduate and Postgraduate Taught Masters applications***: Form and documentation retained at Department level. ***Research Masters, PhD and staff applications***: Form and documentation forwarded to the Research Office research@chi.ac.uk	
Category A+: (for studies where information is withheld/there is an element of deceit or similar see Appendix 13) Proceed with the research project. ***Undergraduate and Postgraduate Taught Masters applications***: Form and documentation retained at Department level. ***Research Masters, PhD and staff applications***: Form and documentation forwarded to the Research Office research@chi.ac.uk	/
Category B: Submit to the Ethical Approval Sub-group for consideration. research@chi.ac.uk Proceed only when approval granted by the Chair of the Research Ethics Committee	

Authoriser, please provide a comment on your assessment of the research project and for those projects involving vulnerable groups that you are authorising as Category A please justify this classification in the box below. As a further point, do make appropriate reference to any other codes of practice in your discipline particularly if you think that the proposed research may be in tension with those codes.
For Category A+: the application would be approved by the line manager/supervisor (as with Category A applications) and also by an independent scrutiniser drawn from a pool of experienced researchers within the Institute/Department approved by its Head/Director

Comment:

Authoriser's declaration:

- I have read the Research Ethics Policy and this has informed my judgement as to the category of assessment of this application.
- I understand that the applicant has taken account of the Research Ethics Policy and other relevant University policies in preparing this application.
- For Supervisors: I understand my responsibilities as supervisor, and will ensure, to the best of my abilities, that the student investigator abides by the University's Research Ethics Policy at all times.

Authoriser, please complete this table making it clear which version of the application form you are approving:

Version of the form (e.g. original version/ amended version following REC sub-group comments)	**Signature of authoriser**	**Date**

For Category A+ independent scrutiniser must also sign as authoriser.

For RO use: IF CATEGORY B: Signature of the Chair of the Research Ethics Committee.

Signature: …… Date: ……

Please note that the Research Office will retain all applications for ethical approval for 5 years after the research project has ended as stated in the University's Privacy Standard

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SECTION C: Ethical Review Questions

C1. Does the study involve human participants?

Yes

Participants in research are taken to include all those involved in the research activity either directly or indirectly and either passively, such as when being observed part of an educational context, or actively, such as when taking part in an interview procedure.

NB: the University does not conduct research on animals. If your proposed project involves animals in any way (including animal tissue) please seek advice from the Research Office before proceeding.

C2. Why should this research study be undertaken?

Brief description of purpose of study/rationale

This research is to investigate if there is any gender differences between students confidence in maths, and their predicted scores on tests they do. There are many conflicting results regarding gender differences in maths at school, although there are no gender differences in academic results, there are in relation to confidence and attitudes towards the subject. I would like to see if there are any differences when asking students what they think they got in a test and comparing it to what they actually get.

C3a. What are you planning to do?

Provide a description of the methodology for the proposed research, including proposed method and duration of data collection, tasks assigned to participants of the research and the proposed method and duration of data analysis. If the proposed research makes use of pre-established and generally accepted techniques, e.g. established laboratory protocols, validated questionnaires, please refer to this in your answer to this question. (Do not exceed 500 words). If it is helpful for the panel to receive further documentation describing the methodology then please append this to your application and make specific reference to it in box 3a below. For category B applications please include the data collection sheet as an appendix

Data: When the sample of students are given a test in class, I will also give students a sheet to write down the number of questions they think they got right and compare this to how many they did get right. I will keep these results on an excel document on an encrypted USB. I will not have the student's names, just their number (allocated by class teacher) and their gender.

Field notes: I will use field notes to record and comments students say in relation to their confidence/attitude towards maths, both positive and negative. I will keep these in an excel document on an encrypted USB. The notes will not be linked to a student's name or number, just their gender.

Questionnaires: the same sample group used for the test comparisons will be given a questionnaire on how confident they feel in maths. This will be created on onlinesurveys.ac.uk, the site the university use.

C3b. When are you planning to do it?

Please enter the anticipated start and end dates of your study (Consider at which point you will be involving human participants, this would typically be in the data collection/information gathering phase of the project but may be earlier):

6th January 2020 - 3rd April 2020

C3c. Is this research externally funded?

Yes/No

If, the answer yes, please name the research funder(s) here:

No

C4. Where will the research be undertaken?

Briefly describe the location of the study, provide details of any special facilities to be used and any factors relating to the study site/location that might give rise to additional risk of harm or distress to participants or members of the research team together with measures taken to minimise and manage such risks:

A non-selective, oversubscribed, mixed academy secondary school in London suburbs. It teaches students from ages 11-18. The school also has a special provision for children with EHCPs and autism.

Research will be conducted in students usual classrooms, with their usual teacher present.

C5. Who are the participants?

Please indicate the number of participants in each of the groups in the table below. If the precise number of participants is not known then please make an estimate. Please enter '0' in the 'Numbers in study' column for those groups that are not included in your study. Please note that the examples provided of different sorts of vulnerability are not an exhaustive list.

Participant	Numbers in study
Adults with no known[2] health or social problems i.e. not in a vulnerable group:	**0**
Children aged 16-17[3] with no known[3] health or social problems:	**0**
Children under 16 years of age with no known[3] health or social problems:	**60**
Adults who would be considered as vulnerable e.g. those in care, with learning difficulties, a disability, homeless, English as a second language, service users of mental health services, with reduced mental capacity[4] Identify reason for being classed as vulnerable group and indicate 'numbers in study' in next column adjacent to each reason (expand the form as necessary): **……..** **……..**	**0**
Children (aged <18) who would be considered as particularly vulnerable e.g. those in care, with learning difficulties, disability, English as a second language Identify reason for being classed as vulnerable group and indicate 'numbers in study' in next column adjacent to each reason (expand the form as necessary): …….. ……..	**5**
Other participants not covered by the categories listed above (please list): ***List other categories here:*** ……..	**0**

C6a. Is there something about the context and/or setting which means that the potential risk of harm/distress to participants or research is lower than might be expected?

Answer: No

[2] Known to the researcher

[3] A summary of UK definition of 'Child' : http://www.nspcc.org.uk/Inform/research/briefings/definition_of_a_child_wda59396.html

[4]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224660/Mental_Capacity_Act_code_of_practice.pdf

Consider if the study is part of routine activity which involves persons with whom you normally work in a typical work context e.g. Teachers working with children in a classroom setting, researchers in the performing arts working with performers, sports coaches working with athletes/players or research involving students in an academic setting.

Optional: Further information to justify answer to 6a

Questionnares and data collection (when students write how many answers they think they got right) will take place in their usual classroom with their usual teacher present.

C6b. Are there any conflicts of interests which need to be considered and addressed?
(For example, does the research involve students whom you teach, colleagues, fellow students, family members? Do the funders, researchers, participants or others involved in the research have any vested interest in achieving a particular outcome? *See section 9 of the Research Ethics Policy (REP)*)

Answer: Yes

If conflicts of interest are envisaged, indicate how they have been addressed:

If conducting research in a class I have been teaching, I will know the students. However, I will not have been there too long or built up a rapport more than on a professional teacher basis. I will let students know the difference from when I am teaching them and when I am asking them research questions.

C7. How will potential participants in the study be identified, approached and recruited?

Please include details of:

- *Basis for selection of participants in the study:* ***e.g. participants must be clinically obese adults; participants must be social workers over the age of 50; participants must have achieved Grade 5 in an appropriate musical instrument***
- *Any criteria for exclusions (e.g.* ***participants declaring a heart problem will be excluded****)*
- *How the selection criteria will be applied* ***e.g. Health questionnaire completed prior to joining the study***

The means by which the participants will be recruited ***(e.g. through an advert, through a school, through a sports club)****, please be specific about the medium of the advertisement/recruitment information* ***(e.g. poster, email, website, social media, word of mouth)*** *and mention any third parties who may be involved in supporting the recruitment.*

Selected through convenient sampling, class identified by school (tutor group with mixed abilities). Convinent sampling will be most beneficial for school and easiest for them to work with. I will ask the head of maths to select the most suitable class, this could be a class I teach, or a different class. This will be a random selection but include whole class (to give the most amount of female and male participants).

C8. Will any payment, gifts, rewards or inducements be offered to participants to take part in the study?
See section 11 of the REP.

Answer: No

Please provide brief details and a justification:

C9a. Is the process of the study and/or its results likely to produce distress, anxiety or harm in the participants <u>even</u> if this would be what they would normally experience in your work with them?
See section 5 of the REP.

Answer: Yes

If you answered Yes to 9a, please answer 9b below:

C9b. Is the process of the study and/or its results likely to produce distress or anxiety in the participants *<u>beyond</u>*** what they would normally experience in your work with them?**

Answer: Yes

If yes this Application must be categorised as 'B'

Please provide details:

It might give them stress/anxiety about their own mathematical abilities. They may get distressed if asked to write down what they think they got on a test if they think they did badly. I will assure them I will not know I am just using this information to compare it to what they got, not comparing it against the student themselves. If an individual student does feel distressed I will encourage them to speak to their usual maths teacher/tutor/directed person for the school following their protocol.

C9c. What steps will you take to deal with any distress or anxiety produced?

E.g. have a relevant professional on-hand to support distressed/anxious participants. Careful signposting to counselling or other relevant professional services. Other follow-up support.

I will find out from the school who to direct students too if they feel distressed (whether this is their maths teacher, tutor, head of year or school nurse). Their usual maths teacher will always be present when conducting research.

C9d. What is the potential for benefit to research participants, if any?
E.g. Participants may gain an increased awareness of some issue or some aspect of themselves.

Potential to increase their knowledge in this subject. This may boost their confidence if they realise they are underestimating their abilities if they then score higher than they predicted. It will also give them some self-awareness of how accurate they are in certain areas of maths.

C10a. Will the study involve withholding information or misleading participants as part of its methodology? *(Please refer to sections 6.2 and 10 of the REP for further guidance)*

Answer: No

Please provide details if this has not already been explained in section 3a:

C10b. Do you envisage that withholding information or misleading participants in this way will lead to any anxiety, distress or harm?

Answer: No

Please justify your answer to 10b:

It is the University Research Ethics Policy that all projects with the exception of double blind placebo trials (or similar) will be categorise as Category B. Double blind placebo trails (or similar) may be categorised as Category A+.

C11a. Does your proposal raise other ethical issues apart from the potential for distress, anxiety, or harm?

Answer: Yes

C11b. If your answer to C11a. was 'yes', please briefly describe those ethical issues and how you intend to mitigate them and/or manage them in the proposed study, otherwise jump to C11c.

Some students may not identify as gender other than male or female. I will initially take their gender from Sims when using test comparison method. When doing the questionnaire, I will have tick boxes for students to select their gender including: male, female, other and prefer not to say. In the other section there will be space to write their gender, but this will not be compulsory and I will make this clear.

C11c Does your proposed study give rise to any potential risk of harm or distress to yourself or other members of the research team? OR is there any risk that you could find yourself in a vulnerable position as you carry out your study.

Answer: Yes

If you answer 'yes' to either of these points please explain briefly what the risks are and what steps you are taking in order to minimise and manage those risks.

For example does your study involve you in 1-1 interviews in a private setting that might suggest precautions need to be taken relating to lone-working (See section 9 of the REP), Have you considered the likelihood of a participant(s) disclosing sensitive information to you about illegal or harmful behaviour and what actions you would take in such circumstances?

Research (questionnaires and confidence ratings) will be conducted in an open classroom with another member of staff present.

C12. Will informed consent of the participants be obtained and if so, how?

Answer: Yes

See section 6 of the REP to help you answer this question. Section 6.3.1 covers research that involves observing behaviour in a public place where gaining informed consent may not be practical or feasible.

When and how will informed consent be obtained? Will it be written or oral consent bearing mind that oral consent will not be considered adequate other than in exceptional circumstances and must be appropriately justified in your application?

NB: Ethical approval should, as a principle, be sought before research participants are approached.

Parental consent for students under 16 (could be through school forms, if parents have already agreed to any research)

Consent form from students over 16 (some Y11 if included).

Assent forms for students under 16

I will talk students through assent/consent form as a whole class once I know which class I will be using. I will read through form whilst students have a copy in front of them. If they agree they will then sign this form.

C13. Is there anyone whose permission should be sought in order to conduct your study? E.g. Head teacher of a school, parents/guardians of child participants.

Answer: Yes

When and how will informed consent be obtained and from whom? Will it be written or oral consent bearing mind that oral consent will not be considered adequate other than in exceptional circumstances and must be appropriately justified in your application? If you are seeking to gain 'loco parentis' consent from a school rather than seeking individual parental consent please describe your reasoning.

Headteachers consent will be sought.

If necessary, parents/guardians consent will also be sought (if school do not have documentation already).

C14. Do you need to seek the permission of any other organisations, individuals or groups other than outlined in section 13? E.g. the Research Ethics Committee of partner or participating organisations. Organisations like the NHS and the Prison Service have specific systems for granting ethical approval for research.

Answer: No

Please note that all applications must go through the University of Chichester Application for Ethical Approval process and that they must meet the Research Ethics Policy (REP) requirements. Other prior approval will be taken into account but will not in itself be sufficient to gain University Research Ethics Approval. Each application must normally be accompanied by evidence (e.g. formal statement from the appropriate Ethics Committee) confirming approval by the external body (and any concerns/issues identified). In cases where an external body requires prior approval from the University Research Ethics Policy (such as some NHS work) the Research Ethics Committee (REC) may grant in principle approval pending written confirmation of ethical approval by the external body.

Please describe the permission that is required and how you will be seeking that permission: Please attach any relevant documentation e.g. letter, that relates to the seeking of the relevant permissions.

C15. It is normally required that a participant's data is treated confidentiality and stored securely at the outset of, during and after the research study. Will this be the case?
How long will data be stored before being destroyed?

Answer: Yes

If the answer is 'yes' please describe how you will be maintaining the confidentiality of participants' data. If the answer is 'no' please justify the exceptional circumstances that mean that confidentiality will not be guaranteed. See section 7 of the REP.

Please make reference to measures you are taking to ensure security of data from the point of data collection, transfer from notebooks/voice recorders etc., onto secure devices, to the point of analysis, sharing and final storage. If you are planning to store sensitive data on portable devices or media, you should only store such data if there is an immediate need and should remove these data when this immediate need no longer exists. All sensitive data stored on portable devices or media must be strongly encrypted greatly reducing the risk of the data falling into the wrong hands if the device or media is stolen. Actions should be in accordance with the University's Electronic Information Security Policy and Privacy Standard (please also refer to Section 9 of the University of Chichester's Data Protection Guidance for Staff). Signed consent forms should be stored in a locked cabinet for a period of 5 years.

Please provide details:

I will ask the class teacher to randomly assign students a number (and keep record of this to themselves). I will know students' number and gender, but not their names from this. This is what I will use when marking work and comparing it to their predicted score. I will keep records of their predictions and actual answers on an excel document, kept on an encrypted memory stick. Class teacher will keep record of students names and numbers, so if a student asked to be removed from study, I can ask the teacher for their number to then delete the data.

When using field notes for students' general comments on the subject, I will write these on an excel document, which will also be stored on an encrypted memory stick. I will only write their comment and their gender, to then be able to compare to comments made by other genders. If I do not have my laptop on me at the time, I will write these comments down in a notebook along with the gender of the student, but never their name. these comments will be transferred to the excel document asap and the notebook will be kept in the locked office.

All emails will be from my university email, which has higher security approved by the university already.

All documents in relation to the data will be stored on the encrypted USB stick.

Paper copies of consent/assent forms will be kept in a folder in the locked maths office.

C16. It is normally required that the anonymity of participants is maintained and/or that an individual's responses are not linked with their identity. Will this be the case?

Answer: Yes

If the answer is 'yes' please describe how you will be maintaining the anonymity of participants. If the answer is 'no' please justify the circumstances that mean that anonymity will not be guaranteed. See section 7 of the REP. NB: in group studies it is likely that each individual in the group will be aware that others in the group are participating in the study – they are therefore not anonymous to each other. However, their identity should not normally be associated with their individual responses. In some studies individual participants may not want their identify known to other participants and the study must be designed and undertaken accordingly.

Please provide details:

The class teacher will randomly allocate each student a number and keep a list of this. I will only know students' numbers and not be able to link them to their names. This means that if student x wants to withdraw, I can go to class teacher and ask for their number, to then delete their information.

When writing the results in my independent project I will change the names of the school and participants.

C17. Will participants have a right to comment or veto material you produce about them?

Answer: Yes

Please give details and if your answer is 'no' then please provide a justification.

Participants will be allowed to withdraw at any point, I will be able to do this by then asking class teacher for their number. Participants will not be identified individually to me or at any point in the study. They will have right to withdraw up until May, if this is when I have left the school I will tell them to tell their class teacher they want to withdraw who can then email me.

C18. Does the project involve the use of or generation/creation of audio, audio visual or electronic material (e.g. Dictaphone recording, video recording) directly relating to the participants?

Answer: No

If yes, please describe how the collection and storage of this will be managed bearing in mind data protection, confidentiality and anonymity issues (see section 7 of the REP). If you are planning to store sensitive data on portable devices or media, you should only store such data if there is an immediate need and should remove these data when this immediate need no longer exists. All sensitive data stored on portable devices or media must be strongly encrypted greatly reducing the risk of the data falling into the wrong hands if the device or media is stolen

C19. How will the participants be debriefed?

It is expected that wherever possible all participants will receive some form of debriefing. This might be a verbal debriefing or a written debriefing depending on the context of the study. Debriefing provides an opportunity to remind participants of the procedures and outcomes of the research, and to provide further assurances on areas such as confidentiality, anonymity, and retention of data. Projects that intentionally withhold information or deceive as part of their methodology must include a written debrief sheet. (Please refer to sections 6.1 and 6.2 of the REP for further guidance)

When students take a test that I will ask them to compare their predicted answers to I will remind them of the research each time. When the online questionnaire is given, I will again remind participants of the study and the chance to withdraw.

C20a. Might the research entail a higher than normal risk of damage to the reputation of the University, since it will be undertaken under its auspices? *(e.g. research with a country with questionable human rights, research with a tobacco company. See section 9.3 of the REP). If a research partnership has been established with an industry partner please ensure that the University is not linked to claims made by that company regarding benefits of their products unless substantiated evidence of beneficial effects is available.*

Answer: No

C20b. If your answer to 20a was yes, please describe the potential risk to the University's reputation and how this risk will be mitigated. If no, please jump to C20c.

C20c. Does the research concern groups or materials that might be construed as extremist, security sensitive or terrorist?

Answer: No

If 'Yes' please describe how you will manage the research so that it is not in breach of the Terrorism Act (2006) which outlaws the dissemination of records, statements and other documents that can be interpreted as promoting or endorsing terrorist acts. For example, relevant documents, records, information and data pertaining to the research can be stored on a secure University server. Contact the Head of Research in the first instance if you are unsure as to how to proceed.

*If you answered **Yes** to question C20c then please complete the additional pro-forma available from the Research Ethics Moodle: **Approval to undertake research concerning groups or materials that might be construed as extremist, security sensitive or terrorist**. Please append the completed form to this application.*

C20d. Does your research fit into any of the following security-sensitive categories? If so, please indicate which:

i. Commissioned by the military: No

ii. Commissioned under an EU security call: No

iii. Involve the acquisition of security clearances: No

If you answered yes to any of the above please provide further information

C21a. Will your results be available in the public arena? (e.g. publication in journals, books, shown or performed in a public space, presented at a conference, internet publication and placing a dissertation in the library) s*ee section 8 of the REP*.

Answer: Yes

If yes, please provide brief details:

Possibility in a journal section of the university library

NB: Please note that if participants wish to exercise their right to withdraw or request erasure of their personal data following collection and analysis this may not be possible having regard to permitted exemptions for research under data protection legislation i.e. where it would seriously impair the achievement of the research objectives. Notwithstanding the above, data subjects must still be advised of their rights to object in the information sheet, which can only be overridden if the "research is necessary for a task carried out for reasons of public interest.

They will be on Chi-prints dissertation portal but this can only be accessed by students and staff at the University of Chichester.

C21b. Will your research data be made available in the public arena?
Certain research funding bodies require that research data is made Open Access i.e. freely available to the public. The University has a Research Data Policy that outlines the expectations and requirements for researchers at the University. Contact the Director of Research in the first instance if you are unsure as to how to proceed.

Answer: No

If yes, please provide brief details as to how the data will be prepared for public access including an overview of the meta-data that will accompany published data sets. Please also confirm that your intentions with respect to making data open access are clearly communicated to participants so that they can provide informed consent:

C22. Are there any additional comments or information you consider relevant, or any additional information that you require from the Committee?

All data will be deleted once I have finished university in August.

[end of form]

RECORD OF INDEPENDENT PROJECT SUPPORT RECEIVED

Trainee: Emily Wellstead **IP Supervisor:** Karen Nanson

TIME LINE	Date of support	Nature of support / Summary of Discussion / Suggestions for a way forward	Action by Tutor	Action by trainee	Time used
	29/11/19	Literature review draft			30 mins
	22/1/20	Ethics form			45 mins
	15/5/20	Methodology			30 mins
	15/5/20	Findings			30 mins

Signed: Emily Wellstead (IP Tutor)

Your IP Tutor will be issued with this form to help account for your support over the year. Please assist them in ensuring the form is kept 'up to date' and that you have, indeed, received the support indicated upon it. Your IP Tutor will submit this form to the IP Module Co-ordinator when you submit your IP for assessment.

This record must be submitted with the Independent Project signed by both trainee and IP Supervisor