Action Research
Tackling a Gender Imbalance in Mathematics

Thank you to the following schools for their work;

<u>Underperformance by male students</u>

Pontypridd High School
Ferndale Community School
Cantonian High School
Fitzalan Comprehensive School

<u>Underperformance by female students</u>

Pencoed Comprehensive School
St Cyres Comprehensive School
Ysgol Gyfun Llangynwydd
Tonyrefail Comprehensive School

Supported by Cameron Stewart and Deborah Lax – GCSE Mathematics Advisers, Central South Consortium.

Thank you to Dr. Jude Brigley for leading the session on the importance of action research on improving teaching and learning.

Project Aims

The aim of this project was to tackle underperformance in mathematics. This was undertaken by identifying and implementing strategies to address the gender imbalance found in the attainment of schools across the region. Whilst the gender gap across the consortium is not significant, the 2015 GCSE mathematics Level 2 results indicate, that within schools, the gap can be as much 25% towards either gender. We envisage that addressing this issue will positively impact on outcomes at GCSE in 2016.

There are many differences between male and female learners (Abigail Norfleet James, 2009) and an ever increasing body of research is enhancing our understanding about the relationship between gender and cognition. We have a much better understanding of the different ways boys and girls process information and deal with stress and anxiety (Abigail Norfleet James, 2009). We will be using this latest research throughout the project to gain a deeper understanding of why certain students in our schools find mathematics so difficult, and to identify strategies to support them in reaching their target grades.

The main publications used throughout the project are:

Teaching the Female Brain by Abigail Norfleet James
Teaching the Male Brain by Abigail Norfleet James
Mathematical Mindsets by Jo Boaler

All other academic articles used are referenced in the individual school reports.

Data Analysis for Central South Consortium

In order to identify the appropriate schools for the study, we analysed the 2013-14 year 9 data for the current year 11 cohort. This data provided a starting point to begin identifying schools with a potential Level 2 gender gap. The data analysed included both the national numeracy procedural and reasoning test scores and the end of key stage teacher assessments. The data was used to highlight schools where one was underperforming at either ends of the national numeracy test spectrum, alongside the gender-filtered KS3 performance data.

An example of the data analysis is shown below;

	Boys – Girls 2013-14 Procedural			**Boys – Girls 2013-14 Reasoning**				**Expected level 5+**	**Expected level + 1 (level 6+)**	**Expected level + 2 (Level 7+)**
	<85	**85-115**	**>115**	**<85**	**85-115**	**>115**		**Boys - Girls 2013-14**	**Boys - Girls 2013-14**	**Boys - Girls 2013-14**
School A	-0.85%	-15.88%	16.73%	-2.71%	-4.86%	7.57%		-4.28	-2.61	6.48
School B	-4.17%	-7.95%	12.12%	-2.33%	-20.66%	22.99%		5.79	10.32	10.00
School C	21.08%	-20.23%	-0.85%	8.55%	-12.54%	3.99%		-22.22	-28.49	-4.27
School D	7.13%	-7.57%	0.43%	7.06%	-6.92%	-0.14%		-10.58	-18.92	-1.57

As can be seen from the teacher level data, in schools A and B, the more-able girls appear to be underperforming in mathematics. The national numeracy data and teacher assessed levels suggest that in schools C and D, the issue for boys is at the lower end of the mathematics spectrum.

As a result of the analysis, a total of 16 schools were identified to be part of the project. As well as improving the outcomes of the targeted learners, the project would provide schools with an opportunity to:

- Develop a deeper understanding of the reasons why boys/girls/eFSM students underperform in mathematics.
- Further develop their own understanding of action research as a tool for improving teaching and learning.
- Use the allocated time and funding to develop strategies to close the gaps.

Practitioner Session 1 – Why do we use action research?

Research in education intends to bring useful changes to either teacher's teaching or students' learning, or both. The first session explored why and how action research can improve a given set of circumstances and provide professional development for teachers.

Action research can be carried out individually, with a group of colleagues sharing a common concern or an entire school staff. It supports the following objectives (Dr Jude Brigley, 2016);

- Building a reflective practitioner
- Making progress on school wide priorities
- Building professional cultures

Dr Jude Brigley was able to lead the session and share her experience in both leading and conducting her own action research.

We discussed the basic steps of an action research process and the teachers involved used this to form the basis of an action plan;

- Review of current practice,
- Identification of aspects of current practice that we want to investigate,
- A vision of a way forward,
- Attempt solution, and take stock of what happens,
- Modify approach in the light of what we have found, and continue working in this new way (try another option if the new way of working is not right)
- Monitoring what we do,
- Reviewing and evaluating the modified action

Whilst the first half of the session focused on action research in general, the second half explored the specific gender balance in mathematics in more detail using the model shown below.

What are the issues?

Further discussion in groups led us to the following issues which may cause underperformance in mathematics;

- Attendance
- Poor attitude to learning
- Behaviour
- Lack of independence
- Quality of teaching and learning/provision
- Test anxiety
- Mathematical mindset
- Lack of engagement
- Poor organisational skills

The group explored each issue in depth and then focused in detail on the ones which could be influenced by the teachers' own practice, such as; addressing pupils' poor organisational skills, attitudes to learning and mathematical mindset. From here the group began to discuss possible objectives for the individual projects beyond raising attainment in mathematics.

Why do girls traditionally underperform in mathematics?

Students' confidence in their ability and their motivation to learn play a significant role in shaping their performance in specific academic subjects. Girls' perceptions of themselves as learners of mathematics determine how well they motivate themselves and persevere in the face of difficulties when learning mathematics. Many girls underachieve in mathematics because they do not have the confidence in their ability to excel in the subject, despite often having the capacity and skills to do so. However, girls' insecurity regarding their own mathematics ability often isn't as simple as them internalising a cultural norm. Primary school teachers, who can be over 90% female, may occasionally express their own anxieties with mathematics to pupils from a young age.

Why do boys traditionally underperform in mathematics?

Generally, mathematics is not seen as being a problem for boys, so when there is a problem, it is often made worse by the boy's expectation to do well in the subject (Abigail Norfleet James, 2009). Boys may lack the organisational skills that girls possess more naturally, and require more guidance and intervention to develop into independent learners.

Studies in the US suggest that there is no difference in mathematics aptitude between the genders before the age of seven. Starting in adolescence, some cognitive differences begin to appear but it is noticed that attainment in different topic areas within mathematics can vary tremendously, often with girls outperforming boys. For example, when boys do better, they are usually also doing worse. Boys are more likely than girls to get nearly all the answers wrong, hence they subsequently overpopulate both tails of the bell curve; boys are both better, and worse, than girls at mathematics. That means that how we report on mathematics ability is often a choice. If you report who is best at mathematics, the answer is boys. If you report on average mathematics ability, it is roughly the same between both of the genders (Natalie Angier and Kenneth Chang, 2005).

All teachers attended the first session having identified the students with whom they needed to work. Several options were discussed for accumulating baseline data. They included;

- Use current progress grade
- GCSE examination result
- QLA to identify weak strands
- Attendance
- Attendance at extra-curricular mathematics sessions
- Homework records

Once an area of focus had been selected, the next step was to generate a set of personally meaningful research questions to guide each inquiry. In the final section of session 1, we discussed possible research questions and left the delegates with the following tasks to complete before session 2.

- Identify target group and set baseline.
- Identify issue(s) and decide on a strategy to improve standards.
- Write action research question.

Practitioner Session 2 – Action Research Questions

During session 2 we split into groups depending on the gender of the action research project being undertaken. We were able to look in more detail at the students who had been identified, the issues affecting their underperformance and the first draft of the action research question generated by each teacher.

"Gender disparities in performance do not stem from innate differences in aptitude, but rather from students' attitudes towards learning and their behaviour in school, from how they choose to spend their leisure time, and from the confidence they have in the subject" (OECD, 2015).

Boys' Underperformance in Mathematics

The discussion for this group centred on the following issues that are likely to affect boys' performance within mathematics;

- Poor attitude to learning
- Behaviour
- Lack of independence
- Mathematical mindset
- Lack of engagement
- Poor organisational skills

The following strategies to tackle these issues were discussed;

- 1-1 mentoring (with a focus on work rather than behaviour)
- Personal and achievable target-setting
- Personal control over learning (independent learning)
- Build in challenge rather than completion as a goal
- Offer clear steps, guidelines and targets for each lesson

- Give information in bite-size chunks
- Provide opportunities for group work, active involvement, practical work
- Competition

Following on from the discussions, the schools focussing on boys performance outlined their thoughts on the action research project they would like to undertake. These are included below;

Cantonian High School

Would pairing a high achieving girl with an under-performing boy positively impact on the performance of boys in Mathematics?

Girls are outperforming boys in A* - B category.
Boys underperforming from data.

- November results as baseline along with pupil voice, teacher assessments and book scrutiny.
- Year 11 higher tier group.
- Seating plan changes & mentoring.
- Shift towards more paired work in class.
- Additional focus on communication skills.

Pontypridd Comprehensive School

Will the coaching of boys to become more independent learners positively impact on their performance in Mathematics?

- November results as baseline along with pupil voice, teacher assessments and book scrutiny.
- Year 11 C/D borderline group.
- Using online tools such as Mathswatch & Edmodo.
- Flipped classroom methodology to be introduced to support boys with becoming more independent.

Ferndale Community School

How important a role does mindset play in the performance of boys in Mathematics?

- November results as baseline along with pupil voice, teacher assessments and book scrutiny.
- Using responses to Carol Dweck's mindset questions will support baseline measure.
- Implementing ideas and strategies from Mathematical Mindsets by Jo Boaler in order to increase confidence amongst the boys.

Fitzalan High School

Does creating a classroom environment of shared and valued mistakes improve the outcomes of boys in Mathematics?

- November results as baseline along with pupil voice, teacher assessments and book scrutiny.
- Publicising and exploring mistakes and misconceptions.
- 'Mistake of the day' / 'Mistake of the week' shared with group.
- Mathematical Mindsets explored.

Girl's Underperformance in Mathematics

Mathematics is an area that has been identified as one subject where a stereotype threat is a problem for girls (Abigail Norfleet James, 2009). Girls may not be interested in maths because they believe that most girls have trouble in this subject. Lack of confidence and test anxiety is also more prevalent in female students and these issues formed the basis of discussion in session 2.

The group felt that the girls that had been targeted had very low esteem and felt that they would never be able to achieve their target grade in this subject because they were previously unsuccessful at it. Following on from the discussion, each school outlined what they had been thinking of as an action research project.

Some suggestions were as follows:

- Teaching in single sex groupings
- Arranging seating plans so that female students were working with other female students.
- Introducing female role models into lessons taught my male teachers.

Pencoed Comprehensive School

Does single sex teaching in mathematics improve outcomes for female students?

- November results as baseline along with pupil voice, teacher assessments and book scrutiny.
- 11 girls have been identified as target group
- D/E grade with targets of C
- Develop single sex teaching groups including revision sessions
- Contextualise questions to appeal to girls
- More group work and discussion to be introduced to raise confidence levels.

St Cyres School

Will the introduction of sixth form role models increase confidence levels in mathematics?

- November results as baseline along with pupil voice, teacher assessments and book scrutiny.
- Train 2 female students to work with small groups of girls during lunchtime and after school sessions.
- Based on ideas from Jo Boaler's book regarding positive role models.

Ysgol Gyfun Gymraeg Llangynwyd

Will introducing a female role model into the class improve girl's confidence in mathematics?

- November results as baseline along with pupil voice, teacher assessments and book scrutiny.
- The class is taught by male teacher and girls are reluctant to share ideas and lack confidence.
- A female teacher will work with small groups to increase confidence.
- Contextualise questions to appeal to girls
- A quieter environment will suit girls learning.

Tonyrefail Comprehensive School

Does single sex teaching in mathematics improve outcomes for female students?

- November results as baseline along with pupil voice, teacher assessments and book scrutiny.
- All borderline classes are taught by male teachers.
- Do they consider how girls like to learn?
- Develop single sex teaching groups including revision sessions
- Contextualise questions to appeal to girls
- More group work and discussion to be introduced to raise confidence levels.
- More research to be done on how girls learn.

Final Action Research Questions

Research Question (Boy's Underperformance)
Will the pairing of a higher-achieving girl with an under-performing boy positively impact the performance of boys in Mathematics?
Will the development of a growth mindset improve test results and confidence in mathematics for boys?
What effect does parental engagement have on boy's attainment?
What impact does an independent, student led, approach to learning have on boys attainment at GCSE?

Research Question (Girl's Underperformance)
Does single sex teaching in mathematics improve outcomes for female students?
Will the introduction of sixth form role models increase confidence levels in mathematics?
Can single gender revision classes impact positively on girls' attitudes to learning maths and girls' outcomes in maths?
Will introducing a female role model into the class improve girl's confidence in mathematics?

School Visits

Between the second and third sessions the groups had the opportunity to visit three schools across the consortium. These schools were selected for either of the following reasons;

1) The school has had a consistently narrow gender gap in mathematics over the last four years.

2) The school has closed the gender gap in mathematics over the last three to four years.

Brynteg Comprehensive School
Ewenny Road
Bridgend
CF31 3ER

Date of visit: 2nd March 2016

	Boys	Boys	Boys	Boys	Girls	Girls	Girls	Girls	B - G	B - G	B - G	B - G
School Name	**2012**	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**
Brynteg School	62.3	71.3	73.6	75.0	57.9	70.4	68.5	76.3	4.4	1.0	5.1	-1.3

Brynteg Comprehensive School is an 11 – 18 Secondary School in the Local Authority of Bridgend. It is currently categorised by the Welsh Government as being a 'Green' school, with 14.1% of its pupils eligible for free school meals.

The mathematics department has seen level 2 outcomes above the national and local authority averages for a number of years. In 2015 the mathematics department secured 75.6% A* - C grades. The school's level 2+ threshold achieved in 2015 was 92%. The school was selected to be a part of the action research project as it has an average gender gap of 2.3% over the last 4 years.

The group was keen to explore the strategies they have put in place to narrow this gender gap.

ATTENDEES
1 x teacher from Tonyrefail (girl's project)
1 x teacher Pencoed (girl's project)
1 x Strategic Advisor (project lead)

DAY STRUCTURE
The format of the day was agreed in collaboration with the Strategic Adviser and the Assistant Head Teacher responsible for teaching and learning.

Registration	Arrival
1	Meeting with Assistant Head Teacher responsible for Teaching and Learning
2	Meeting with Assistant Head Teacher responsible for Tracking and Monitoring
Break	Meeting with Mathematics Department
3	Meeting with Head of Mathematics
4	Year 10 Lesson Observation
Lunch	

OUTCOMES
We started the day by meeting with the Assistant Head Teacher responsible for learning and teaching. She shared with us the school's structure for professional development and distribution of leadership. This included staff working in triads to develop aspects of their own practice with directed time allocated for maintaining professional portfolios and to reflect and complete a staff self assessment. The triads consisted of a teacher, coach and observer and, throughout the academic year, each member of staff had the opportunity to take on each of the roles.

We also discussed the school improvement groups made up by middle leaders across a range of curriculum and pastoral responsibilities. The two main focuses for the discussion were the group responsible for learning and teaching and the group responsible for curriculum change.

The focus for the teaching and learning group was based around the three C's; co-construction of learning, challenge and collaborative learning. The mathematics department focused on collaborative planning and there would be more opportunity later in the day to look at this in more detail. The focus for the curriculum change group was how to sustain success in spite of changes to the curriculum.

There was also opportunity to look at the Brynteg learning cycle model, discuss the roles of the two learning directors (responsible for LNF and provision), and the introduction of growth mindset.

A meeting was then held with the Assistant Head Teacher for tracking pupil progress where he detailed the school's rigorous tracking procedures of pupils across all year groups.

We were given the opportunity to observe a year 10 lesson on calculating the area under a curve of a speed/ time graph. This was an example of a lesson that had been collaboratively planned within the department. The lesson was designed so that the students discovered the rules and strategies as they progressed through the lesson and was rich in discussion. Students also took responsibility for the level of work that they started on during the second half of the lesson and the majority of students chose the appropriate level of challenge.

The remainder of the time was spent with the Head of Mathematics and the mathematics department. The HoD discussed the importance of meeting and planning collaboratively as a department. Where possible, the department met on a weekly basis and the focus was always learning and teaching with any paperwork and administration being sent out via email. Resources were shared and stored centrally and included many rich tasks. The gender gap in mathematics at Brynteg School is averaged at 2.3% over the last 4 years, and we discussed how the department ensures that the quality of teaching and learning is of the highest standard for all students.

We also had the opportunity to consider:

- The importance of positive relationships in maths lessons
- High expectations in mathematics
- Developing numerical reasoning
- Preparing for curriculum changes in mathematics.

FEEDBACK

Both attending practitioners stated that the visit would have a positive impact on their own teaching and learning. They valued the opportunity for a professional discussion around topics of national concern such as closing the gap and preparing for curriculum changes.

Cardiff High School
Llandennis Road
Cyncoed
Cardiff
CF23 6WG

Date of Visit: 11th March 2016

	Boys	Boys	Boys	Boys	Girls	Girls	Girls	Girls	B - G	B - G	B - G	B - G
School Name	**2012**	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**
Cardiff High	94.3	83.2	90.1	93.9	84.1	76.3	90.0	92.4	10.2	6.9	0.1	1.5

Cardiff High School is an 11 – 18 Secondary School in the Local Authority of Cardiff. It is currently categorised by the Welsh Government as being a 'Green' school with 6.8% of its pupils eligible for free school meals.
The mathematics department has seen level 2 outcomes considerably above the national and local authority averages for a number of years. In 2015 the mathematics department secured 93.2% A* - C grades.
The school's level 2+ threshold achieved in 2015 was 89.4%.
The school was selected as it has had an average gender gap of 0.8% within mathematics over the last 2 years, which has closed significantly from 10.2% in 2012. The group was keen to explore the strategies they have put in place to narrow this gender gap.

ATTENDEES
1 x teacher from Cantonian (boys project)
1 x teacher from Fitzalan (boys project)
1 x teacher from Ferndale (boys project)
1 x teacher from Tonyrefail (girls project)
1 x teacher from St Cyres (girls project)
1 x teacher from Llangynwyd (girls project)
2 x Strategic Advisors (project leads)

DAY STRUCTURE

The format of the day was agreed in collaboration with the Strategic Adviser and the Assistant Head Teacher responsible for Teaching and Learning.

Period	Time	Detail
Registration	08:40 – 09:05	Arrival
1	09:05 – 10:05	Meeting with Curriculum Leader for Mathematics
2	10:05 – 11:05	Lesson observation 1 Learning walk
Break	11:05 – 11:25	
3	11:25 – 12:25	Lesson observation 2 Learning walk
Lunch	12:25 – 13:10	
4	13:10 – 14:10	Meeting with Assistant Headteachers for Learning & Teaching
5	14:10 – 15:00	Meeting with Assitant Headteacher Performance and Standards

OUTCOMES

The Head of Mathematics talked to the group about all aspects of teaching and learning within the department, the intervention strategies she has in place for the learners and also the strategic approach and direction of the department. Many aspects of effective teaching and learning were discussed during the meeting, which included;

- Learning and teaching centred department including all department meetings
- Team ethos of developing and sharing resources / best practice / innovation
- Relationships – meet and greet all students
- Mathematical role models
- High expectations – inspirational target setting
- Growth Mindset (staff and pupils)
- Resilience and effort
- Group work and collaboration
- Schemes of Learning development (KS3/4)
- Shallow – Deep – Profound focus on all lessons
- IMCA / HIRED / new spec resources to develop problem-solving skills
- Maths & English department share skills and strategies for GCSE Numeracy
- Investigations at KS3 to build resilience and problem-solving skills
- Technology – iPads, Moodle
- Chess club
- DR ICE lesson planning (adapted from the OTP programme)
- Feedback / feedforward / AfL
- Close the gap sheets (end of topic / test)
- Closing the gap strategies (TTT, EW, PPPB, no opt out)
- LNF across the curriculum / bring back from other subjects

- Current pedagogical research

The Head of Department also discussed some of the interventions and support systems in place within the department. They include;

- Behaviour – time out timetable / reports
- Wellbeing and achievement teams
- Communication with parents – twitter / phone calls / letters / info evenings
- PLC's post tests and resources
- Maths Surgery
- Holiday / Weekend revision sessions
- Walking Talking Mock
- FSM tutoring (targeted individuals)
- Over-staffing – support teachers / hours / class sizes and make up
- Use of learning support time
- Learning support specialist
- Study leave timetable pre and post examinations
- KS3 – numeracy support / extension / drop in sessions
- Evaluation and improvement of intervention

To conclude the meeting, the Head of Mathematics moved on to discuss some of the strategic elements that she has embedded since her arrival in September 2015. She discussed:

- Wider Leadership Group – weekly meetings
- Maths & English – timetabled back to back / split classes / borrowed time
- Science, Maths & English Heads of Departments meet half-termly
- Department data packs for all teachers
- Vulnerable learners, FSM, LAC, late arrivals
- Knowing all cohorts and planning for them (e.g. Boy heavy Year 9)
- Ambition strategy for every pupil
- Ongoing tracking / departmental discussions – openness and honesty

All of these points were discussed in detail with the group and many questions were asked on the back of the discussions. The teachers commented how valuable it was to have the time to have a professional conversation with a colleague from another school.

A meeting was then held with the Assistant Head Teacher for Performance and Standards where she detailed the school's rigorous tracking procedures of pupils across all year groups. Teacher data packs were shared with the group with a particular focus paid to the separate analysis of the performance of girls and boys. The school is currently very mindful of a boy-heavy Year 9 cohort and is currently making arrangements to best cater for the needs of this year group. This was particularly interesting to the delegates undertaking the research in relation to the performance of boys.

To conclude the day the group held a further meeting with the Assistant Head Teacher responsible for Teaching and Learning, where he shared the schools policy on closing the gap for eFSM learners. The Assistant Head Teacher stressed how, by focussing on raising the aspiration and performance of every pupil, this will have an impact on closing the gap within the school for both boys and girls, and eFSM pupils. He also shared the school's revised lesson planning template and lesson observation template. As the school is a host school for the OTP programme, they have incorporated aspects of the programme into their templates. The delegates spent time discussing DR ICE, which stands for Deepening Thinking, Role-Modelling, Impact on Pupils, Challenge and Engagement. The delegates

were keen to ask questions and share ideas and experiences from their own schools. The school has invested in IRIS technology to assist its teachers in being reflective practitioners. The use of IRIS as a tool to develop whole-school teaching and learning was explored.

Throughout the course of the day, the delegates each observed one lesson with a member of the Mathematics Department and participated in a 'Learning Walk', spending time in 3 other mathematics classes. The teachers observed a variety of lessons over a selection of ages and ability ranges.

Delegates discussing learning and teaching at Cardiff High School

Bryntirion Comprehensive School
Merlin Crescent
Cefn Glas
Bridgend
CF31 4QR

Date of visit: 15th March 2016

	Boys	Boys	Boys	Boys	Girls	Girls	Girls	Girls	B - G	B - G	B - G	B - G
School Name	**2012**	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**
Bryntirion	63.3	58.5	75.3	78.4	52.7	73.0	75.3	79.7	10.5	-14.5	0.0	-1.3

Bryntirion Comprehensive School is an 11 – 18 Secondary School in the Bridgend Local Authority. It is currently categorised by the Welsh Government as being a 'Green' school. 14.4% of its pupils are eligible for free school meals.
The mathematics department has seen a steady increase in level 2 outcomes over the last 4 years; well above the national and local authority averages. In 2015 the mathematics department secured 78.9% A* - C grades.
Over the same time period, the schools level 2+ threshold has also seen a steady increase to 78.4% in 2015.
The school was selected as it has had a gender-gap average of 0.65% within mathematics over the last 2 years, which has closed significantly from 14.5% the year previous.

ATTENDEES
1 x mathematics teacher from Ferndale Community School (boys project)
1 x teacher from Pontypridd High School (boys project)
1 x Strategic Adviser (Project Lead)

DAY STRUCTURE

The format of the day was organised in collaboration with the Strategic Adviser and the Assistant Head Teacher responsible for Teaching and Learning.

Registration	Arrival
1	Year 10 Lesson Observation
2	Meeting with Head of Mathematics
Break	
3	Meeting with Assistant Head Teacher in charge of Teaching and Learning and Assistant Head Teacher in charge of Data and Tracking
Lunch	
4	Year 8 Lesson Observation
5	Meeting with Assistant Head Teacher in charge of Teaching and Learning

OUTCOMES

During the meeting with the Head of Mathematics, strategies that the department were currently implementing to improve the performance of all learners were shared. The Head of Mathematics advised that, although there were no specific strategies in place for boys, the boys in the school would benefit from many of the interventions currently in place within the department.

All learners begin studying for the GCSE course in Year 9 and sit their mathematics exam at the end of Year 10. The Head of Department indicated that the success of the department was down to the strong team spirit from within the department, the systematic restructuring of classes following early entry, the effective tracking and aspiration target setting for pupils, along with excellent teaching.

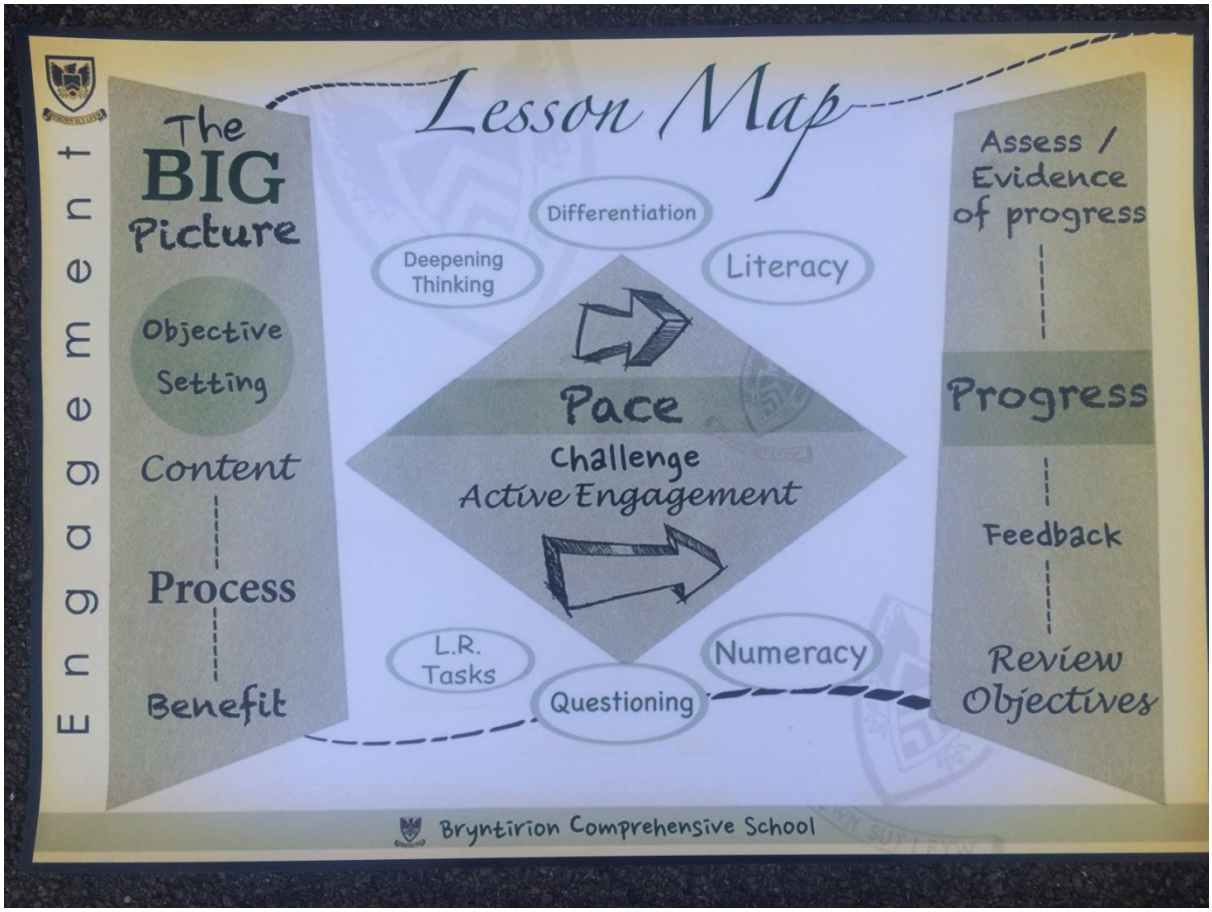
The Assistant Head in charge of Teaching and Learning shared with us the common framework for effective lessons within the school, based around the 3 fundamental components of pace, challenge and active engagement.

The school is currently involved in a lesson observation cycle that is geared to provide no formal judgements and focussed solely on building step-by-step continual improvement and development of its staff.

The Assistant Head Teacher responsible for Data and Tracking talked the group through their current procedures and their use of fine level grading, one of the many strategies the school has adopted from PiXL.

The school's emphasis on pace, challenge and active engagement were very evident within the 2 lessons that the group observed. The pupils were focussed and on task, and demonstrated an ability to reason effectively using appropriate mathematics terminology.

Both classroom teachers that attended the visit were able to obtain a valuable insight into the teaching and learning within the school and within the mathematics department. They were able to ask questions that will directly feed into their action research projects, and explore effective methods to track pupils' progress over time.



Bryntirion Comprehensive School's Lesson Map

The following reports were submitted by the schools who engaged with the project;

Boys Attainment

Fitzalan High School Elaine Bailey

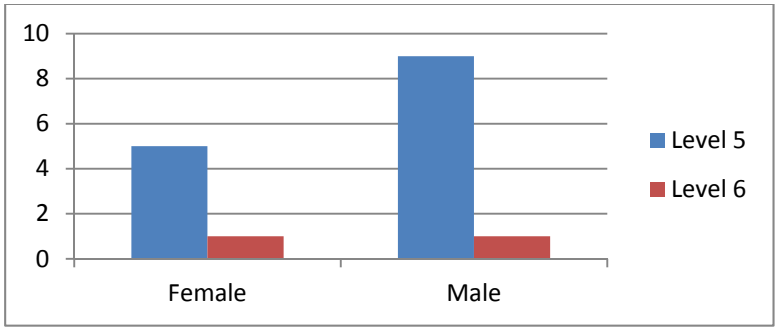
Will a growth mind-set improve test results and confidence in mathematics for boys?

Outline

This research was undertaken to ascertain if results for under achieving boys could be improved. Early signs with the year 10 group I selected were not encouraging. Pupils in the class, particularly boys, seemed to lack the motivation to learn, they lacked resilience when completing work in class and definitely in tests. With the introduction of the new GCSE I realised that the new examination would be difficult for them and I needed an intervention to change their attitudes and get them on the path to success.

The context

The research class was a year 10 group of 6 girls and 10 boys.



Key Stage 3 Levels – Mathematics

In this graph it can be seen that the majority of the year 10 class achieved level 5 at the end of key stage 3. This graph and other available data highlighted to me that I needed to provide intervention to support development to enhance the boys' capabilities, the boys within the group are competent mathematicians but lack confidence and feel inhibited and this can often manifest itself in the form of low level disruptive behaviour, thus I decided to complete this project with this class.

Several pupils have Additional Learning Needs including Dyslexia and Behaviour, Social and Emotional Difficulties. The group embarked on the new GCSE at the end of year 9. Several of the male pupils lack motivation and confidence with the subject. The pupils have various ethnic backgrounds; consequently accessing the English language fluently is an issue for some pupils. The baseline data for the tests are shown below.

Surname Forename	Gender	Maths Non Calc 1 Year 10	Maths Calc 1 Year 10	Maths Non Calc 2 Year 10	Maths Calc 2 Year 10	Maths Non Calc 3 Year 10	Maths Calc 3 Year 10	Maths Non Calc 4 Year 10	Maths Calc 4 Year 10	Maths Non Calc 5 Year 10	Maths Calc 5 Year 10
Pupil A	F	48	32	52	56	52	56	84	68	52	60
Pupil B	F	88	56	12	40	28	48	32	8	44	32
Pupil C	F	44	76	0	0	64	60	76	72	100	76
Pupil D	F	44	36	0	0	60	68	84	48	80	80
Pupil E	F	24	12	8	32	40	24	36	44	28	40
Pupil F	F	44	52	20	44	32	32	68	44	68	80
Pupil G	M	48	52	8	36	72	60	68	32	84	72
Pupil H	M	44	40	0	28	32	32	52	28	56	52
Pupil I	M	32	24	12	12	68	24	56	36	76	48
Pupil J	M	24	32	24	52	40	32	48	24	64	48
Pupil K	M	44	24	24	40	44	56	40	64	52	72
Pupil L	M	72	48	24	60	64	76	64	76	92	84
Pupil M	M	32	28	4	36	36	24	44	16	44	52
Pupil N	M	28	36	8	40	36	36	28	24	40	52
Pupil O	M	44	28	44	52	60	48	64	44	76	80
Pupil P	M	32	24	8	24	56	44	80	56	60	52
AVERAGE FOR BOYS		40	34	16	38	51	43	54.4	40	64.4	61
AVERAGE FOR GIRLS		48.7	44	23	43	46	48	63.3	47.3	62	61.3

The results above show the test results of the class before and during the intervention. It is quite evident that, despite the limited number of girls within the class, girls out performed boys in the first assessment prior to the intervention. It can be seen that the gap between boys and girls narrows as the intervention is taking place. It can also be seen that not only has the class average improved for boys in the last non calculator assessment but boys also outperformed the girls and the gap in attainment for the last calculator assessment is only 0.3. These results not only show that implementing growth mindset within the classroom following the guidance of J. Boaler supports boy's attainment but also it supports the class as a whole.

Research

Given the nature of the class and lack of motivation particularly with some of the boys I wanted to focus on developing a growth mindset to investigate if I could inspire the pupils to take chances, make mistakes and be open to challenge.

With reference to 'Mathematical Mindsets' (Boaler, J. 2016) I began talking to the class about the ability of the brain to develop i.e. a growth mindset. I showed the pupils various growth mindset videos on how the brain will develop by making mistakes and learning from those mistakes. I used several videos from Carol Dweck's website, TED and 'The girl with half a brain'. Initially, the pupils were sceptical but they watched each of the videos and started to believe that there was more to the growth mindset idea than they had imagined. The videos were discussed with the class and feedback was interesting. During one video in particular called 'Growth Mindset for Pupils', which looked at the way pupils feel when they fear getting an answer wrong, I could hear pupils saying 'I feel like that' and 'yeah me too, I don't like giving answers' and 'I always wait for someone else to give the answer'. I had never heard the pupils confessing like this before and it helped me to think of different ways of developing their confidence. Over a series of a few lessons pupils were becoming more prepared to take risks and make those all-important mistakes. On one occasion, Pupil A gave an answer which was incorrect and another pupil gave the correct answer. What was interesting about this first incident was that Pupil C said 'Let's clap miss, he took a risk', which is what we all did. After this point the acceptance of making mistakes grew and grew and every time we celebrated. To reinforce the idea of making mistakes, to improve, every lesson we would start with a 'Power Up' question which was a recap from a previous lesson. I would collect in the answers and pick out the best mistake. This technique helped to highlight potential pitfalls in answering questions and was the catalyst for pupils to see that mistakes are valuable in developing a growth mindset. Another important milestone in changing behaviours for the class was an activity which forced pupils to confront their feelings of making mistakes. Taken from the book Mathematical Mindsets I asked all pupils to write a single word, on an A4 sheet of paper, to express how they felt when they made mistakes. The responses were quite alarming; they included 'dumb', 'idiot' and 'stupid'. The pupils were asked to crumple up the paper and throw it at the board. Needless to say, the pupils enjoyed this part immensely. The pupils were then asked to retrieve the paper and draw lines over all the creases they had made on their paper to represent brain growth, again to reinforce the idea of the brain growing and forming new connections. Watching the students supporting each other and taking risks from the beginning of the project to today has been astonishing. The pupils, particularly the boys, went from a class that would snigger at an incorrect answer to celebrating the risk taken; I have also noticed members of the class encouraging each other to take risks in their written and oral tasks where prior students had felt inhibited to do so.

Following my part in the growth mindset experimental project I ensure that growth mindset is promoted every single lesson, by altering student's responses and enhancing the way I communicate mistakes, ideas and correct answers. To support the growth mindset I have several displays of growth mindset quotes and responses, which I continually reference. In tests, pupils are now trying questions they would have left previously. Presumably, pupils did not want to make mistakes on tests so avoided questions in which they were not confident.

Conclusion

This project has highlighted to me the power of growth mindset and I plan to implement a mathematical growth mindset with all my classes and discuss the implementation throughout the department. The introduction of growth mindset appears to have been very powerful in changing attitudes to learning mathematics, albeit for a short time. In future I would ensure a growth mindset ethos be introduced at the beginning of the year to fully embed it within the classroom. One area which I want to develop is the use of iPads to show pupils mistakes on the board taken from their work and also to exemplify good work. Through the use of iPads, mistakes can be shared with the class instantaneously, which will help to reinforce learning from making errors.
I will continue to investigate other methods of growth mindset and would like to experiment with more able and talented pupils and students with challenging behavioral needs to see if there would be similar results.

Ferndale Community School Sarah Morris

What effect does parental engagement have on boy's attainment?

Responding to the parental suggestions taken from parents' evening survey that Ferndale Community School offer a text messaging service, I set about informing parents about homework deadlines, pupil performance in class and homework and also celebrate individual successes. I was especially keen to investigate how this type of parental surveillance may impact on the performance of maths students in Ferndale Community School when consideration is given to the effect size of 0.63 reported by Hattie (2007) of homework and reported variance in effects of parental surveillance by various meta analyses.
In preparation for the GCSE Summer Examinations, my year 11 class are completing past papers for homework, which allows for a relatively fair comparison to be made between performances. My baseline measure for this action research was the WJEC November 2015 Paper 2 from which the percentage achieved and their equivalent grades were sent via text message home to parents. Using the subsequent homework results, which were again text home, I performed 't test' calculations to assess the impact on pupil performance:

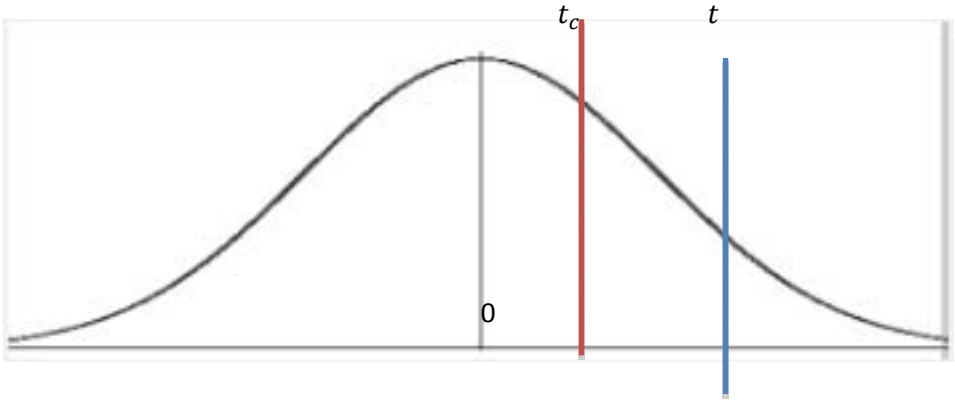
Texting
$\overline{x_1} = 48.53$
$S_1 = 19.932$
$S_1^2 = 397.284624$
$n_1 = 17$
$H_0: \mu_1 \leq \mu_2$
$H_1: \mu_1 > \mu_2$

Baseline
$\overline{x_2} = 30.65$
$S_2 = 14.83$
$S_2^2 = 219.9289$
$n_1 = 23$

Degrees of freedom:
$df = n_1 + n_2 - 2$
$= 17 + 23 - 2$
$= 38$

Therefore at the 95% confidence level $t_c = 1.6859$
So decision rule is to reject H_0 if $t > 1.6859$

$$Sp^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$
$$= \frac{(17 - 1)397.284624 + (23 - 1)219.9289}{38}$$
$$= \frac{6356.553984 + 4838.4358}{38}$$
$$= \frac{11194.989784}{38}$$
$$= 294.604994316$$



$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{Sp^2(\frac{1}{n_1} + \frac{1}{n_2})}}$$
$$= \frac{48.53 - 30.65}{\sqrt{294.604994316(\frac{1}{17} + \frac{1}{23})}}$$
$$= \frac{17.88}{\sqrt{30.1386\ldots}}$$
$$= 3.2569$$

$t > t_c$ Therefore, reject H_0.

At the 95% confidence level texting home can again be seen to have a positive impact on pupil performance in maths homework at Ferndale Community School.

The boys' average performance increased from 33.73 to 50.25, with the girls within the class increasing from 28.83 to 47.00 marks, meaning that the girls performance increased marginally more than the boys. However, the increase was notable for both groups. Although very promising, the investigation was time limited and will need to be revisited to assess its impact over an extended duration over all year groups. It would also be beneficial to extend this research to assess the impact on various groups within a school such as the impact on eFSM pupils. Additionally, I would like to widen the approach to include the assistance of parental understanding with the language of the education system; much of which is unfamiliar to parents from disadvantaged backgrounds. This is often an issue for parents within the catchment area of Ferndale, as well as raising the aspirations and expectations of those parents by involving them in the process of target setting.

Pontypridd High School Jonathan Astley

What impact does an independent, student led, approach to learning have on boys attainment in Mathematics at GCSE?

Rationale

I am currently a Mathematics teacher at Pontypridd High School and have agreed to carry out a small scale action research project with the aim of addressing 'what works for boys' in Mathematics. The school was chosen due to a small gender gap within the current Y11 cohort using the National Numeracy Test data from 2014.

The target group consisted of four males in a Year 11 set 5 class, containing 15 pupils in total. All members of the class had sat the GCSE exam in November and achieved D or E grades. The four pupils P1, P2, P3 and P4 making up the focus group, have target grades of; D, C, C and D respectively.

Throughout my short teaching career I have often felt that many students are over reliant on their teachers and lack the skills to meaningfully work independently. This is a view that many of my colleagues have shared. There is also growing interest and research being carried out in fields that explore this opinion. There are a number of different ways of defining independent learning but all describe very similar themes and processes, including pupils having an understanding of their learning; being motivated to take responsibility for their learning, and working with teachers to structure their learning environment. For these reasons it was decided that this report would address the following question: *What impact does an independent, student led, approach to learning have on boys attainment in Mathematics at GCSE?*

Implementation

As the pupils had sat the November exam and had recently received their results (6th January 2016) it was decided to use this as the baseline assessment. The pupils would then be re-tested at the end of the action research period. I also prepared a short questionnaire to attain an understanding on the pupil's attitudes to independent study. As the time period for the study was very short I decided to carry out only a few strategies that could be implemented easily. Firstly item level data was shared with the pupils, detailing topics in which they had performed well or underperformed in. Using this information pupils were asked to decide on topics that were to be covered in class and secondly to choose a topic and complete a weekly homework based on that topic. The homework task required pupils to watch an online instructional video, using a website that the school subscribes to, and complete an accompanying worksheet with each student selecting a homework of their choice. Each Friday pupils were then required to spend a designated period of the lesson sharing their homework with a partner and any other useful resources that they had found.

Item level data

	Number skills	QWC money	QWC - using fc	Pictogram / Ba	Area and perim	Coordinates	Ratio / Proport	Number / Mont	Simplify algebi	Scale Drawing	probability	Angles in Quad	Product Prime f	Timetables	Transformatio	Speed/Distanc	Solve Equation	Reasoning - Are
Max	12	7	4	11	6	4	3	4	6	3	6	6	3	3	6	7	5	4
	11	7	4	7	6	1	0	4	4	2	5	4	3	3	1	3	0	0
	12	5	2	9	5	2	0	0	3	3	4	6	1	3	5	1	3	0

Results

Baseline data

Max Mark	Initial Assessment Grade	Total Marks	Marks away from C grade
P1	D	**113**	7
P2	D	**113**	7
P3	D	**111**	9
P4	E	**94**	26

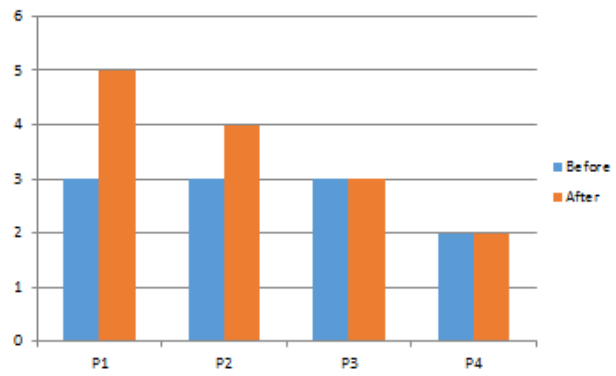
Re-test data

Max Mark	Follow Up Assessment Grade	Total Marks	Marks away from C grade
P1	C	**127**	-7
P2	C	**120**	0
P3	D	**99**	21
P4	D	**104**	16

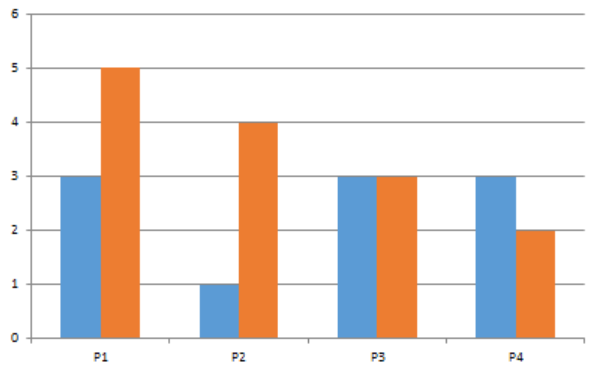
Of the four pupils involved in the study 3 had made progress between the baseline assessment and the re-test carried out at the end of the action research time period. Pupil 3 had worked well for the period of the study and his regression was not expected, although the nature of the subject and the testing procedure will inevitably produce variability in results.
At the outset and at the end of the research period the focus group were required to fill out a short questionnaire using a Likert response scale to respond. The pupils were given three statements and asked to score on a scale of 1 (strongly disagree) to 5 (strongly agree). The questions were as follows:

1. I am confident I will achieve a C in my Mathematics GCSE
2. I know the topics I am weakest at and need to improve on
3. I know how to study topics I am weakest at independently

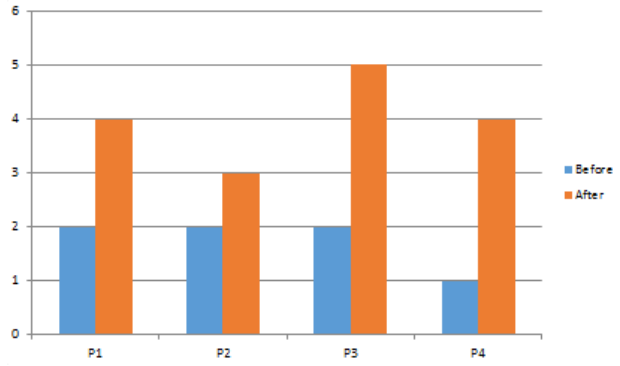
Q1.



Q2.



Q3.



The responses to questions 1 and 2 indicate a slight improvement in both confidence within the subject and the ability to identify weak areas. The biggest improvement however was shown in response to question 3, where all pupils had used a higher rating than at the start of the research project. This suggests that the pupils felt their ability to work independently had improved.

Findings and Limitations

By the end of the project the pupils involved have demonstrated a greater ownership of their learning. Initially the pupils seemed anxious about selecting their personal homework and when feeding back to their peers their responses were often brief and not fully explained. However, this greatly improved with pupils clearly explaining what they had done and in effect teaching each other; this was perhaps the greatest success of the project. The pupils also enjoyed having the authority to select the topics that were covered in class and commenting on the style of lesson that they seemed to think worked best.

In the second assessment 3 out of 4 of the pupils had improved by a considerable amount. I would, however, have expected a similar level of improvement regardless of this trial. It is also worth noting that 72% of the females in the same class made improvement too, so although the boys made improvement the progress was not solely aligned to their gender. Other limitations of this project are obviously the very small sample of pupils and the short time period.

In conclusion I believe that there has been an improvement in confidence and attitude within the pupils in the study which is obviously beneficial to learning, although to create truly independent student a change of culture over a much greater period of time and across the school would have to take place.

Cantonian High School Kevin Williams

Will sitting low level boys with high level girls improve the attainment and confidence of the boys?

Cantonian is a Local Authority Comprehensive in Cardiff; it has 500 pupils on roll and an FSM of 30.9%. My case study will centre on closing the gender gap in Mathematics, in particular improving the outcomes of boys. From published data boys in the Y11 cohort were significantly below girls at the end of KS3 levels and WNT tests. My target group for this is Y10 set 1, there is quite a variation in their KS3 levels ranging from Level 8 to Level 6, and it is a 1:1 boy/girl ratio. At present there is no seating plan but I have taught this group for 4 years and therefore have a good understanding of their ability and personality.

Objectives

- To close the gap between boys and girls.
- To increase student motivation for different seating arrangement.
- To improve students' rapport with classmates.
- To increase opportunities for learning.
- To lead to a positive change in the attitude of the students towards studies.
- To eliminate gender bias amongst the students.
- To lead to a better discipline and organized class.

Research Question

Will sitting low level boys with high level girls improve the attainment and confidence of the boys?

Strategy Implemented

The focus of this research was to alter the seating arrangement in the class and measure its impact on boys' performance in a way that does not have an impact on the progress made by the girls. It was decided to investigate whether this will change the students' perspective towards not only studies but also their classmates, which will then in turn solve the problem of the gender gap within the group. Seating arrangements should be a strategic element of classroom management in order for the pupils to maximize their opportunity for progress within a given subject. Several seating arrangements have been talked about and researched upon.

To initiate this case study I decided that the pupils need to have a modified seating plan where they were sat boy/girl. Not only did they sit boy/girl but I would sit them as high level, low level. The strategy was to try to get the girl to instill confidence in the boy so that their levels would improve but also not at the detriment of the girl. Before changing the seating plan a test was carried out and this then helped to inform me where the pupils should sit.

Initially quite a number of pupils were a bit averse to being sat in a seating plan and could not understand the merits of doing so. Slowly, as the lessons progressed, the noise of discontent abated and it became apparent that where they sat was less of a distraction and they were concentrating on their Mathematics instead. One resource I used to help with the lessons was an iPad and Apple TV, this allowed me to walk around the classroom and observe the learning that was taking place and I was able to take photos of work being completed. I could then project this onto the interactive whiteboard for discussions to take place. More share and pair was used in order to get the boy/girl to discuss their work so getting them to collaborate without making it explicit what I was doing.

The pupils were monitored as the lessons proceeded, and through the progress of their learning and discussions. Progress was also assessed against the baseline test and the resulting test after a month of the new seating arrangement. A survey was written and pupils were then asked to complete it. From the outcomes it was clear that there were two main reasons why they either liked or disliked the new seating plan. Pupils who liked the new seating plan did so because they were not sitting next to a friend, they were less distracted and their work improved. They could ask the person next to them for help as they felt more comfortable doing so because it was not their friend. Pupils who did not like the new arrangement gave the reason of not sitting next to their friends.

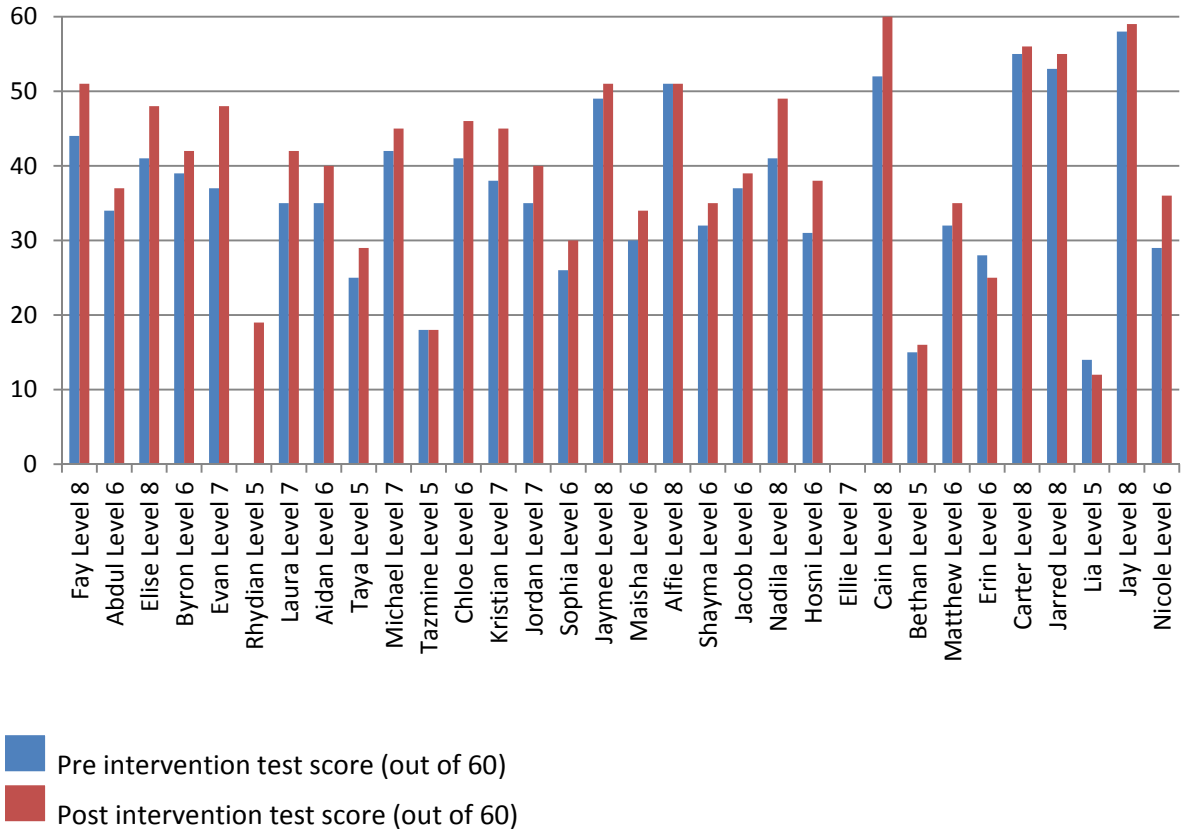
Outcomes

From this case study it was quite evident that the seating plan made an impact on the learning of the pupils (see data) but it did vary from pair to pair. It was interesting to note that even though some pupils (from the survey) did not like the new arrangement, they still made a small improvement. The rapport between the pupils made the classroom more relaxed and conducive to learning and progress was made throughout the lesson. Most of the points which I set out to achieve through this case study were met, the gap between boys and girls closed, pupils were learning more and progress was achieved far more readily than before. The whole class was more disciplined and this again helped the pupils' to progress. The boys that were sat next to a girl with a higher ability on the whole did improve without any detriment to the girls' outcomes, although, again this did vary from pair to pair.

It is clear that a strategic seating plan in any classroom is a vital tool to aid pupils to progress in the lessons. The strategy employed will differ from class to class, but, for the process that I have completed, the high/low, girl/boy plan was successful to a point. The seating arrangement created less distraction for the pupils and therefore better learning and teaching could take place which, in turn, meant pupils' progress was improved. Classroom management was far less called upon, hence creating an atmosphere based on learning and progress. Challenge within the lesson was far more evident with pupils far more freely discussing topics, solutions and progress. I feel that this case study has been a success as the results have shown, but the one difficulty with it has been the timescale and the time of year it was to be done. In the future, if it was changed to start in September and a full year applied to it, then different scenarios could be played out and a more conclusive case study could be done.

What I have learnt from this study is that a strategic seating plan is vital for all classes regardless of ability. Getting the right mix of pupils' sitting together does rectify/improve learning and progress of the pupils in the lesson and helps reduce the amount of time required for classroom management and, as a result, pupil progress improves. I am now in the process of addressing the seating plans in all of my lessons. It will not necessarily follow the same rationale but my work in this project will certainly come into consideration when doing so. If this process and progress can be replicated throughout the school then whole school outcomes will be better. With improved and strategic seating plans the learning and teaching that can take place within the lesson can be excellent and is something that should be encouraged throughout the school.

Assessment Results



Girls Attainment

Tonyrefail Comprehensive School Phil Henshaw

Can single gender revision classes impact positively on girls' attitudes to learning maths and girls' outcomes in maths?

Introduction

Tonyrefail is an 11-18 mixed comprehensive school maintained by Rhondda Cynon Taf local authority. There are 935 pupils on roll, including 150 in the sixth form. The school serves pupils from Tonyrefail and a few surrounding villages. Around half of pupils live in the 20% most deprived areas of Wales. Around 25% of pupils are eligible for free school meals, which is higher than the national average of 17.4% for secondary schools in Wales.

Research Question

Can single gender revision classes impact positively on girls' attitudes to learning maths and girls' outcomes in maths?

GCSE results for Year 11 (2014/2015) indicate a slight underperformance by girls compared to boys. Girls in Tonyrefail are also currently underperforming against girls in our family of schools. Furthermore, in the 2013 National Numeracy Tests, boys outperformed girls in both the reasoning and procedural tests.

The aim of this short term action research project was to implement an intervention with current year 10 girls in the form of a 2 session revision project over the Easter holidays focussing on a group of C/D borderline girls (4 of whom were eFSM students).

Some of my preliminary reading on attitudes revealed that the range of emotions that pupils develop as a result of their experiences in mathematics had a direct bearing on their performance in mathematics. Furthermore, studies in the area of affect showed that the self-efficacy beliefs of learners in the mathematics class, their peers and those of their teachers were important contributors to students' disposition toward mathematics.

Affect is a student's internal belief system (Fennema, 1989). The affective domain includes students "beliefs about themselves and their capacity to learn mathematics; their self-esteem and their perceived status as learners; their beliefs about the nature of mathematical understanding; and their potential to succeed in the subject" (Tanner & Jones, 2003, p. 277).

Further reading on attitudes towards mathematics (Middleton & Spanias, 1999, Hall & Ponton, 2002) revealed that the range of emotions that students developed as a result of their experiences in mathematics had a direct bearing on their performance. Furthermore, studies in the area of affect, showed that the self-efficacy beliefs of learners in the mathematics class, peers and educators were important factors and contributed to pupils' disposition towards mathematics.

Strategy Implemented

13 girls (identified by class teachers with perceived low confidence levels in maths) were invited to a 2-day revision course provided by an excellent practitioner (female) sourced from a local school. The teacher was instructed to focus on problem solving / reasoning problems in a bid to improve confidence levels.

A questionnaire focussing on self-efficacy, metacognition and strategies for learning mathematics during assessment time was issued at the start of the research and at the end to all girls. The questionnaires were not made anonymous so that the tracking of pupils and their responses would be possible. However, guarantees of anonymity were made in terms of reporting of results. The questionnaire detailed statements to be answered on a five-point Likert-type scale ranging from "strongly disagree" – value =1 to "strongly agree" – value = 5. Responses are then divided into three sub-sections: self-efficacy, metacognition and learning strategies. The self-efficacy section was further sub-divided into their beliefs on the fixed or changeable nature of their mathematics ability and what they attribute to their success or failure in mathematics assessments. A parallel set of questions were phrased negatively in these sections. This was implemented in order to avoid possible instances of response bias.

Outcomes

Monthly assessment attainment - GCSE Paper 1 was measured in March (pre-intervention) and compared to April (post-intervention) and is detailed below:

	March (pre-intervention)	April (post-intervention)	Difference
Pupil 1	58	58	0
Pupil 2	40	41	+1
Pupil 3	53	55	+2
Pupil 4	35	42	+7
Pupil 5	34	42	+8
Pupil 6	40	37	-3
Pupil 7	48	43	-5
Pupil 8	40	31	-9
Pupil 9	50	56	+6
Pupil 10	29	33	+4
Pupil 11	32	33	+1
Pupil 12	28	21	-7
Pupil 13	38	32	-6

A slight majority of pupils improved their marks with the mean change of mark being negligible. Three out of the four eFSM pupils (highlighted in red) improved their results.

Significant results from the self-efficacy questionnaire (higher value more positive) were as follows:

- Some people are naturally good at maths (all girls) – pre= 3.462, post = 3.25
    - (eFSM – pre 3.5, post = 2.75)

- Some people just can't do maths (all girls) – pre = 2.692, post = 2.417
    - (eFSM – pre 2.25, post = 2)

- You can either do maths or you can't (all girls) – pre = 2.231, post = 2.083
    - (eFSM – pre 2.25, post = 2.25)

- You can't change your maths ability (all girls) – pre = 1.769, post = 1.883
    - (eFSM – pre 2.25, post = 2)

- If I do well in a maths exam, it is because I have natural ability in maths (all girls) – pre = 2.308, post = 2.5
    - (eFSM – pre 2.25, post = 2.75)

As can be seen from the change in values, the girls' perceptions regarding an innate ability to being able to "do maths" has improved in most cases. eFSM pupils' views largely follow the same trends.

The girls' views were sought on whether they felt the Easter Revision would improve their maths grade for the GCSE in Year 11 and 100% stated it would.

When asked what the best aspects were and areas to improve, responses included the following:

Best aspects

- "Having someone different teach us to learn more techniques"
- "I was able to have more support and learn more ways of answering questions – and the food!"
- "I understand a lot of things I didn't before"
- "I was given the chance to develop my understanding of maths more – it showed me how to work around big questions"
- "I enjoyed the Easter revision as I now know many different ways to work out questions. I now have a better understanding of maths"

How could we improve the revision for you?

- "Have more than 2 days - more revision booklets to take home for revision"
- "Make it longer"
- "More choice of food and longer breaks"

Conclusion

Positive responses from the intervention group give clear indications of a high value and regard they place on the revision sessions. Some further make positive comments requesting more intense revision.

The impact on attainment is clear, with a clear difference between the two sets of assessments. Given my interest in exploring pupils' views, I suggest that further research into self-efficacy beliefs and attitude to learning mathematics and its impact on mathematics attainment will provide further insight into this relationship. It is hoped that early identification of the onset of low self-efficacy in mathematics will provide us mathematics teachers with the insight needed to help prevent some (if not overcome) underachievement (both in boys and girls) or apathy in our subject. I am hoping that this research can help guide decisions on overcoming this challenge to learning.

Most of the research done in the area of affect and achievement share similar views and that is;

- affect is a powerful factor in pupil achievement,
- self-efficacy beliefs are major contributors of affect that if developed can improve achievement in the mathematics class.

From a personal point of view, I feel it is imperative that an improvement in attitudes of pupils (both girls and boys) towards mathematics is focussed upon.

References

Fennema, E. (1989). The study of affect and mathematics: A proposed generic model for research. In D. B. McLeod & V. M. Adams (Eds.), *Affect and mathematical problem solving: A new perspective*. 207-219. London: Springer-Verlag.

Hall, M. & Ponton, M. (2002). A comparative analysis of mathematics self-efficacy of developmental and non-developmental freshman mathematics students. Presented at the meeting of Louisiana / Mississippi section of the Mathematics Association of America.

Middleton, J. A., Spanias, P. A. (1999). Motivation for Achievement in Mathematics: Findings, Generalisations and Criticisms of the Research. *Journal For Research in Mathematics Education, January 1999,* 30 (1), 65–85.

Tanner, H., & Jones, S. (2003). Self-efficacy in mathematics and students` use of self-regulated learning strategies during assessment events Proceedings of the 27th conference of the International Group for the Psychology of Mathematics Education, Hawaii, 4, 275-278.

Pencoed Comprehensive School Cath Pope

Does single sex teaching in mathematics improve outcomes for female students?

I was approached by Central South Consortium to take part in an Action Research Project with a Gender Focus. As Head of Mathematics in Pencoed School I am accountable for the GCSE Maths data. At KS4 there has been a noticeable gap, in that boys perform better than girls at all levels.

Year 11 data after the November GCSE examination

YEAR 11 NOV 2016	D's	C's	B's	A/A*
Males	79	54	19	17
%	58.96	68.35	24.05	21.52
Females	55	35	10	10
%	41.04	63.64	18.18	18.18
Boys less girls (%)	**17.92**	**4.71**	**5.87**	**3.34**

Strategies

- I selected a target group of 11 year 11 girls that had not achieved a C grade. Grades already achieved were 2 D, 4 E and 5 F grades.
- I decided to hold girls only lunchtime revision sessions because my initial thought was that girls would prefer working without boys as they may feel intimidated by them.
- I purchased packs of maths equipment to ensure that all girls were prepared for lessons. Thus avoiding the negative 'where is your pen/ruler/pencil/ calculator?' discussion at the start of each lesson.
- I was conscious of the fact that boys took up more of my time in lessons, so I made sure that my time was shared equally. I helped a boy then a girl when going round the class helping pupils. I also questioned pupils alternating from boy to girl and so on.
- I looked for more past paper questions that were not the traditional boy themed questions: football, building etc. Instead shopping and recipes!
- I visited Brynteg School.

Pupil Voice

Prior to doing any interventions I carried out a pupil voice questionnaire to find out what the girls feelings were about mathematics. I asked 20 girls, 11 from the sample and 9 others.

Questionnaire Outcomes

- 70% did not think that working in a girls only class would be better for their learning.
- 65% thought they worked better in pairs.
- 70% didn't like maths and 70% thought they were not good at maths.
- Only 45% had help at home with maths but 80% worked on past papers outside of maths lessons.

Maths Questionnaire Results

%	Strongly Agree	Agree	Disagree	Strongly disagree	POSITIVE	NEGATIVE
I like Maths		30	40	30	30	70
I enjoy my Maths lessons		40	55	5	40	60
I am good at Maths	5	25	40	30	30	70
I learn better working in pairs	5	60	25	10	65	35
I would learn better in a girls only class	15	15	60	10	30	70
I bring all the correct equipment to my lessons		60	30	10	60	40
I work on past papers outside of my maths lessons	5	75	15	5	80	20
I ask for help on my past papers		70	30		70	30
My parents help me with my maths homework	5	40	45	10	45	55

School Visit Outcomes

As part of the project I visited Brynteg Comprehensive School in Bridgend because they have a small gender gap in their KS4 data. The main observations were;

- Classroom practise is a very high priority with all staff directed to work in cross curricular triads.
- All lesson observations were judged.
- Consistency - common slides were used throughout the school and the LNF was broken down into verbs for staff to use in lessons.
- Data: One whole school target is used for pupils.

Mock Exam Outcomes

Towards the end of the project year 11 sat a mock exam.

- 5 of the girls improved their raw score mark
- Of which 3 improved their grade.

Conclusion

I assumed girls would prefer working in a single sex class. The questionnaire showed me that most of the girls were happy in a mixed class. All the girls responded well to the extra attention and extra help in lessons. Having the packs of equipment prepared for pupils made the lessons start much more smoothly. I found it difficult to get the girls to come in lunchtime to work. All 11 attended but not regularly. The project time scale was a little short to measure lots of improvements in results. However, 5 pupils improving their raw score on the mock was pleasing. After the results in the Summer I would like to carry out a pupil voice again.
This project has really inspired me! I am now focusing on reducing the gap for my year 10 girls. I have booked them onto a girl's only event at the Celtic Manor. I will continue to consider girls only revision sessions next year and I will ensure that my questioning is shared equally.

Ysgol Gyfun Gymraeg Llangynwyd Angharad Morris

Will introducing a female role model into small single-sex mathematics classes improve girl's confidence in mathematics?

The research conducted throughout this project aims to explore the issues regarding girl's confidence in Mathematics. The cohort of pupils that I have chosen to carry out this research upon is a group of year 11 girls, who are currently in set 4 targeting a C grade. The gender gap between pupils on the C/D border line highlights that our girls are failing to reach the C grade during exams. Having spoken to the girls regarding their feelings towards mathematics, the most common answer I received was "I'm not good at maths Miss, I can't do it." It was evident that there is a clear lack of confidence with this group of girls.

In order to overcome this issue, an intervention was put in place with the aim of increase girls' confidence while completing past GCSE questions and papers. This included taking the girls in small groups from their mathematics lessons, next door to an empty classroom, where the same lesson was taught to them (groups of 4/5 when possible). The reason behind this was to see if the girls would answer more confidently during the lesson; and to see if they feel more relaxed in a smaller group and less pressured environment. To assess the effect of this intervention, a comparison of pre and post intervention exam results will be made, in addition to a brief questionnaire for pupil feedback.

Pre – intervention Results

	Gender	November Exam 2016
Pupil 1	F	E
Pupil 2	F	D
Pupil 3	F	D
Pupil 4	F	E
Pupil 5	F	E
Pupil 6	F	D
Pupil 7	F	C
Pupil 8	F	E
Pupil 9	F	E
Pupil 10	F	E

As previously mentioned, the above girls openly admitted to "not being very good at maths," and a low level of self-confidence was evident amongst them. Additionally, three girls mentioned that they get distracted easily during mathematics lessons, mainly due to the boys drawing their attention and therefore being off task too often. The general feeling from the girls is that they lack confidence in answering, fearing that they might get a question wrong.

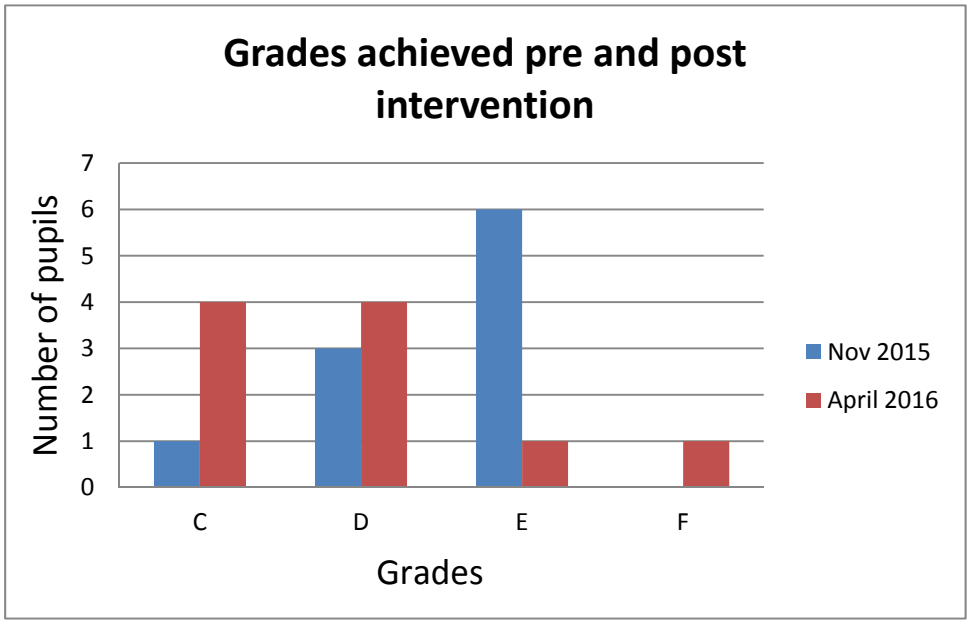
Intervention

During the intervention stage girls were taught in groups of 5 in a separate classroom during their mathematics lessons. Within these sessions the girls would have an identical lesson to their peers, but in a more relaxed environment. This generated many discussions within the lesson, where the girls were able to ask more in-depth questions regarding certain topics that they are unsure of. As a result of this uncertainty with various topics, a revision pack was also created. The revision pack

includes past GCSE questions separated into different topics, allowing the girls to independently work on the areas they most find difficult.
Additionally, after school revision sessions have been taking place on Monday and Wednesday evenings. These sessions have given the girls an opportunity to work as a group of friends on the past papers they have received. Similarly, the session are relaxed sessions, where 3 members are staff are on hand to assist the pupils when needed. This has allowed the pupils to work not only independently, but also as a group where many pupils have offered a helping hand to others.

Post- intervention Results

	April 2016 P1	April 2016 P2	Total	Grade
Pupil 1		43	43	F
Pupil 2	52	78	130	C
Pupil 3	51	72	123	C
Pupil 4	62	47	109	D
Pupil 5	49	34	83	E
Pupil 6	49	48	97	D
Pupil 7	56	63	119	C
Pupil 8	48	58	106	D
Pupil 9	53	81	134	C
Pupil 10	48	39	87	D



The results show that 80% of the girls have increased their grade by at least one grade. The above graph highlights this; with only pupils marking shown to decrease having not completed paper 1. This may suggest that the small group intervention has had a positive effect on the girls' confidence and therefore their grades. It may be argued that the reason for this increase was simply having more practice since the November exam. However after asking the participating pupils how they felt about the small group intervention there were mixed reviews.

Pupil 10 – *"I'm glad we were able to do it, I can concentrate better without the boys in the class."*
Pupil 2 – *"I enjoyed these sessions because I could answer questions and not feel embarrassed."*
Pupil 5 – *"It hasn't really made a difference to me, if I'm honest."*
Pupil 9 – *"I like working in small groups with the girls. I think more sessions would have been even more helpful and would have had more of an impact. But I do feel confident in answering."*

The main reaction from the pupils indicates that they feel more confident within a smaller environment. The teaching strategy used within the research was small group lessons as suggested by Chambers & Timlin, 2000. This proved to be an effective strategy to use as pupils enjoyed interacting during the lesson, and after school session in which they appear to have gained confidence in themselves and their female peers.

Although a direct comparison was made using the pre and post intervention exams, it is possible that the improvement seen was due to timing of the post intervention exam, and information being fresh in pupils' memory. Recommendations for future practice would be to allow more time to conduct these sessions, and continue with the intervention of smaller, single gender lessons. As mentioned by 'Pupil 9', the number of these lessons attended by the pupils was relatively low, and thus a true comparison of results was not entirely reliable.

Continuing with the small group, single gender lesson for a longer period would be more beneficial. This would also allow for a more reliable evaluation of the teaching strategies used (Cohen, Manion, & Morrison 2004).

Reference List

Boulton-Lewis (1996). *Teaching Mathematics: Developing Learning in the Foundation Stage.*. London:
Chambers.R & Timlin.R (2013). *Teaching Mathematics in The Secondary School*. London: Sage. 216.
Cohen, Manion and Morrison (2004). *Research Methods in Education*. London: 1.
Tanner. J & Jones.S (2000). *Becomings a Successful Teacher of Mathematics*. New York: Routledge. 86

St Cyres School Ryan Jones

Do girls gain more confidence when working with female role models?

This research is intended to identify possible causes of the gender gap in maths in schools. It is also looking to develop possible solutions to address these causes. The imbalance is currently in favour of the boys at St Cyres School. Boys generally outperform girls at most stages in the school especially with end of year 9 levels; in my literature research it was suggested that this could be due to a lack of confidence and so this is something that I decided to look at in my action research.

My target group is the girls in a year 10 class that I teach. They are set 3 of 8, following the GCSE intermediate course and all have a target grade of a B; this includes the boys in the class. I decided to look at this group as it is a class that I have noticed a distinct lack of confidence in the girls and perhaps overconfidence in the boys. Most of the girls were not achieving target grades and those that were meeting targets still had a clear underestimation in their abilities, some of these even appearing completely disenfranchised with maths. I also chose this group of girls because many of them were very inconsistent and had greatly fluctuating grades. One example of this would be an October test result of 29% going up to 54% in December and then down to 19% in February. Obviously there was something that needed to be done. Due to the noticeable lack of confidence I decided to pick this as the cause that I would investigate. From research into the works of Jo Boaler, I learnt that female role models often influence girls. So my research question was '*Do girls gain more confidence when working with female role models?*'

Confidence in a subject is a largely opinion based focus; this meant that data I collected would largely be qualitative and based on student feelings and opinions. This would be collected from quick questionnaires and interviews. I decided to do group interviews with the girls right at the beginning of the research. I did this in groups of 2 or 3 and I got their perspective on how well they were doing with maths, what their thoughts were on the differences in boys and girls were in maths and also how they felt about female role models. The role models weren't specifically in relation to maths; I asked them whether they were inspired by female athletes and musicians, or by women in positions of power in business and state as well as women who have made a more direct impact on their lives like family members, teachers and coaches. I also looked at test data for the group of girls. This could give me a better idea of actual ability as opposed to feelings about maths. It means that I can look at changes in scores before and after my proposed interventions.

The strategies that I put in place were mostly aimed at giving the girls a role model in specifically in terms of mathematics. The first strategy I looked at was getting the maths LSA in to as many of the lessons as possible, whereas normally she would not be supporting that class. She also tried to concentrate on giving support to the girls where possible. As she had recently gone back to studying and completed her own A-level in maths and is currently studying for her degree I thought that she would be an ideal role model. I also looked into doing extra sessions, for the girls, in which female sixth form students could come along and help out. These were initially used as revision sessions before tests and to go through the test papers afterwards, but they were also used to work through numeracy reasoning style questions. Revision sheets were printed off that pupils and the A-level students could go through in groups. Also numeracy problem placemats were printed and laminated. The girls worked through these real life problems in groups with an A-level student where possible. Some of these problems were the numeracy GCSE sample problems. The girls were given dry wipe markers and highlighters to highlight and draw on top of the mats as it could be rubbed off. The girls like to be able to annotate and label to help them consolidate their ideas. I had wanted the A-level students to be a consistent strategy throughout the research, however they felt they were too committed with their own exam revision so they were only able to help for the first few weeks.

I found progress slightly hard to measure with these strategies as I was mainly looking to improve student confidence. Therefore my main study of progress was through impromptu conversations with the pupils on their opinions, as well as my own observations, on how they engaged with a task, whether they were enjoying the work and if they seemed more confident in their own abilities. I also followed test results before and after the implementation of these strategies, confidence in maths should give some effect and change in these.

The results of the initial group interviews were interesting but by no means unanimous. Most of the girls said that they did not feel that they were very good at maths, even the ones that were strong mathematicians. There wasn't a consensus on whether they felt boys or girls were stronger at maths but they did feel that boys controlled the lessons more by shouting answers out and generally being more boisterous. There was a general agreement that these girls did look up to female role models, for many different reasons depending on the individual. Test results also painted a varied picture; it showed that many of the girls were underperforming compared to the boys. It also showed a great variation in their own marks, they could fluctuate greatly, which could make measuring the success of my interventions hard. The range in some girls marks between tests were as much as 20%.

Having an LSA in the class had obvious benefits as it meant pupils could be given more individual time and support through the lesson. In conversations with the girls of the class some felt that it had a positive effect on them but they didn't say it was for any reason other than because they had more support. However the after school revision sessions seemed to be very helpful. Pupils were very engaged and working in groups, when a problem was found they worked cooperatively to find a solution or they looked for help from the A-level students. A pupil in a discussion afterwards said 'it felt like we were doing the work together because they weren't teachers, it wasn't like we were being told the answers.' I feel that this would give a great boost to confidence, as they didn't seem to see encountering a problem as getting stuck or getting something wrong they saw it as a challenge that they could overcome. This was true of the numeracy tasks also they were tackling real life problems with some guidance from a peer, or someone very close to a peer, rather than a teacher. Test marks increased as a whole towards the end of the study; not every pupil got their highest result but they were working toward the top end of their range. The mean increase in marks from the previous test was 5%.

The outcomes were obvious on an individual scale as well. Two girls who were performing well but did not feel confident in their capabilities jumped at the opportunity to move up a set and try out the higher tier course. They were offered this option before but turned it down. Another girl who seemed to be performing well with classwork, she continually answered questions in class and completed classwork ahead of time, was drastically underperforming in tests. In the test immediately after the interventions her result balanced; where by no means best in the class, she was working at a level much closer to her target grade. This is a result that needs to be followed up as her grades did fluctuate previously. Possibly now the most outspoken girl, both in terms of answering questions and general talking, is one who was among the quietest in the class. She seems to have found a huge amount of confidence in class, I do not think this can be entirely down to working with female role models but the change in strategy did coincide with the change in behaviour. She is now consistently the first with her hand up to answer a question and the first to finish her work, not just among the girls. She also seems to be enjoying lessons more and paying a lot more attention in class. There are also girls that seem indifferent to the changes; they try their best not to join in the group activities in the afternoon sessions and there seems to be no significant change in results or outlook both in classwork and in tests. In discussions with this group they said that they did not like the extra attention. Two girls said that it made them feel pressured that they needed extra help; it made them feel less confident. This is the complete opposite effect to the intended.

This study showed me that generally female role models were beneficial to the girls in this group. They said that the sixth form students enjoyed and saw the importance in maths, which helped them to see that 'it's not always a boring and nerdy subject.' General enthusiasm from the girls in the class improved which helped the teaching of the whole class. It also meant that the girls had extra support and opportunity to succeed which could only be beneficial. It could however be said that these improvements could be from working in same-sex groups and having extra support and maths sessions rather than being exposed to female role models. Discussions with the girls at least showed that they felt working with the sixth form girls was helping, for the most part at least. My study did also show that some girls did not react particularly well to the extra support; they would have rather been left alone to work in their own way. This could have been because they felt they were targeted due to underachievement and so felt less confident than ever.

I felt that the interventions were beneficial as the pupils saw successful students showing maths in a positive light. It showed that the girls, for the most part, enjoyed doing extra sessions even if they had to be coaxed into going in the first place. The results showed some increase in test results, an average increase of 5%. There are some limitations and this would inform my future practice. I will continue to offer the extra sessions, in more convenient times for the sixth form students. But I will also run the sessions without them to see if extra support in smaller groups would give the exact same benefits to the girls. I also need to make sure that the girls do not feel targeted by these sessions and drain their confidence.

I found difficulties in this study in that it was largely opinion based which could be hard to quantify. It meant that I had to have more in-depth and individual conversations with the pupils which, even though beneficial , could also be time consuming. I also had difficulty in the reliability of the sixth form students, some students couldn't make every session and towards the end of the study they couldn't make any at all.

Conclusions

Although the timeframe for the action research was limited, the individual school reports above clearly show there have been several meaningful conclusions that can be drawn from their work. These findings can be used to inform teachers across the region when they are looking to address the underperformance of either gender in mathematics.

In summary, the main issues affecting the underperformance of boys in mathematics include;

- Poor attitude to learning
- Behaviour
- Lack of independence
- Mathematical mindset
- Lack of engagement
- Poor organisational skills

The schools involved in the action research have used a range of strategies to address these issues, and some of their findings include;

The celebration of mistakes and risk can have a positive impact on the growth mindset of learners of mathematics. A classroom environment that embraces and promotes mistakes to encourage open and honest contribution from its students appears to aid the development of a more resilient and positive learner of mathematics.

Regular, direct and focussed communication with parents on the specifics of their child's learning journey has a positive impact on all learners, not just specifically for boys or girls.

Providing opportunities for boys to study independently allows them to take a greater ownership of their learning. Given them the freedom to select revision tasks and topics most appropriate to their needs improves boy's perceived value of the task.

Sitting a lower performing boy with a higher performing girl can have a positive impact on the learning outcomes of the boys, without negatively impacting on the girls. Success is likely to vary from pair to pair, and although pupils may not initially like the arrangement, the research has demonstrated that most boys are likely to make an improvement. Positive benefits to the atmosphere within the learning environment were also noted.

In summary, the main issues affecting the underperformance of girls in mathematics are;

- A lack of self-confidence in their ability to solve mathematics and scientific problems
- Higher levels of anxiety towards the subject
- Lower expectations amongst parents and teachers
- A greater fear of failure in mathematics and science
- Less willingness to engage in the trial and error processes fundamental to acquiring knowledge in mathematics and science
- More likely to say that they are "*just not good at maths*"

The schools involved have used a range of strategies to address these issues, and some of their findings include;

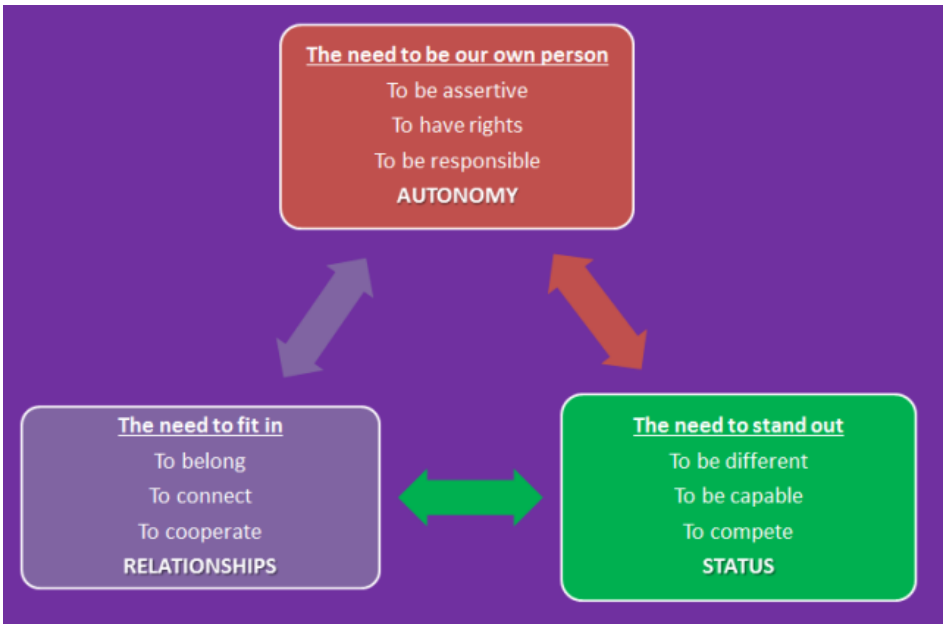
Single sex revision class can have a positive impact on the attainment of girls in mathematics through developing their self-confidence in the subject.

Single sex classes can have a meaningful influence on the attainment of girls in mathematics by allowing them more freedom to ask questions without fear of embarrassment or ridicule.

Self-efficacy beliefs in girls can play a major role in their performance in mathematics, which if developed and challenged over time, can improve their attainment within the subject.

Introducing female mathematical role models can be beneficial to a girl's performance. Female sixth form mentors, along with other strong female members of staff with a positive outlook and relationship with the subject, can increase girls' enthusiasm and interest in mathematics.

Final Thoughts



Psychological Cycle of Need – *www.classteaching.com (2016)*

Although this action research has explored the different approaches we can take to teaching boys and girls in mathematics, the above 'Psychological Cycle of Need', indicates the same underlying basic needs for boys and girls – we all need to be our own person, to fit in and also to stand out. When the above researchers surveyed and observed boys and girls in the classroom, they noticed the following about both genders:

- They both wanted structure in their lessons.
- They both feared punitive measures.
- They can both be emotionally fragile.
- They both want status and autonomy.

In consideration with all of the above findings, we should aim to;

- Establish a non-negotiable and secure classroom with rights and responsibilities.
- Ensure there is a consequence for poor behaviour.
- Make sure that we direct the learning, so that it is structured and purposeful.
- Share the power between the genders in the classroom – don't allow one or the other to dominate.
- Avoid a vicious circle of re-enforcing gender stereotypes.

Evidence suggests that teachers who are most effective at challenging gender underperformance do the following – equally to boys and girls:

- Give feedback that encourages growth and self-improvement.
- Give feedback that encourages mastery.
- Give feedback that challenges students to think hard.

- Gives feedback that is descriptive and supportive.
- Less generic praise and more encouragement e.g. 'It's great that you've tried really hard on this problem, that's why you're being successful'.
- Don't be fooled by loud boys.
- Don't be fooled by quiet girls.

If boys and girls are left to themselves, it is likely they will reinforce stereotypes – simply because of the external pressure placed upon them by society. As educators, we need to address this by taking them out of these comfort zones, by challenging our own default settings in terms of how we interact with boys and girls. This may include;

- Appreciating and admiring girls for their wit, confidence, energy, courage, risk-taking and sporting prowess.

- Appreciating and admiring boys for their thoughtfulness, their empathy, conscientiousness, sensitivity and their ability to listen.