

# Does teacher gender amplify the gender imbalance when pupils pick Science subjects?

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## **Abstract**

*There is an obvious gender imbalance in Science, with concern over the lack of female representation in Physics, and more females than males studying Biology. This has been evident in research for many years and is a well-established pattern. Consequently, there have been many initiatives and documentation produced to rectify this issue. We know there are many influences on young people's decisions in school, including peers, parents, stereotypes and personal interests. This study investigates the niche impact of teacher gender and whether this contributes to the gender imbalance. Data collection considered the number of pupils studying the STEM subjects, dual scientists and whether they followed recommendations. Consultations with staff and pupils gave revelations into unconscious bias, gender stereotypes and insecurities. It was evident that our female numbers in Physics are considerably lower than we would like. Although it cannot be concluded that teacher gender is the sole reason there is a gender imbalance, our department does fit the stereotype and there is a need to promote role models of the opposing genders. This study will inform future training, decisions, and research to further investigate and address the gender imbalance in Science subjects.*

## **1. Introduction**

Every secondary teacher will talk about their "passion" for their subject, such passion that rather than enter a career in the field/industry they enter the teaching profession to pass this passion on to the future generations. From personal experience and discussions with colleagues, 9 times out of 10 the inspiration to enter the profession refers to their teachers from school. It is without question that teachers have a major impact on the young people they teach and should endeavour to be that positive role model (Lumpkin, 2008). By instilling a love of Biology in others I contributed to an increase of 175% in Higher Biology uptake from year 1 to 5, which led to the recruitment of 2 further Biology teachers. Consequently, Science was removed from the Health and Well-being faculty and became a standalone department due to the increasing numbers. As the newly appointed PT of Science, I want to explore gender bias within my department and the field, to inform my strategic vision to build a fully inclusive department. Gender bias in the classroom is not new (Banks, 1988), and there have been significant investigations into gender imbalance specifically in the Science field (Feller, 2004). Despite many initiatives and policies to address this, it remains prevalent across most schools in Scotland. The gender imbalance in Science can be attributed to many factors including peers, parent influence, teachers, career choice, stereotypes, etc (Robnett & Leaper, 2013). It cannot be denied that teachers have an underlying responsibility to be

positive role models, and I have opted to focus this small-scale study on whether teacher gender has a notable impact on subject choice. By carrying out this research, I hope to identify the steps we need to take as a department, and as individuals, to become more “gender-neutral”.

## **2. Background/Policy**

Curriculum for Excellence (CfE) endeavoured to enable more personalisation and choice in education (Scottish Executive, 2004). CfE introduced a 3-3 model, but many schools still carry out subject choices in S2 in favour of the previous 2-2-2 model (Education and Skills Committee (a), 2019). STEM has reportedly been affected by the new curriculum structure with a drop of approximately 25% of pupils studying STEM due to the 6-column set up which most schools adopted (Education and Skills Committee (b), 2019). This then filtered into STEM studied at Higher level which also had a drop in number (Learned Societies Group, 2019). However, Science is mandatory in the BGE due to the transferable skills gained applicable to many careers (Longbottom & Butler, 1999). Despite a rising number of job opportunities in the STEM field, the number pursuing them is relatively low (Abbott, 2018). Abbott’s research into science graduates showed that Chemistry leads the way with 17% of graduates entering a career in the field, the majority of which are male. Females opting for careers in which conversely males are underrepresented including Education (Sellgren, 2016) and Care (Day, 2015).

To address the lack of female representation in STEM fields there have been numerous initiatives including “hack a hairdryer”, “girls into engineering”, “pinkify Physics” and “girl-friendly physics”. By advertising as “girl friendly” and “pink” to attract girls, some argue it simply supports stereotypes and sexism (BBC, 2015). I have taken groups of girls to some of these events which do allow the girls to flourish and the success of such events has been documented (Bamberger, 2014). Although, it could be questioned whether having gender-focused events highlights the problem and creates a gender bias to the opposing effect. Girls only events could eliminate pupils with genuine interests and begs the question, does this counteract Inclusion policy (HMIE, 2002) in line with Getting it Right For Every Child (GIRFEC, 2006)? It could be argued whether gender-specific initiatives and statistics are relevant in a world where society is moving towards removing labels and focusing on the individual (Naidoo, 2017). It is clear when looking at STEM initiatives the focus is on girls into Physics as opposed to boys into Biology. This is something I am keen to explore further as 2019 SQA figures show 34% of H Biology candidates were male and 28% of H Physics candidates were female as opposed to Maths which has a relatively 50:50 split (SQA, 2019).

A great contribution to the gender bias debate which cannot be ignored in this study is “Improving gender balance and equalities 3-18” publication for Education Scotland (Improving Gender Balance, 2018a). I

attended two twilights delivered as part of this initiative and it sparked my interest in gender and made me question my own unconscious bias. The STEM equity key messages confirmed that STEM can be perceived to be masculine and some of the main issues are girls lacking confidence and difficulty adopting a scientific mind. The publication has an action guide for secondary school teachers which offers many starting points for discussion (Improving Gender Balance, 2018b). These are generalised and should be used to supplement each school's individual plan and approach towards gender balance. One success story referenced is Lomond High School which saw a 30% increase in girls studying physics over a 3-year period (Improving Gender Balance, 2018c). The study discusses the strategies used to implement this. This school is opposite to my setting, in relation to private vs public sector, SIMD, and related attainment which makes it incomparable. My focus is on the impact of teacher gender and this study did not reference teacher gender but from school website information appears to fit the stereotype of male physics teachers suggesting the increase in female physicists was not affected by teacher gender.

The gender balance in STEM research briefing discusses role models including parents, college mentors, peers, and working professionals (Education Scotland, 2015). However, there appears to be a gap in the literature for the Science teacher as the role model and whether this has an impact on pupil choices. In other countries it has been suggested there is a correlation stating that "a female science teacher increases the likelihood that a girl views science as useful for her future" (Dee, 2007). Other studies state teacher gender is insignificant when teacher behaviour and attitude are considered (Sansone, 2017). However, Sansone specifically mentions that teacher gender does have an impact on student interest in STEM. It is the lack of research in this specific area of STEM education that has initiated this research project.

### **3. Research Design**

This is a small-scale research project therefore will focus solely on information from my own school. This research will focus on S3 subject choices – it is the first time in our school pupils get to personalise and structure their own curriculum. A mixed-method approach will be used comprising of quantitative data collection on subject choices and qualitative responses from pupil and staff. (Johnson & Onwuegbuzie, 2004). The purpose of the data collection is to identify the scale of our gender imbalance across all 3 Sciences and in relation to national figures. The pupil and staff consultations will allow further investigation in the role that teacher gender could play in these figures and highlight the importance of addressing it as a department. This research design of gathering quantitative data first then engaging in discussion is supported by Shah & Corley, (2008) theory that quantitative data precedes the research, and theory emerges from qualitative data.

### **3.1 Data Collection**

Majority of the research will involve gathering statistical information on S3 subject choices. This will span the previous 3 years to establish any patterns or anomalies. The future 2020 cohort subject choices will also be viewed alongside the recommendations from teachers. These recommendations are based on their attainment in the 3 Sciences across S1-2 and CAT predictors. This information will be evaluated tentatively, recognising that these recommendations are made on ability but there will be valid reasons for pupils to opt/be encouraged to go against teacher recommendation. There will also be a comparison of dual scientist numbers. This study primarily uses S3 options choices but there are no national statistics available for this. Therefore, to view how our school compares to the gender picture at a national level there is a comparison of National 5 and Higher statistics for Science and Maths for 2019 only.

### **3.2 Staff Audit and Consultation**

All staff involved in this project were informed that this was part of my research and that some of their comments may be used anonymously before the conversation took place.

A Departmental meeting at the start of the year will introduce the department to this research and plans for improvement. The agenda includes unconscious bias, stereotypes, BGE courses, class makeup, initiatives and staff confidence. All staff will engage with the unconscious bias survey (Harvard, n.d.) and research by Sansone to take notes for discussion at the next meeting (Sansone, 2017). Staff were reminded that GTCS requires engagement with professional reading and particularly professional values including integrity and social justice (GTCS, 2012). I had informal discussions with teachers in Home Economics, Hairdressing and Technical Department which are subject to the same gender imbalance. I also had informal conversations with pastoral care and PT raising attainment who are involved in the subject choice process. The purpose was merely to gain an insight into the driving force behind most subject choices and their opinion as to whether teacher, more specifically genders, play a role.

### **3.3 Pupil Interviews**

To ensure confidentiality pupils were always made aware at the start of these conversations that anything they said would be kept confidential and they were also made aware of my research.

The importance of pupil voice has long been championed (Flutter & Rudduck, 2004) in both creating school policy and gaining an invaluable insight into research (Cook-Sather, 2006). As PT Science I had lots of timetabled opportunities for learner conversations and could use this for my research. A target group of 10 S2 pupils, 5 males and 5 females (10% of the year group) were interviewed at the start of the year to discuss which Science they aimed to pick for S3. These pupils represented a range of abilities. They were asked their reasons for choosing the subject. These same pupils option choices were noted during the

option choice process and they were surveyed as to why they made that choice in June (electronically due to COVID-19).

A male and female volunteer from each S1 class created a group of 12 pupils for an open discussion. These pupils were used to investigate their awareness of specific teacher specialisms in Science, their perception of Science teachers, any preferences and their favourite Science based on S1. This discussion took place in December after pupils had the opportunity to study topics from all 3 Sciences to inform their decisions. We were lucky to have 4 student teachers in the department this year. One male biologist, one female physicist and 2 male chemists. This was an excellent opportunity in line with this project and I asked the student teachers not to share their specialist Science with the lower school. The S1 and S2 classes taught by the students were asked to vote which Science they specialised in to give an insight into perceived stereotypes.

## **4. Findings and Analysis**

### **4.1. Data Collection**

*Figure 1: S3 Subject Choices*

<b>S3 Uptake</b>	<b>Biology</b>		<b>Chemistry</b>		<b>Physics</b>	
	Male	Female	Male	Female	Male	Female
<b>2019</b>	29%	71%	41%	59%	90%	10%
<b>2018</b>	24%	76%	34%	66%	94%	6%*
<b>2017</b>	31%	69%	38%	62%	86%	14%

Pupils must pick a Science in S3 therefore all pupils in the cohort fit into these 3 subjects. However, it is important to note that some pupils will be studying two Sciences which could affect figures. It is worth noting that although these have been converted to percentages class size in physics is around 50% lower than Biology which can affect the statistical picture. Interestingly, the female figure for 2018 is \* because although this pupil is biologically female, they identify as gender-neutral. What is clear from these statistics is females are by far the majority in Biology and minority in Physics, with Chemistry the closest to being completely balanced. These figures are consistent across the last 3 years with no real shift in pattern. Staff in the department remained the same from 2018 to 2019, and although a change in physics teacher from 2017 to 2018 both are male.

Figure 2: 2020 S3 Actual Subject Choice vs Teacher Recommendation

	Biology		Chemistry		Physics		Total
	Male	Female	Male	Female	Male	Female	
<b>Actual Numbers</b>	25	27	22	17	16	2	<b>109</b>
<b>Recommendation</b>	20	17	10	22	23	7	<b>99</b>

The teacher recommendation is automatically formulated by a spreadsheet and is cross-referenced by the teacher. This spreadsheet averages their performance in all 3 Sciences across S1-2. The teacher consults the predictions using CAT Score information from tests take in S1. There are limitations with these predictions e.g. if a pupil has missed assessments this will not be considered in the calculations and thus they may have strengths in the subject but not recommended due to lack of assessment scores. This is where teacher judgement is paramount. What these statistics show is that these recommendations do not enforce a 50:50 split but in Physics would lead to a higher female representation. The actual numbers are slightly higher than recommendation due to dual scientists and some pupils are missing from the data due to remote data collection during COVID-19. The difference in recommendation vs actual numbers represents pupil choice and we need to consider the impact of subject enjoyment over simple attainment.

Figure 3: 2020 Dual Scientist and N4 Scientist Numbers vs Recommendation

	Dual Scientists		N4 General Scientists	
	Male	Female	Male	Female
<b>Actual Numbers</b>	13	7	7	8
<b>Recommendation</b>	16	13	10	6

For the 2020 S3 cohort pupils were recommended to study 2 Sciences. The dual scientist numbers support the statement by the Education and Skills Committee (b), 2019, that Science suffers in a 6-column setup. We lose dual scientists due to the inability to study two sciences and two social subjects. It can also be seen that this is particularly evident in the female cohort with almost half ignoring the recommendation to do two sciences in favour of two social subjects, which has previously been documented (Trusz, 2020). Our school currently offers Chemistry as the second Science, allowing pupils to study Biology and Chemistry, or Chemistry and Physics. 6/7 females are studying Biology and Chemistry and 8/13 boys have opted for this combination. This shows that aside from gender, biology and chemistry is the more common combination. In previous years pupils who would struggle academically or did not enjoy Science had no choice but to pick one of the specialisms. This year we have offered the N4 Science Course which has more practical elements of the BGE courses. This study is not focused on ability but previously students in this bracket

were recommended to study Biology as the “easy Science” which would have an impact on our gender statistics. Therefore, this has been included for future reference. Another common choice is for boys in this bracket to pick Physics simply to be with their friend

Figure 4: SQA Exam Subject Numbers

Using statistics from insight <https://insight.scotxed.net/>

N5 2019	Biology		Chemistry		Physics		Mathematics	
	Male	Female	Male	Female	Male	Female	Male	Female
School	59%	41%	55%	45%	100%	0%	51%	49%
Local Authority	31%	69%	44%	56%	72%	28%	45%	55%
National	33%	67%	47%	53%	71%	29%	48%	52%

H 2019	Biology		Chemistry		Physics		Mathematics	
	Male	Female	Male	Female	Male	Female	Male	Female
School	31%	69%	14%	86%	71%	29%	22%	78%
Local Authority	34%	66%	40%	60%	70%	30%	49%	51%
National	33%	67%	47%	53%	73%	27%	52%	48%

These statistics show the uniqueness of our school. Our year groups do tend to have a higher proportion of males, in these statistics the N5 base cohort = 61% boys and 39% girls. The Higher cohort 52% males and 48% females. However, this is for the number enrolled in that year group so doesn't take into consideration pupils who have left, again the majority of which are male. Focusing on Physics statistics it is evident that girls are firmly in the minority across both levels and at school, local authority and national level. 2019 saw an improvement with 29% of girls studying Higher physics but looking at the 0% N5 Physics there are no females to progress into H for 2020. There is always the option for females who studied Higher Chemistry and Higher Biology to crash Physics. The mathematics statistics have been included due to the transferable skills between Maths and Physics. This is an area we need to explore further and promote Physics to female pupils with a love of Maths.

As PT Science, I am interested in all the Sciences, and in N5 our Chemistry and Biology numbers are fairly balanced, and a different picture to the imbalance at local authority and national level. This could suggest that perhaps male pupils in our school are not influenced by teacher gender in the same way females may be or that we pitch our subject equally to both genders. The numbers are more female heavy at Higher level so this is a window of opportunity to investigate what subjects males are carrying on instead and reasons for this.

### **Summary of Data Collection**

The data for S3 subject choices and insight statistics does show that the problem with girls in Physics as expected. Surprisingly, this is not reflective in Maths numbers which have a similar skill set. Our maths department is all female teachers, so could this be a factor? Or is it simply that Maths is viewed as a more useful subject? This will require further research. Pupils are also choosing not to study Physics when they have proven to be the strongest in this area of Science. Reasons for this will be explored in the pupil section. What does not appear to be a major problem in our school setting is the number of Males in Biology. Our school has a fantastic sports community and pe department. I believe the link between Biology and Pe is the reason behind our higher male numbers. As a Biology teacher, it does concern me that there is not the same initiatives and research behind getting males into Biology at a national level when these figures are not far removed from female Physics statistics.

### **4.2. Staff Audit and Consultation**

Our Science department fully fits the gender stereotype, where our 1 Physics teacher is male, and our 5 teachers across Biology and Chemistry are all female. After discussion, it was also found that of the 5 female teachers, every one studied Biology and Chemistry at Higher level. One teacher did Higher Physics in her 6<sup>th</sup> school year. This opened the open discussion about our confidence in teaching the Physics topics and promoting the subject (Sanders, et al., 1993). Although at BGE level everyone reported feeling knowledgeable enough to cover the key content, admittedly there was less discussion and room for exploring thoughts, ideas and challenging misconceptions. Teachers are always reminded not to have favourites and treat everyone fairly, but to introduce the idea of unconscious bias I gave everyone a post-it note and asked them to write the name of the first pupils who came into their head. The results showed 3 female pupils and 2 males (I did not take part). On further investigation, this revealed that the male teacher had picked a male pupil and 2/3 female teachers picked a female. It was at this point I used some of the examples from the Gender Balance twilights and directed them to the unconscious bias survey. By the next meeting, everyone was quite enthusiastic about exploring gender balance further. We all consulted the Inclusive Teaching Tips for teacher's poster created by the Institute of Physics and decided to have it displayed in every classroom. It was agreed that in future we would challenge our unconscious bias within our teaching. As a department and from pupil evidence it was clear pupils very quickly identified teachers as the "Biology one" etc, so we want to change our image in the BGE to being "all-round" Science teachers. We feel that we need to upskill in our non-subject specialisms and are planning "teach the teacher" sessions and will actively seek CPD opportunities (Millar, 1988). Some teachers admitted when a question was asked in a topic out with their specialism they would say "Go ask Mr/Mrs \*\*\*\*\*, he/she is



the expert in that area.” Instead, we are creating a post box display board in the corridor entitled “Ask the expert.” We hope that this removes tying teachers to specific areas and could also involve senior pupils.

The focus is on Science in this study, but speaking to teachers of other gender-biased subjects including Technical, Home Economics and Hairdressing, one of the main issues they perceived to be the problem was stereotypes and stigma attached to some subjects. All these teachers spoke of pupils who were gifted in the subject at BGE level (when it is mandatory), but then dropped it in favour of a more gender suitable subject as they progressed through school. They also discussed the impact of peer groups and self-awareness that often is not present in the younger pupils and most definitely not in the primary pupils when they come for visits. After a quick discussion of statistics females in our school are simply not represented in Technical, and likewise for males in Hairdressing/Home Economics. The question is whether this imbalance should be challenged or simply accepted that pupils have freedom of choice and personal interest lead them down a similar path (Su & Rounds, 2015).

Pastoral Care teachers have a vital role during option choice interviews. They must balance the right to choose whilst also making sure that pupils are making informed decisions and thinking towards the future. For a small percentage of pupils, pastoral care admitted that the option forms simply do not work. This was for a variety of reasons including, providing a range of subjects, ability, career choices etc. Many pupils also enter these interviews and make these life-shaping decisions, with no idea what career path they want to go down. Pastoral care said they often hear responses like “my mum wants me to” or “I’m not doing that if my friends aren’t” and unfortunately this is simply the influences and pressures that young people are under. No one can recall a pupil picking a teacher because they are male or female but reported that pupils have clear favourites and will often choose because of this. However, it is not an obvious girl picking female teachers and boys picking males, it is mixed and accountable to close working relationships - which could somewhat be influenced by gender.

### **4.3. Pupil Interviews**

During the learner conversations with S1 pupils, pupils could tell me the subject specialism of their specific teacher. They did not know the specialisms of all teachers in the department. They said they knew this because they had asked the teacher or because of signs in the classroom. However, when discussing the 3 Science topics they had covered the majority of pupils struggled to identify which specialism it fitted. This suggests that we will need to make more explicit links between the topics and specialisms, at the same time as introducing role models (out with the teachers in the department) and careers linked to that topic. When asked what their favourite Science was 75% picked Chemistry, 17% picked Biology and 8% picked

Physics. For this study, it is important to note that it was females who picked Biology and a male who picked Physics. The main reason for 75% picking Chemistry was due to the experiments, most commonly Bunsen Burners. It could be that the novelty wears off by the time pupils are picking subjects and that's why it becomes more balanced, or that we should revisit our Biology and Physics S1 topics to ensure they have plenty of experimental opportunities. Interestingly, when asked if teacher gender mattered 100% said no, but when asked if they would pick a subject if they were the only girl/boy in the class 85% said they would change their mind. This suggests that there could be pupils not doing a subject they would like to due to imbalance in that subject and their insecurities about being the minority group.

The S2 interviews were much more insightful as they were currently going through the option choice process. The pupils were asked at the beginning of S2 which Science they will pick and by March when they picked their subjects, 100% picked that same Science. Again, male numbers were higher in physics with only one female opting to study the subject. Figure 5 below shows the responses to a survey of Biology students.

Figure 5: Forms Survey of pupils who picked Biology for S3 Science

7. Why did you pick Biology? You can pick more than one	
I didn't know what else to pick, I don't know	<a href="#">1 response</a>
I don't know	<a href="#">3 responses</a>
I find it interesting, I find it easiest	<a href="#">4 responses</a>
I find it interesting	<a href="#">11 responses</a>
The job I want to do, I find it interesting, I find it easiest	<a href="#">1 response</a>
The job I want to do, I find it interesting	<a href="#">7 responses</a>
The job I want to do, The teachers, I find it interesting	<a href="#">2 responses</a>
The job I want to do	<a href="#">3 responses</a>

*\*\*Note not all students completed the survey which was sent out remotely due to COVID-19. However, the majority picked the subject based on their interest and intended career path. Only 2 pupils noted the teachers as having an influence on their choice and a few were unsure why they picked it.*

In line with this study but completely consequential, we had 4 students this year, two of which opposed the stereotype. We had a female Physics student and a male Biology student. Unfortunately, when the BGE pupils were asked to vote on which Science the teachers specialised in, they all voted in line with the stereotype. It was also interesting that Chemistry was not considered at this point with pupils simply pigeon-holing the female teacher into Biology, and male Physics. However, this could be merely down to learned behaviour and what they currently experience. It would be interesting to explore the stereotype further and when it arises.

## **5. Conclusion**

This study aimed to explore the gender imbalance in Sciences, within my school setting. Females are poorly represented in the Physics sector, but less often published the male numbers in Biology are not far apart. There are many influences in a young person's life that can impact on their choices. The focus of this study was to investigate whether the gender of the teacher has an impact on Science subject choice. On the whole, it would seem that this is not a major influence on pupil decision, but they are aware of the different teacher specialisms and have some unconscious gender bias themselves. As teachers, we accept that we are probably all guilty of trying to promote our own subject against others, but we should make sure that it is fully inclusive and that we challenge gender inequality. As a result of the study, I am not convinced that the gender of the teacher has a major impact on the subject choices in the Science sector but I am definitely intrigued and determined to investigate the reason for bias further. This study was somewhat limited due to coronavirus, as I had intended to investigate teacher gender in Science across the local authority. Regardless, it would be impossible to conclude that decisions are purely down to teacher as there are many other influences.

Moving forward as a department we are making a conscious effort to challenge gender bias and make sure that we are fully inclusive. As part of the Developing Young Workforce (DYW) initiative, we have introduced career profiles for both genders to all BGE subjects. We are also revisiting content to make sure it appeals to both genders. Moving forward in my own professional learning and enquiry, I hope to explore the influence of parents on pupil decisions. It has been clear in this research that stereotypes are embedded and to address this there is a need to discover when they arise and how we address this in education. Early education is the entry point if we hope to change stereotypes and initiate change in

secondary school. Research into STEM delivery in primaries also referenced the gender debate (Scottish Parliament, 2019).

The gender imbalance has been present in Science for years, and to some extent, it is likely it will continue to some degree. However, it is our professional responsibility to challenge stereotypes and provide a fully inclusive learning environment where young people are empowered to make choices for themselves.

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