What can teacher nominations for a science prize reveal about perceptions of primary science over time?

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Abstract

This article is an analysis of data from teacher nominations of their chosen student scientist of the year. With seven years of the School Physicist of the Year (SPOTY) data to draw upon, several trends and patterns emerge that allow critical reflection on local science interventions during that time. Findings include an increasing profile for primary science, but also a lack of young female student nominations in the primary education phase. The authors consider evidence of any shift in primary teacher perceptions of what science is, who science is for, and how primary science is valued across the city of Stoke-on-Trent.

Keywords: Science capital, community, unconscious bias, crossing boundaries, science identity

What is SPOTY?

The School Physicist of the Year (SPOTY) is an annual awards event, now in its seventh year (hosted by Keele University) and supported by The Ogden Trust and, more recently, Science Across the City (SATC). SPOTY is designed to celebrate the outstanding effort and achievements of science (physics) students currently in Year 6 (ages 10-11) or Year 10 (ages 14-15) at schools within a given radius of Keele University. The Ogden Trust has previously provided funding for similar SPOTY events across the country; however, this paper considers data from the Stoke-on-Trent events only.

How is SPOTY organised?

All eligible schools are notified by letter of a timeframe within which to nominate a student for the SPOTY award. Social media forums are utilised to raise awareness of SPOTY. The guidance to schools invites the teacher to select one student who they feel deserves to be recognised for their efforts and achievements in science. The guidance states that this does not necessarily need to be the highest achieving student academically, and encourages that the focus is on significant improvement or demonstrated enjoyment and great interest in the subject. The letter and associated guidance have remained consistent over time and the letters for secondary phase and primary phase only differ by the use of Year 6 or Year 10 in the target group. The nomination form requires contact details along with a 'long paragraph' response for the teacher to add in an explanation of their choice. All nominated students are successful and are invited to receive the award at the formal certificate evening.

Why does SPOTY exist?

It is well documented that the number of young people studying A-level physics (ages 16-18) has been stagnant for decades (Ofqual, 2021). This has contributed in part to the so-called STEM skills shortage (UKCES, 2015), as low numbers of A-level physics students lead to low numbers of physics undergraduate students, ultimately meaning that tens of thousands of crucial STEM jobs remain unfulfilled. This pipeline of physics graduates provided the initial stimulus for setting up the SPOTY awards, but the programme should now be considered in the broader context of supporting interest in science.

In Stoke, SPOTY was included as part of an outreach programme focused on raising and maintaining the award winners' science capital (the sum of all the science-related knowledge, attitudes, experiences and resources that an individual builds up through their life – see the Science Capital videolink below for an accessible introduction). It is proposed that SPOTY students will not only continue to enjoy the subject but, moreover, begin identifying as scientists/physicists who are therefore more likely to pursue further study and (ultimately) a STEM career. The ASPIRES Research (Archer *et al,* 2013) found that *'A student is least likely to express science aspirations if they are female, white, have low/very low levels of cultural capital, are in the bottom set and do not have any family members who use science in their jobs'* (p.3). For girls and those from some minority ethnic backgrounds, the visibility of physics role models to whom they can relate (both in the science national curriculum and broader media) is often low. SPOTY not only provides an external 'validation' of a student's effort and achievement in the subject but, through the scientist guests invited to the awards ceremony, brings them face-to-face with real, relatable and local role models.

What is SATC?

Science Across The City (SATC) was established from a DfE Opportunity Area grant in 2019, with the purpose of closing the attainment gap between students in Stoke-on-Trent and their peers nationally. The vision was to enable more school-to-school collaborative reflective learning, to engage more teachers with quality STEM CPD, to enable more school access to STEM resources and STEM pupil offers, and to empower teacher subject leaders with depth in their specialism. SATC has supported teacher professional learning, with over 85% of city schools engaged in at least one of following formal CPD interventions: Thinking Doing Talking Science (EEF, 2022), TAPS (TAPS, 2022) and PSQM (EEF, 2020).

Why does SATC exist?

Science in primary schools is known and reported as being too often overlooked in favour of English and mathematics. Amanda Spielman, in her commentary on the Annual Report (2020), states that Ofsted saw both the quantity and quality of science teaching reduced (Ofsted, 2020). Science across the City focused city-wide strategic attention to the forgotten core subject by engaging at Headteacher and city governance forums alongside the English and mathematics improvement teams.

Investing in teacher professional development has potential long-term sustainable gains, as it is not only the current pupil cohort that benefits, but also ongoing future cohorts too. SATC adopted the DfE values for effective CPD, ensuring expertise, collaboration, sustainability over time and senior leader commitment (DfE, 2016). Improving teacher quality through school-based teacher learning communities is argued as essential to a culture of continuous development by Dylan Wiliams (Wiliams, 2010). SATC, as its model of change, established a community of science leaders who share and support beyond their own schools. This community, known as the SATC science influencers (SATC, 2020), supports rapid transfer of messages and signposting between peers.

Method

Data existed that had been collected each year from 2016 to 2022 for the purpose of managing the success of the SPOTY awards events. Anonymised data were stored securely, with permission, enabling the authors to explore trends over time. Data each year included: the number of nominations received, the nomination written by the teacher, and the gender of the student nominated.

Given the investment in primary science in Stoke-on-Trent during 2019-2022, the authors looked for patterns over time, to consider whether there were any discernible changes to the participant engagement in SPOTY.

Three themes are considered in the findings below:

- Over time, was interest in the SPOTY awards for primary science in schools increasing?
- What features do teachers describe in their nomination of a 'good scientist'?
- Over time, have there been changes in the proportion of girls and boys nominated?

Findings

Table 1. Number of SPOTY nominations annually.

SPOTY year	Date	No. of teacher nominations	Average word count per teacher nomination	No. of boys: girls nominated by their teacher	
				Boys	Girls
1st	July 2016	8	63	5	3
2nd	July 2017	23	79	20	3
3rd	July 2018	25	51	19	6
4th	July 2019	27	62	15	12
5th	July 2020	36	64	26	10
6th	July 2021	54	63	35	19
7th	July 2022	42	60	30	12

1. *The increasing profile of primary science*

The very first Keele SPOTY awards, held in 2016, saw just 8 nominations (see Table 1). This grew slowly over the next four years and, in 2020, there were 36 SPOTY award winners. Through collaboration with SATC in 2021, there was a significant increase in the number of nominations, up to 54 (Figure 1), suggesting that the SATC localised community of science influencers may be helping to raise the profile of the Awards. This year, 2022, saw the first dip in nominations, with a total of 42 students recognised. This reduction in numbers is likely attributed to 'COVID-exhaustion', with the summer of 2022 being an incredibly challenging year for many students, teachers and wider school communities. SATC is seeking further funding to host a 2023 SPOTY event, which may provide an opportunity to explore if this was a COVID dip and if the numbers can climb again beyond the previous best total.

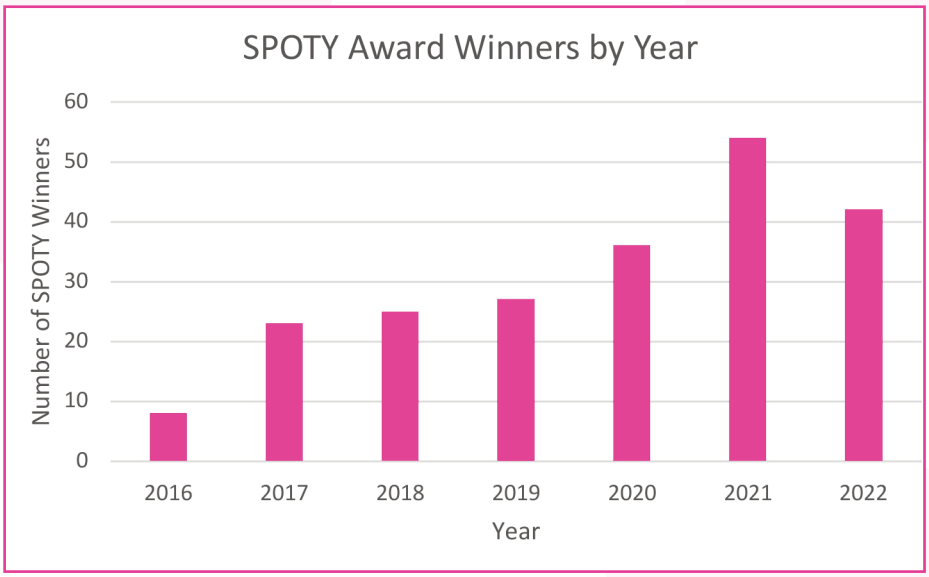

Figure 1. The number of SPOTY nominations made annually since launching in 2016.

2. *Teacher perception of what it means to be a 'good scientist'*

In 2018, the average number of words written by a teacher for a SPOTY nomination was ~51. This rose to ~62 in 2019, where it has remained approximately stable since (Table 1). This year, the average was 60. As can be seen in the SPOTY nominations from teachers (see Table 2), there is overwhelming reference to the nature of scientific method, with many teachers noting question-asking, problem-solving and authentic curiosity. Scientific behaviours are celebrated, and these traits are associated with the identity of being a scientist, and essential in the study of science at all levels. Of particular interest is the recognition that children engage in science outside the classroom and there is clearly an appetite for reading about and engaging in science beyond the formal curriculum.

Table 2. Sample narratives from the teacher SPOTY nominations.

SPOTY Award Winners 2022: Examples of teacher nominations

Child A stands out as being passionate about science. A takes part in science club, on many occasions she completed questions at home to ask visiting scientists. A expressed in parents evening with mum that she aspires to be a scientist in the future as she loves to experiment. She especially enjoys working practically and loves to question and predict during science experiments. Curious about the world around her. She loves to problem-solve and communicates with clear enthusiasm about her findings.

Child B is an amazing scientist, always asking questions, pondering on ideas and thinking about what might happen if… He often arrives at school asking about things he has researched, especially about space. I even gave him some books by Dr. Brian Cox, which he said he had really enjoyed reading. In science lessons B studies hard and comes up with amazing ideas that are always followed by more questions! He is, in my opinion, a scientist of the future.

Child C demonstrates a huge amount of enthusiasm for science. He has taken on the role of a Science Ambassador with dedication. He is always keen to find out information regarding the science topics that he is learning about and asks about his role as Science Ambassador regularly. Our school can always rely on him to discuss science with visitors to our school. He is a true scientist in every respect.

Child D began the year with little confidence in science. After staff have implemented the Thinking, Doing, Talking Science approach through activities such as bright ideas time and odd one out, D has flourished in science lessons. She has explained that she now feels that she can have a go in science without worrying that she might be wrong. D has even worked hard at home to produce a fantastic poster celebrating the work of primatologist Jane Goodall. D loved having the opportunity to share this with different classes around our school and this work then started a whole school celebration of the role of women in science.

Child E has a keen interest in science and will often watch *YouTube* videos at home to learn more about the current topic. He is so passionate about the subject that he has initiated a science club to run on Friday afternoons. At his request, he has sat with the teacher to choose a variety of science experiments to conduct, and a list of resources needed. E is eager to take the lead in the club, with support from his teacher. In his own words, he 'wishes he could just do science for every lesson'

3. *Unconscious bias a barrier for young female scientists*

With seven years of data to draw upon, several trends and patterns have clearly emerged. Alarmingly, the data show an unequal numbers of female students being recognised in comparison with their male counterparts (Figures 2 and 3). For example, in Year 6, only 6 out of 30 (20%) SPOTY nominations this year went to female students. This is entirely consistent with the Year 6 long-term average of just ~21%, with the largest percentage of ~35% seen in 2019. However, there is a stark and striking difference when

comparing these data with those of the Year 10 equivalent. Interestingly, if you are a female student, you are twice as likely to be nominated by your teacher in Year 10 as you are in Year 6, with the 7-year Year 10 SPOTY female nomination average being ~41%. The 2022 figure was exactly 50%, thus young female Year 10 scientists were equally as likely to receive the award as their male colleagues.

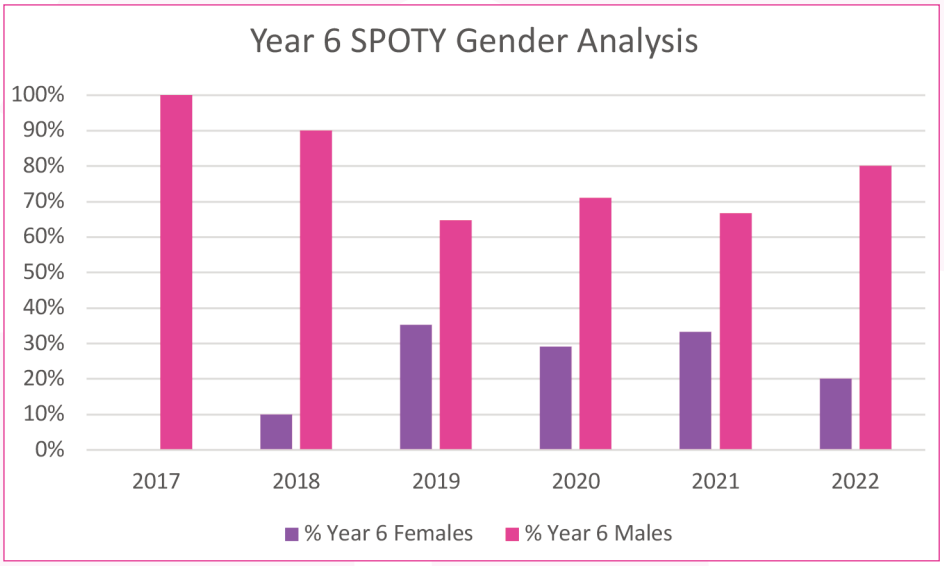

Figure 2. A comparison of percentage male to female SPOTY nominations (Year 6) recorded annually since launching the award in 2016.

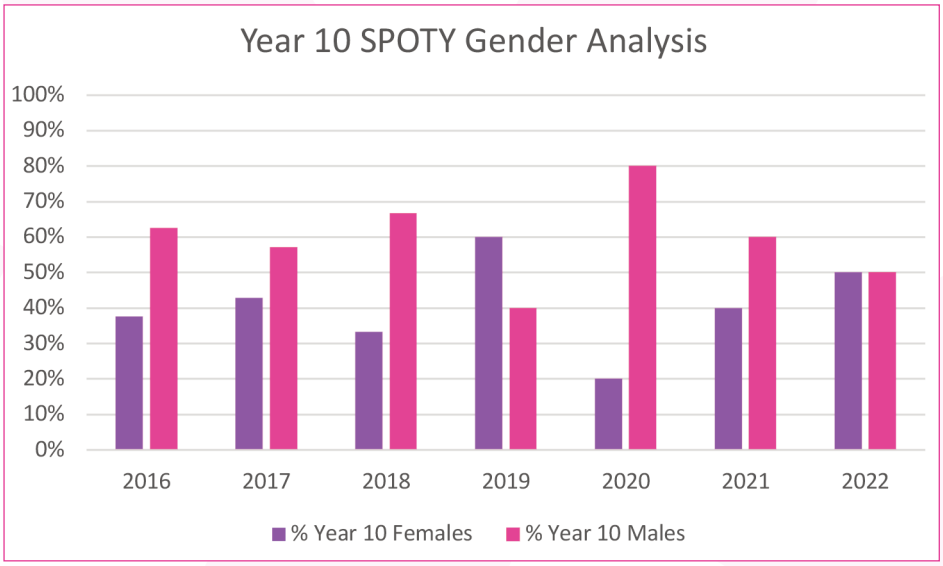

Figure 3. A comparison of percentage male to female SPOTY nominations (Year 10) recorded annually since launching the award in 2016.

Conclusions

Was the profile of the SPOTY awards and primary science increased?

The change over time trend of increased nominations provides evidence for the increasing profile of primary science in Stoke-on-Trent. The authors propose that localised, personalised and trusted messengers matter. They have found that organisations working together can simplify and align key messages to and for teachers:

'It isn't about everybody doing everything but knowing who is doing what best!' (Headteacher, SATC advisory group).

'So many e-mails – we used to ignore most of them but knowing that the messenger knows my needs makes a huge difference to my workload and focus' (Subject leader and science influencer, Stoke-on-Trent).

The authors believe that organisations with a good STEM offer might consider increasing their reach through a community of lead teachers as the respected knowledgeable others. Involving teachers as integral to supporting and influencing other teachers is empathetic, realistic and well-informed.

Did the quality of teacher explanation of a 'good scientist' change?

In response to the line of enquiry, it was noted that quantity of explanation increased over time and the teacher narrative examples included a broad view of science that aligned with SATC values. SPOTY is additional to and supporting of a wider SATC evidence base that investment in sustained professional development improves teacher understanding of the discipline of science (DFE, 2022). The evidence informs an interesting hypothesis, but is not sufficient for discussion of causation, thus further research is needed.

Is unconscious bias for STEM participation a diminishing concern?

The gender findings were unexpected. The SPOTY data analysis poses important questions around (un)conscious biases of primary (science) teachers with respect to who is perceived to be the 'scientists' in their classrooms. Is it possible that 'non-science specialists', as is the case for many primary science practitioners, are themselves directly subject to long-standing, deeply engrained conceptions of who (white, bearded, middle-class, men) and what (white coats, safety goggle-wearing, lab-based) science is? This is particularly notable given that 69.5% of teachers are female, which rises to 82.4% in primary schools (DfE, 2020), where you might expect there to be a positive bias towards female teachers nominating female students.

There is insufficient data to identify whether there is a connection between a teacher holding a degree in a science discipline (the raising of their own science capital through the process) and their likelihood to nominate a female student.

The authors propose that these data provide an alarm-raising call for action, yet more intervention to raise the science capital of under-represented groups in science/physics (such as women) should not be undertaken in isolation from broader awareness-raising and development work with teachers, and the wider school community, so that this capital can be readily recognised, supported and promoted.

Discussion

One of the aims of SPOTY was to increase the science capital of the young person receiving the award. As such, it has always been made clear to the nominating teachers that the SPOTY nominee should *not* necessarily be the highest attaining science student, as there is an assumption that this person may already have higher levels of science capital compared to their cohort. However, by essentially providing no nomination criteria, and leaving this entirely up to the interpretation of the nominating teacher, this may provide an opportunity for unconscious bias[es] to influence their nominations. That said, the authors are mindful that, by providing prescriptive nomination criteria, there is an increasing likelihood that students who achieve higher grades, engage in lessons more actively (or have the confidence to do so) and/or have perceived or actual elevated levels of good behaviour within the classroom, are by proxy likely to be those with higher science capital and therefore the award would reinforce the current STEM meritocracy, as opposed to challenging this, with the many social benefits that such a challenge brings (Reay, 2020).

In 2021, SATC invested in many schools participating in CPD on the theme of unconscious bias. The authors anticipated a shift towards more female nominations. However, given that the data show that the gender bias in Year 6 nominations is as stark as it has ever been, there are inferences here that this training has raised awareness of unconscious bias, but has done little to effect change in behaviour (Fitzgerald, 2019).

What next?

With further iterations of SPOTY, the authors would be keen to complete more extensive scrutiny beyond the limitations of the dataset available. In planning further exploration, the following lenses might be of interest: Does the gender of the nominating teacher affect nomination choice? Does the science specialism affect nomination choice? Does the age demographic affect nomination choice? Does teacher science capital affect nomination choice?

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