Do teachers and mothers overestimate boys' and underestimate girls' mathematics performance?

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Introduction

In their report on the Leaving Certificate results and the standardisation process undertaken, the State Examinations Commission (2021) note that research suggests that unconscious estimation bias in such contexts are generally in the direction of favouring female students. Further, they state "knowing that such unconscious bias might come into play and that it would not be possible to address it during standardisation … the Department made strong efforts to mitigate such difficulties by means of the guidance offered to schools in both 2020 and 2021" (SEC, 2021, p.59). These assumptions of unconscious gender bias are problematic in a society where, despite girls' superior educational achievements, they are under-represented in senior positions in most institutional structures. Our research, on estimations of mathematics performance for children in the mid-primary years, recently published in *Oxford Review of Education*[2] (McCoy, Byrne, O'Connor, 2021) provides evidence of gender bias, but operating in favour of boys not girls.

It is widely accepted that mathematics is a gender marked subject in that achievements in the area are seen as indicative of boys' 'natural' ability. Using data on 8,500 nine-year-old children from the *Growing Up in Ireland* study, our research examines whether primary caregivers[3] and teachers are less likely to perceive girls' mathematics achievements as excellent/above average than boys', taking account of girls' and boys' actual performance on nationally validated standardised tests. The

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[2] The vast majority (99%) of primary caregivers were mothers, so henceforth we refer to mothers.

evidence reveals that teachers and mothers have lower assessments of girls' performance, taking account of their mathematics achievement, school engagement, liking for mathematics, self-concept and their economic, educational and cultural background. Gender stereotypes are used as an explanatory concept to understand the over-estimation of boys' mathematics performance and the under-estimation of girls' performance.

International evidence

Children's mathematical performance has attracted a good deal of attention nationally and internationally (Borgonovi et al., 2018; OECD, 2015). Cross-cultural research has traditionally shown that parents impart, and children take on, the view that boys are good at mathematics from a very young age (Muntoni & Retelsdorf, 2019). In Finland, despite girls' and boys' equal school performance in mathematics, parents' explain girls' mathematics accomplishments by referring to hard work and boys' by references to their natural ability (Räty & Kasanen, 2007). Primary school mathematics teachers also see boys as better at mathematics (Hyde et al., 2009; Guiso et al., 2008). The evidence is not unambiguous, but a range of studies find that teachers tend to associate 'natural mathematical' ability with boys more often than girls (Tiedemann, 2002) and explicitly stereotype mathematics as a male domain (Leedy et al., 2003). Timmermans et al., (2016) found that girls' compliance and work orientation can increase teacher's perceptions of their ability, while Tiedemann (2000) found that teachers attributed girls' failure to low ability but boys' failure to effort-arguably ultimately reflecting gender stereotypes. Among US children, Cimpian et al. (2016) showed that teachers consistently rated girls' mathematical proficiency lower than that of boys with similar achievement, with a particular reluctance to identify girls as excellent. Holder and Kessels (2017) also found that teachers saw male students as performing better in mathematics than female students despite similarities in their actual achievements.

Mathematics is the most 'gender marked' subject (Räty and Kärkkäinen 2011) and is seen as a 'true' indicator of innate intelligence. Boys do better than girls in mathematics at the highest level other than in a small number of countries such as Sweden (OECD, 2015) where gender stereotypes are weaker than in Ireland (O'Connor and Goransson, 2015). The stereotype of boys' 'innate' male intelligence is

reflected in perceptions of their 'natural' mathematical ability. These perceptions of gender differences may both affect and reflect actual achievement (OECD, 2015). Insofar, as performances conform to stereotypes, they are seen as 'natural' and 'inevitable'. Boys' above average performance at mathematics is compatible with the stereotype in a way that girls' above average performance in this area is not. In an era of increasing gender fluidity, binary gender stereotypes appear increasingly archaic but none the less persist in the home and the school.

Our research draws on a feminist institutionalism perspective, which is concerned with 'the gendered patterning of institutional rules and norms' (Mackay et al., 2010, p. 581; Krook and Mackay 2011). We use a 'performative concept' of gender as something people 'do' or 'perform'. Thus, what comes to be seen as natural is in fact a social accomplishment, achieved through constant repetition and regulation. Many of these patterns reflect gender stereotypes. Such gender stereotypes do not simply define boys and girls as different; they implicitly define boys as superior to girls. This gender order (Connell (2005, 13) is part of young people's lives. Families and schools reflect and reinforce it. In it what Connell (1995, 82) calls 'a patriarchal dividend' persists, from which the majority of men benefit 'in terms of honour, prestige or the right to command. [They] men also gain a material dividend.' Among young men, this dividend is less tangible but can be seen as reflected in an over-estimation of their abilities and/or in the value of such abilities.

Data and Methods

Our paper utilises data on 8,500 9-year-old children from the *Growing Up in Ireland* study to examine how mothers and teachers rate boys' and girls' mathematics performance. The children were surveyed in 2007/2008, and detailed information was gathered from them, their parents and teachers. Each child's teacher was asked 'How would you rate the study child's performance in mathematics relative to children in his/her age group?', to which they could respond 'below average', 'average' and 'above average'. Mothers were also asked: 'How well is the child doing in mathematics relative to other children of their age?', to which they could respond 'poor', 'below average', 'average', 'above average' and 'excellent'. We looked at the relationship between mothers' and teachers' perceptions of these nine-year-olds'

mathematics performance and the children's own actual performance in mathematics using standardised and widely used mathematics tests. We also included measures of their liking of mathematics, their self-concept, school attendance and homework completion and their economic, educational and cultural background. Taking these factors into account, we can see if boys or girls are more likely to be rated as excellent in mathematics by their mothers or above average by their teachers.

Findings

Overall, boys demonstrate higher mathematics achievements and more positive attitudes towards mathematics compared to girls. However, the evidence also shows that girls' mathematics performance, relative to boys', is underestimated particularly by mothers, but also by teachers. Both rate boys more highly than girls, at all levels of achievement, and disparities are particularly pronounced among high achieving girls. The judgments partly reflect children's actual performance on standardised tests and their liking for the subject, but a notable gender gap remains in favour of boys. It is suggested that gender stereotypes are affecting the overestimation of boys' and the underestimation of girls' mathematics performance.

More specifically the paper shows that mothers and teachers are 1.3 and 1.5 times (respectively) more likely to rate boys as 'excellent' or 'above average' in mathematics than girls. While mothers and teachers use actual mathematics achievement, as well as children's liking for mathematics, diligence at school and self-concept to inform their perceptions, when comparing like-with-like, girls are underrated in mathematics relative to their academically similar male peers. This study thus supports the evidence of studies by Cimpian et al. (2016) and Tiedemann (2000, 2002), among others, showing gender bias in teacher and parent perceptions of performance, over-estimating the boys' performance and under-estimating the girls'. We find that female teachers are less likely than male teachers to rate nine-year-old children as 'above average' in mathematics, perhaps reflecting women's internalised devaluation of themselves: with their reluctance to identify excellence reflecting their own stereotypical lack of confidence as professional women making such assessments in mathematics. Mothers' gender bias is particularly evident among daughters who are the highest mathematics achievers and is highest among mothers with higher

education. Finally, gender bias is more evident among mothers than teachers, presumably because mothers have less day-to-day evidence of their children's mathematics performance. As found by Tiedemann (2000, 2002), Räty, (2006), and others, it appears that mothers, who are the major figures in most nine-year-olds lives, endorse gendered stereotypes about mathematics, leading them to underestimate high achieving girls' mathematics performance.

Policy implications

Mathematical ability is widely perceived as a marker of intelligence. In Ireland this is reflected in the fact that bonus points are attached to young people's performance in this area on the Leaving Certificate exam. Girls are significantly less likely to take the higher-level course in mathematics and hence to be potentially eligible for these bonus points (McCoy et al., 2019, 9). The fact that as early as nine years old, high achieving girls' performance at mathematics is being underestimated by both mothers and teachers is worrying. The fact that this effect is mediated through primary caregivers (who are mainly women) and particularly through female primary teachers illustrates the way in which women can (inadvertently) perpetuate a system which devalues girls by perpetuating such gendered stereotypes.

It is highly likely that this will impact on girls' subsequent performance. It will certainly impact on their career choice, since mathematics is seen as a key element in pursuing highly valued careers in Science, Technology, Engineering and Mathematics. Thus, calls for girls by nation states in Western society, including the EU, to consider such careers are likely to be ineffective. Girls from as young as nine years old will have learned that even if they excel in this area, their teachers and mothers will not necessarily perceive them as such. They may well feel that they are better off choosing areas which are more compatible with existing gender stereotypes: thus, in many cases perpetuating their position in lower paid and potentially less personally satisfying career positions. The evidence from this and other research may help in raising awareness about the often unconscious and 'taken for granted' way in which stereotyping operates. In particular, the results highlight a role for teacher education, in challenging stereotypes around maths performance and in particular the view that mathematics achievements reflect 'natural' ability and encouraging female

teachers to transcend their lack of confidence in assessing excellence in mathematics performance. It also highlights the importance of encouraging mothers to take seriously their daughters' performance on nationally validated tests.

For educators, this research raises important questions about the conditions under which gender stereotypes are reinforced or challenged by schools and the part played by teachers and mothers in perpetuating such stereotypes. It also raises troubling questions about the observation by the State Examinations Commission (2021) that girls' performance in the Leaving Certificate reflects the existence of estimation bias in favour of girls. At least in the case of nine-year-olds' mathematics performance, the evidence is in the opposite direction.

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