WHO IS BEST IN MATHEMATICS? GRADE NINE STUDENTS' ATTITUDES ABOUT BOYS, GIRLS AND MATHEMATICS

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Sweden has a reputation for its equality work, but at the same time mathematics is still considered a male domain. We studied grade nine students' attitudes about who could be considered best in mathematics, both from an individual perspective and how they perceived different groups in society would answer. A questionnaire was used and the analysis showed that girls more often think that this is not a matter connected to biological sex, whereas boys more often state that boys and girls are equally good. Two groups are stereotyped as thinking that boys are better in mathematics both by girls and boys: boys in grade nine and boys in general. This is not reflected in their self-evaluation. Overall, the students showed an awareness of the concept of gender, including some intra-cultural dimensions of the concept.

INTRODUCTION

In many western countries, although there is no major differences in achievements in mathematics (OECD, 2013), the subject is often considered as a male domain; for instance, there are differences in enrolment in various STEM subjects, both at undergraduate level and at graduate level (Piatek-Jimenez, 2015), and stereotypical symbols have been attributed to boys and girls, such that boys are creative and girls insecure (Walkerdine, 1998; Sumpter, 2016). Another example is that boys express a higher degree of ability and self-confidence compared to girls (OECD, 2013). In this way, gender is an issue relevant for research and discussion. This is true for Sweden too, which is interesting given it is a country with reputation for its work regarding gender equality (Weiner, 2005). In the curriculum for Swedish school, we can read that teachers should actively work to enhance and develop students' critical thinking about gender stereotypes and this has been a central topic in governing school documents for over 50 years (Hedlin, 2013). Previous studies signal that students at different ages consider mathematics as a male domain (Brandell, Leder & Nyström; 2007; Brandell, 2008) including boys reporting higher levels in measures of self-evaluation (OECD, 2013; Sumpter, 2012), this despite that girls' grades are higher throughout secondary school (age 13-19). At the same time, teachers state that gender is not an issue neither in their teaching nor for themselves as teachers (Gannerud, 2009).

Therefore, there is a paradox between the social, political norm and the symbols that individuals express including gender stereotyping. This paradox invites to further study how individuals perceive that different groups in the society view mathematics and gender, and how individuals would reply from their own perspective. Here, we would like to study grade nine students' expressed attitudes with a focus on attributed ability

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in mathematics. Our research questions are: (1) In what way do boys and girls attribution differ regarding ability in mathematics?; (2) How do they experience other groups attributions?; and, (3) To what extent do students express that this has changed over time?.

BACKGROUND

Our theoretical starting point is that gender is a social construction more than just a consequence of a biological sex, that gender is:

> "a pattern of social relations in which the positions of women and men are defined, the cultural meanings of being a man and a woman are negotiated, and their trajectories through life are mapped out." (Connell, 2006, p. 839).

These social relations include characteristics and traits that are cultural dependent, and in a longer time perspective, they create norms. This is a dynamic process meaning that the attributions, beliefs, identities, norms etc. are not static and as socially constructed differences, they support differences and inequality (Acker, 2006). In order to study attributed symbols, a further division of gender is fruitful. Here, we follow Bjerrum Nielsen (2003) and divide gender into four different aspects: structural, symbolic, personal, and interactional gender. The first aspect, structural gender, is about social structures alongside with other factors such as class end ethnicity. One example of structural gender is the ratio men/women in enrolments in mathematics. The second aspect is symbolic gender which appears in the shape of symbols and discourses. It informs us what is considered normal and what is deviant (Bjerrum Nielsen, 2003). One example is the idea of mathematics as a male domain (Brandell, Leder & Nyström, 2007; Brandell, 2008). Symbols as such can be very powerful; studies have shown that the main reason for gender imbalance at university level is the explanation for success that uses the two symbols 'the hard working female' (e.g. Hermione Granger) and 'the male genius' (e.g. Sherlock Holmes) (Leslie, Cimpian, Meyer & Freeland, 2015). The third aspect is personal gender which looks at how individuals perceive the structure with its symbols (Bjerrum Nielsen, 2003). Given it is a dynamic process, the structure and symbols can influence and change which in turn affects personal gender.The following quote illustrates the experience of not fitting in to the created norm:

> An advantage of being male would be to have been more encouraged to pursue a career in mathematics/engineering/technology. I would also have fitted in at high school better than I did—my Years 9 and 10 were spent on an all-girls campus where it was supremely uncool to be good at maths and science (Leder, 2010, p.453).

The last aspect described by Bjerrum Nielsen (2003) is interactional gender which focus on interactions of individuals within the structure with its symbols. In the present paper, we are interested in how individuals perceive themselves in the structure (i.e. personal gender) and symbols including stereotyping (i.e. symbolic gender).

METHODS

The first step towards the data collection was a pilot study where a well-known questionnaire was used with the intention to reproduce studies of individual's attitudes about gender and mathematics (e.g. Gómez-Chacón, Leder & Forgasz, 2014). However, although following "good practices", the results indicated several limitations and not just intercultural differences but also intracultural (Nortvedt & Sumpter, 2017). The feedback stressed that "you can't ask question like this" meaning a revision was needed to make the questionnaire function in a Nordic context. A literature review showed that most prior research treat gender as a cultural-neutral construct and do not consider cultural dimensions: that questionnaires very seldom gave the respondents opportunities to demonstrate knowledge about gender beyond the classic male –female dichotomy or nuances in gender symbolism. (Sumpter & Nortvedt, 2018). We therefore applied Clarke (2013)'s seven dilemmas: (1) Cultural-specificity of cross-cultural codes; (2) Inclusive vs Distinctive; (3) Evaluative Criteria; (4) Form vs Function; (5) Linguistic Preclusion; (6) Omission; and, (7) Disconnection. One solution to meet some of these dilemmas were to apply vignettes. One example is the first question, Question 1a, "Who is best in mathematics, boys or girls?" with a vignette saying that different groups in the society might have different views of who is considered able in mathematics. By adding such a vignette, the question allows the respondent to express perceived gender stereotyping from others whilst expressing a personal attitude that might differ. The pilot study indicated that the questionnaire did allow students to demonstrate their awareness of a range of culturally rooted differences in attitudes towards boys' and girls' abilities to learn mathematics (Nortvedt & Sumpter, 2018).

To answer the research questions in the present paper, we will focus on Question 1a, "Who is best in mathematics, boys or girls?", Question 1b, "Do you think this has changed over time?" where the latter also allowed qualitative responses. We also analyse the responses to one of the background questions which was a self-evaluation. The data comes from lower secondary school students (grade 9; age 15; n=241) from seven schools in different locations in Sweden (north/south; rural/town/city). Given that online surveys have less response rate (Fan & Yan, 2010), the first author used personal contacts to find participating schools. Ethics rules provided by Swedish Research Council were followed. This means that those students who had not turned 15 before December 2019 could not participate, which according to Statistics Sweden should be around 6% of the population meaning two students per class. The statistical analysis of the replies used stated gender (boy/girl) as a factor (n=222) and we applied chi-squared test to analyse where girls' replies differ from boys. The qualitative responses were analysed using inductive thematic analysis (Braun & Clarke, 2006), and then compared to previous research as a second step. This means that we searched for similarities and differences in the written replies, gathering similar statements using a coding scheme. One example are statements that could be connected to a broader theme describing gender as a dynamic concept, where the codes were words like "change" or "difference". In this way, disjoint themes were created.

RESULTS

The first set of results focus on the attribution of ability in mathematics meaning the responses to the question "Who is best in mathematics, boys or girls?". In Table 1, G stands for Girls and B for Boys:

Groups	Girls are best	Boys are best	They are equally good	It is not about sex*	I'm not sure	*p*
Girls in grade 9	G: 27(24.5%)	7(6.4%)	19(17.3%)	**50(45.5%)**	7(6.4%)	<0.05
	B: 57(53.3%)	5(4.7%)	14(13.1%)	27(25.2%)	4(3.7%)	
Boys in grade 9	G: 17(15.6%)	**49(45.0%)**	19(17.4%)	19(17.4%)	5(5.0%)	>0.05
	B: 23(21.9%)	**45(44.9%)**	14(13.3%)	18(17.1%)	5(4.8%)	
Dads	G: 7(6.5%)	21(19.4%)	31(28.7%)	**36(33.3%)**	13(12.0%)	<0.05
	B: 17(16.3%)	27(26.0%)	**30(28.8%)**	24(23.1%)	6(5.8%)	
Mums	G: 12(24.5%)	1(0.9%)	31(28.7%)	**59(54.6%)**	5(4.6%)	<0.05
	B: 23(53%)	9(8.7%)	**40(38.5%)**	28(26.9%)	4(3.8%)	
Male teachers	G: 14(13.1%)	10(9.3%)	31(29.0%)	**48(44.9%)**	4(3.7%)	>0.05
	B: 17(16.5%)	14(13.6%)	**36(35.0%)**	32(31.1%)	4(3.9%)	
Female teachers	G: 10(9.3%)	3(2.8%)	32(29.9%)	**57(53.3%)**	5(4.7%)	<0.05
	B: 23(28.7%)	7(6.7%)	**41(39.4%)**	28(26.9%)	5(4.8%)	
Girls in general	G: 31(28.7%)	10(9.3%)	19(17.6%)	**36(33.3%)**	12(11.1%)	<0.05
	B: **44(42.3%)**	8(7.7%)	25(24.0%)	14(13.5%)	13(12.5%)	
Boys in general	G: 24(22.2%)	**40(37.8%)**	17(15.7%)	18(16.7%)	9(8.3%)	>0.05
	B: 18(17.5%)	**40(38.8%)**	22(21.4%)	12(11.7%)	11(10.7%)	
You	G: 7(6.6%)	2(1.9%)	13(12.3%)	**81(76.4%)**	3(2.8%)	<0.05
	B: 12(11.4%)	18(17.1%)	24(22.9%)	**37(35.2%)**	14(13.3%)	

Table 1: Responses to "Who is best in mathematics?", *n*(%). Total responses differ from 106-110 (girls) and 103-107 (boys).*In Swedish, there is a difference between gender ('genus') and biological sex ('kön').

The majority of boys and girls attributes no gender, both regarding what they think other groups would answer but also in their own responses. It is interesting to note that one difference between girls and boys is that girls more often has their main response ‘It is not about gender’ more often than boys, whereas boys more often choose ‘they are equally good’. A few results stand out: both girls and boys reply that boys in grade nine and in general would reply that they are better. However, when responding as themselves (as ‘you’), this is not reproduced. Instead, the majority of boys (58.1%) think it is not a question about sex or that boys and girls are equally good. Here, there is a difference between what is attributed to boys as a symbol and what could be considered as a personal view on a group level. Continuing with self-confidence and stereotyping, boys more often reply that girls in grade nine and in general would answer that girls are best in mathematics, a response pattern girls do not repeat. An interesting symmetry which is statistical significant appears in the responses about what the students think that mums and dads would reply: both boys and girls state that fathers would pick boys as better in mathematics, and for mothers to pick girls. This symmetry is not repeated regarding female and male teachers.

On the question whether this has changed over time, girls and boys differ in their responses, Se Table 2:

	Yes	No	I’m not sure	*p*
Girls	**85(75.9)**	9(8.0)	18(16.1)	<0.05
Boys	**56(50.9)**	22(20.0)	32(29.1)	

Table 2: Changed over time *n*(%).

Although the majority of both groups states “Yes”, girls do it more so. In the motivations why, the analysis generated three themes. The first theme is based on the idea that things do change over time, especially stereotypes:

> I believe that before, one thought that boys were better. Women have always been oppressed and lads were the ones who got to show that they could do maths. Lately, I think that girls also have had a chance to show that they are good at maths and humans have realised that the difference is not so big [Girl 1]; I think that everything depends on the stereotypes what is male and [what is] not. We have [previously] related that men are often best in mathematics since they used to be [Boy1].

Both these motivations show an awareness of gender as a dynamic concept and that stereotyping is a part of the this changes of power. The second category is about boys and symbols attributed to boys:

> I believe that boys normally are less interested [in school] than girls and therefore are looked upon as worse than girls. Guys live a life where you should not care about school to be considered cool. [Boy2]

In this response, there is an awareness about the relationship between symbolic gender and personal gender. The third theme is that biological sex is irrelevant:

> Biological sex should not determine your knowledge in math and there is no sex better than the other. [Girl2]

Since Swedish language uses different words for gender and biological sex, the focus here is that biological sex is extraneous in this matter. That doesn't imply that gender is not relevant.

Table 1 indicates that both boys and girls more often connect boys with the reply 'Boys are best', but when looking at responses from a personal view, this is not repeated. As a final measure, we studied girls and boys responses regarding self-evaluation (see Table 3):

	Very good	Good	Average	Below average	Weak	*p*
Girls	13(11.7)	34(30.46)	**39(35.1)**	12(10.8)	13(11.7)	>0.05
Boys	19(17.1)	26(23.4)	**40(36.0)**	10(9.0)	16(14.4)	

Table 3: Self-evalutation *n*(%).

In Table 3, most responses are 'Good' or 'Average' and the results do not significantly differ. As a summary, the students participating in this study indicated that overall, gender is not a determining factor or there is no difference between boys and girls. In their written motivation, they showed great awareness of gender as a dynamic concept. However, their responses still signalled that boys, as a group, would think that they are better in mathematics, either as a sign of self-confidence or ability.

DISCUSSION

Here, grade nine students' attitudes about boys, girls and mathematics were studied with a focus on who could be considered better in mathematics: boys or girls, if they were equally good or if the question was not about biological sex at all. The majority of the respondents picked the latter two categories, but there were some differences in their response patterns. One pattern is that although the majority of responses, both from boys and girls, signal that neither boys nor girls are better at mathematics, boys more often answered that boys and girls are equally good and girls more often state that this is not about sex. When one take this result in comparison with gender theories (e.g. Acker, 2006; Connell, 2006), it could be seen as a difference between the level of understanding of gender; that boys more often signal that there is a gender division whereas girls more often state that such division is not fruitful. Both groups, however, turn to traditional stereotypical patterns when answering the questions from a group perspective of boys in grade 9 and boys in general. Both groups are connected to the statement 'Boys are best'. This is in line with previous reports that boys more often than girls opt for higher levels in self-evaluations (OECD, 2013; Sumpter, 2012). This it is not repeated when boys answer from a personal perspective: girls and boys responses in the self-evaluation do not differ. Here, we have a variation between what is attributed and what is reported from an individual perspective. Boys also attribute similar gender stereotyping to girls, which girls do not repeat. This difference needs to be further investigated since it can inform us about intra-cultural tensions (e.g. Clarke, 2013; Nortvedt & Sumpter, 2017) or, in the light of Bjerrum Nielsen (2003) different aspects of gender, relationships between symbolic gender and personal gender.

When the students responded what they think their parents would reply, a symmetry appeared: fathers would say that boys are better in mathematics and mothers would choose girls. However, this symmetry should be viewed from the perspective that most students state that parents would express gender neutral attitudes. One possible explanation could be found in the written motivations where the main theme was that gender stereotypical views has changed in the society as a whole. The awareness of gender as a social construct, and not just a division of sex, among the 15 year olds participating in this study was impressive. When comparing to Gannerud's (2009) study where the teachers answered that gender is not an issue since the society is already equal, the students talked about an awareness of change including less oppression and how power has shifted (e.g. Acker, 2006). One possible explanation could be that this is a reflection of gender equality work in Swedish schools (e.g. Hedlin, 2013) or that progress has continued (e.g. Brandell, 2008). One implication is that if teachers want to fulfil the goals of the curriculum where it states that they should help students to critically analyse and discuss gender issues, they should be aware of that the students might have a developed gender view but that old stereotypes could still exists within this view.

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