Upper secondary school students’ gendered conceptions about mathematics

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ABSTRACT. This study explores Swedish Natural Science students’ conceptions about gender and mathematics. I conducted and compared the results from two questionnaires. The first questionnaire revealed a view of rather traditional feminities and masculinities, a result that did not repeat itself in the second questionnaire. There was a discrepancy between the traits the students ascribed as gender different and the traits they ascribed to themselves.

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1. Introduction

A body of research has pointed out the importance of achievement-related, motivational and other self-beliefs and their influence on goal-settings and performance (Valentine et al., 2004; Zimmerman et al., 1992; Pajares, 2003; Guimond and Roussel, 2001; Stage and Kloosterman, 1995). What you think about yourself and your ability play part when solving mathematical problems. Previous research has indicated that decision making in mathematical reasoning are often based on beliefs about safety (e.g. this algorithm is safe), expectations (e.g. I’m supposed to solve this task with this algorithm) and motivation, the latter one often negative (e.g. I can’t construct my own reasoning) (Sumpter, 2008). One of the questions arising from this study is whether these beliefs are considered female, male or gender-indifferent.

In mathematics, gender-stereotyping is often favouring male despite equal performance in reality (Kimball, 1994, 1995; Walkerdine, 1998; Öhrn, 2002). There is a difference what is gender stereotyped and what is reported in terms of grades and performances. In Sweden, even though there is an explicit equity goal in society, mathematics especially at higher levels is still an unbalanced area (Brandell and Staberg, 2008). There is evidence that a view of mathematics as a male domain exists among students at upper secondary school in Sweden, particularly at the Natural Science programme. Brandell and Staberg (2008) concluded that the results\(^1\) showed that positive motivational beliefs such as mathematics being joyful and a subject you will need for the future are considered male. Boys are thought of as successful in mathematics and therefore logical and clever. Girls are considered diligent and hardworking, but since they are seen to have to work more and harder than boys, they are therefore not as bright. Looking at upper secondary school teachers’ attributions to students’ mathematical reasoning, boys are assigned gender symbols such as multiple strategies (especially on the calculator), chance-taking and exploring (Sumpter, 2009). Girls are attributed imitative reasoning, insecurity and use of standard method.

When focusing on gender differences in self-concept such as achievement-related beliefs, motivation and performance expectations it is equally promale. Gender differences in self-evaluation favour males (Jackson et al., 1994). Male students have higher self-concepts, performance expectations and a positive intrinsic motivation (Skaalvik and Skaalvik, 2004).

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\(^1\)More fully described in a preprint (Brandell et al., 2005).
rates their ability lower and are more likely to attribute success to luck and their failure to low ability (Stipek and Gralinski, 1991). Males have been reported to have higher self-esteem although sometimes the differences are small (Kling et al., 1999).

Combining the above results and with a focus on beliefs about safety, motivation and expectations, in this study I investigate upper secondary school students conceptions about these specific beliefs. The research questions posed are: (1) How do upper secondary school students gender stereotype beliefs about safety, expectations and motivation?; and, (2) How does the gender stereotyping differ to the traits the students ascribe to themselves?

This will be investigated by looking at students’ from the Swedish Natural Science programme ranking of statements describing beliefs about safety, motivation and expectations using the same type of instrument as Brandell et al. (2005). The focus is on how they perceive their identities, how they understand female and male gender construction in the school context, when focusing on these specific beliefs. In order to investigate this, we need a gender perspective that deals both with the social construct of gender stereotyping and the process of forming the individual identity.

2. Theoretical framework

2.1. Gender perspective. I focus on the result of having a specific gender in a specific situation. This is in contrast to, for example, seeing boys and girls as different independent of the context, or to see sex-differences as a biological difference. Gender is then thought of as an “analytic category which humans think about and organize their social activity rather than as a natural consequence of sex difference” (p. 17) (Harding, 1986). People have through history assigned gender to non-humans entities such as ships, countries and hurricanes. Here, I see the assignment in two ways: (1) you can attribute a gender to an object, characteristics or an action (e.g. a ship is female); or, (2) you can attribute an object, characteristic or an action to a gender (e.g. boys are more likely to use the graphic calculator). In both these cases, an element (object, characteristics or action) is identified and picked out as typical with the assignment to a specific gender.

Gender is asymmetrical; human thought, social organisation and individual identity and behaviour are categorised in an order making some
more a 'boy-thing' or a 'girl-thing'. Harding (1986) emphasises the ranking within the asymmetrical organisation of gender saying "part of what it means to become gendered as masculine is to become that kind of social person who is valued more highly than woman" (p. 104).

Gender is a fundamental structure, a process, that is constantly reproducing and changing itself. It has three aspects (Harding, 1986): (1) gender symbolism (or gender totemism); (2) gender structure; and (3) individual gender. By using these three aspects, it is easier to separate what is related to the structure (e.g. younger children are taught by women, the majority of the professors in mathematics are men), to the symbols in thoughts, word and pictures (e.g. males are considered being more logical than females) and to the individual gender. The structure confirms the symbolism, which then supports the structure. Both will influence the individual’s choices. So even though most teachers at a lower level are female, and girls will perform as good or better than boys at compulsory school, the overall system through textbooks, teacher education and teaching practice will affect the students’ view not only of mathematics as a subject but also of who could be a mathematician. When developing your own gender identity you have to deal with the norm of gender equality that exists in the Swedish society but also with the traditional discourses of masculinity and femininity in mathematics education that coexist at the same time. These different discourses function side by side. It is in this context that boys and girls develop their gender identities by facing, often contradictory, images and negotiate them to a personal identity (Volman and Ten Dam, 1998).

As stated earlier, students at upper secondary school in Sweden especially at the Natural Science programme perceive mathematics as a male domain (Brandell and Staberg, 2008), which means that the structure, the symbols and the identity are all more likely to be pro-male. Such an environment could be connected to a potential underperformance by women since they are under a stereotype threat (Cadinu et al., 2005; Spencer et al., 1999).

2.2. Conceptions and beliefs. This study aims to investigate students’ conceptions about specific beliefs. Thompson (1992) describes conceptions as "conscious or subconscious beliefs, concepts, meanings, rules, mental images, and preferences" (p. 132). I agree with this description. Conception is defined here as an abstract or general idea that may have both affective and cognitive dimensions, inferred or derived from specific instances.
Hence, students’ conceptions consist of their belief systems, values and attitudes reflecting their experiences. Their conceptions will be studied by looking at if and how they gender stereotype statements describing beliefs and how they rank the truthfulness of these statements. Gender stereotyping is identified with the ranking of the statements as female or male.

Beliefs is by the above definition part of conceptions. Schoenfeld (1985) describes beliefs as the perspective with which one approaches mathematics and mathematical tasks. He refines this definition by saying that beliefs could “be interpreted as an individual’s understandings and feelings that shape the ways that the individual conceptualizes and engages in mathematical behavior” (Schoenfeld, 1992) (p.358). This broad definition is accepted by a majority of researchers in the field as at least a starting point for investigations of beliefs (Furinghetti and Pehkonen, 2002). Unlike Schoenfeld, I like to exclude emotions from the definition of belief since the same belief may be connected with different emotions for different individuals.

I define beliefs as an individual’s understandings that shape the ways that the individual conceptualizes and engages in mathematical behaviour generating and appearing as thoughts in mind (Sumpter, 2008). In this sense beliefs are primarily cognitive. They are neither objective knowledge nor emotion (e.g. it is easier to understand a function if you look at the graph.). Here, beliefs are divided in to four different categories: beliefs about mathematics (e.g. mathematics is based on rules), beliefs about self (e.g. I am able to solve problems), beliefs about mathematics teaching (e.g. teaching is telling), and beliefs about the social context (e.g. learning is competitive) (Schoenfeld, 1985). An individual’s beliefs are linked to each other in a system, and the individual defines the links in this system itself. Schoenfeld (1985; 1992) describes this belief system as “the individual’s mathematical world view”. The notion of a belief system is a metaphor used to describe how one’s beliefs are organised (Green, 1971). Each of an individual’s beliefs is dependent on their other beliefs. They are connected and the relationship between different beliefs is not necessarily logical, since it is the individual herself that arranges them from how she sees these connections. There is a quasi-logical structure with primary beliefs and some derivative beliefs. How convinced an individual is about something depends on the psychological strength of the belief. A belief could be central and strongly held, or peripheral and likely to change. This dimension doesn’t exist in a knowledge system (Furinghetti
and Pehkonen, 2002). If you know something, you are not likely to accept any contradiction to this. Beliefs are held in clusters. These clusters don’t necessarily have any relationship to each other and therefore can be kept more or less isolated.

The reasons for seeing beliefs as a part of a system is that beliefs are not isolated and they are context/situation bound. They function in operational terms as a part of a model of cognition.

3. Method

3.1. Method of data collection. The data comes from two questionnaires. They are two forms of one instrument (Leder and Forgasz, 2002). Both questionnaires consist of 24 statements all given as arguments for decisions made during school tasks solving by year two students (age 17) from the Natural Science programme in Swedish upper secondary school (Sumpter, 2008):

- $S_1$ A well-known method is the safest one.
- $S_2$ If you have not solved a task within ten minutes, you have chosen the incorrect method.
- $S_3$ The graphic calculator saves time and work.
- $S_4$ If a method I have chosen doesn’t work, I choose a new one that feels safe.
- $S_5$ If I can’t remember how to solve it (which method to use), I can’t proceed.
- $S_6$ Answers to mathematical tasks often look similar.
- $S_7$ I should do well in mathematics.
- $S_8$ My own reasoning is not a safe strategy.
- $S_9$ It is important to remember every step of a method.
- $S_{10}$ The graphic calculator is a safe choice.
- $S_{11}$ Mathematical task should be solved with a specific method.
- $S_{12}$ You can from the answer decide whether you have solved the task correctly or not.
- $S_{13}$ To try to create your own solution to a mathematical task is impossible.
- $S_{14}$ I can pass the courses in mathematics.
- $S_{15}$ The graphic calculator is fast and efficient.
- $S_{16}$ You don’t learn as much mathematics if you use the graphic calculator.
- $S_{17}$ I can’t reason to a solution myself.
• S18 Graphs are helpful if you want to understand a function.
• S19 Mathematical tasks often look similar.
• S20 You should finish a task before starting with a new one.
• S21 The key to success is good memory.
• S22 Mathematics is to memorise methods.
• S23 You work with a mathematical task a limited amount of time.
   If you have not solved it[within this time limit], you take a new task.
• S24 The safest method is the one that the teacher has presented.

Eight classes from the Natural Science programme from four different schools at different locations participated, a total of 180 students (102 boys and 78 girls). They were all in between the courses Mathematics C and Mathematics D meaning completing a first course in differentiation: seven of them in year two and one class in year three.

The first questionnaire, *Who and mathematics*, aims to look at if the students rank the statements being more likely to be true for girls or for boys, or whether there is no gender difference. This questionnaire highlights what traits the students ascribe to different groups and the focus is how they understand female and male gender construction. Half of the classes (one class from each of the four schools, 44 boys and 44 girls) were asked for each statement to select one of the following responses to the question ‘Who is more likely to think this?’:

• *BD* boys definitely more likely than girls
• *BP* boys probably more likely than girls
• *ND* no difference between boys and girls
• *GP* girls probably more likely than boys
• *GD* girls definitely more likely than boys

The second questionnaire, *Me and mathematics*, aims to look at how the students rank the statements from their own standpoint. This questionnaire focus on what traits the students ascribe to themselves, highlighting how they as individuals perceive themselves as mathematics students. The other four classes (58 boys and 34 girls) were asked to select one of the following options for each statements that describe their own standpoint most correctly:

• *AT* absolutely true
• *MT* mostly true
• *N* neutral
• *PT* partly true
• NT not true

The inspiration for these questionnaires comes from Leder and Forgasz’ instruments *Who and mathematics* and *Mathematics as a Gendered Domain* that were developed from Fennema-Sherman’s *Mathematics Attitudes Scales, MAS* (Leder and Forgasz, 2002). These instruments give the opportunity to see mathematics not just as a male domain but also as female or neutral. The *Who and mathematics* instrument measures if and to what extent the students stereotype the statements as gendered. Three students (3.4 %) answered only ‘No difference’ for this instrument, all of them girls. The second questionnaire, here renamed *Me and mathematics* following Brandell et al. (2005), measures how true the students rank the statements, providing the possibility to compare boys and girls’ results. In this version the middle option was changed; instead of ‘Not sure (NS)’ the students were given the opportunity to be neutral about a statement. If they were unsure about a statement, they could leave it blank.

The questionnaires were handed out by the teachers. Two respondents did not indicate gender and not included in the study.

Two pilot studies were made. The first one was with 15 prospective teachers and had the aim to test the instrument. It was followed up by an interview. As a result one minor change of the language in one of the statements was made. The second pilot study was with two classes from the Natural Science programme, year two. The results from this study indicated that most statements were thought of as neutral for *Who and mathematics* and the differences between boys and girls’ responses to *Me and mathematics* were marginal but with some exceptions.

### 3.2. Method of analysis.

The goal of the analysis is to present and highlight students’ gendered conceptions about specific beliefs. The analysis was conducted in two steps:

1. First, an analysis of the differences between girls and boys responses by statement. For each statement, the responses were gathered. Instead of using parametric statistical methods as Brandell et al (2005) and Leder and Forgasz (2002), I use non-parametric statistical methods since the questionnaires do not indicate how big the steps are and the assumption of normally distributed data is not justified.

   a) For *Who and mathematics* the five answer categories were condensed into three: ‘Boy’; ‘No difference’; and ‘Girl’. This allowed me to identify gender stereotyping although not to investigate the extent to which it was made. The gender stereotyping is here defined as if the students rank
the statements as female or male. The option neutral was no ranking at all. The largest proportion of responses was identified. If the statement had the largest proportions of respondents choosing 'No difference', the statement was considered as not gender stereotyped.

The statements which had the largest proportion of responses in the male or female category were picked out to further investigation. A sign test was made to test the null hypothesis that the respondents are equally likely to choose boy or girl (i.e. if the gender stereotyping was significant). If \( p < 0.05 \) we reject this null hypothesis. Then, a comparison of boys and girls' responses were made making it possible to analyse similarities and differences between the two groups.

b) The responses to *Me and mathematics* were condensed into three: 'True'; 'Neutral'; and 'Not true'. In order to compare girls and boys' responses, Fisher’s exact test was made. In contrast to the sign test, which identifies whether answers tend towards particular stereotyping, the Fisher’s test explicitly tests whether statements differ between girls and boys. This test calculates the probability of all possible outcomes in an experiment given a null hypothesis that there is no difference between the treatments. It then calculates which of these outcomes are more or less 'extreme' than the experimental outcome and sums the probability of all these more extreme outcomes. This calculation can be done either as a one or two sided test. The two-sided test, which I apply here, is more general in that it tests both whether (1) the data is more equally distributed amongst outcomes than expected and (2) whether the data is less equally distributed amongst outcomes than expected. A one-tailed test only measures the second of these possibilities. The two sided test is also stricter than the one sided test, so that if the two sided test is significant then the one sided test is also significant.

In the test applied here, boy and girl were used as treatments and 'True', 'Neutral', and 'Not true' as outcomes. The \( p \)-value is the probability that this outcome would have occurred given the null hypothesis that there is no difference between boys and girls. If \( p < 0.05 \) we reject the null hypothesis that there is no difference between boys and girls.

The statements with \( p < 0.05 \) were identified. Special cases such as borderline cases were investigated as well.

2. The results from the two questionnaires were compared. This comparison made it possible to analyse the differences between what the students gender stereotyped in terms of the traits they ascribe to groups of
people (Who and mathematics) and the traits boys and girls ascribe to themselves (Me and mathematics).

The results will be discussed with the gender perspective, as presented in section in 2.1, in mind.

4. Results

4.1. Self-evaluation. The students were first asked to value themselves as very good (VG), good (G), average (A), below average (BA) or weak (W). In order to compare girls and boys’ responses, Fisher’s exact test (FET) was made. In this test boy and girl was used as treatments and the different grades of evaluation as outcomes. The $p$-value is the probability that this outcome would have occurred given the null hypothesis that there is no difference between boys and girls. If $p < 0.05$ we reject the null hypothesis that there is no difference between boys and girls. All figures have been calculated in percentages to allow comparisons:

<table>
<thead>
<tr>
<th>Gender-Answer</th>
<th>VG</th>
<th>G</th>
<th>A</th>
<th>BA</th>
<th>W</th>
<th>FET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>10.3</td>
<td>46.2</td>
<td>38.4</td>
<td>3.8</td>
<td>1.3</td>
<td>$p &lt; 0.01$</td>
</tr>
<tr>
<td>Boys</td>
<td>31.4</td>
<td>36.3</td>
<td>23.5</td>
<td>4.9</td>
<td>3.9</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1: Self-evaluation*

The result of Fisher’s exact test is that there is a difference in boys and girls’ evaluation. In Sweden, grades at this level are to girls’ advantage (Brandell et al., 2005). Given the large number of participants, there is no reason to believe that the students’ grades should differ from those nationally. However, self-evaluation is not only about performance. Self-evaluation is linked to self-concept, often favouring males (Jackson et al., 1994), and achievement-related beliefs, also pro-male (Stipec and Gralinski, 1991). These are about how you see yourself and your capacity. Boys are also found to have higher intrinsic motivation, which is connected to self-concept, than girls (Skaalvik and Skaalvik, 2004). According to Table 1, boys are more likely to evaluate their own performance in mathematics higher than girls. This is similar results as indicated by previous research (Brandell et al., 2005; Kimball, 1994). This higher evaluation can be made even though the students have exactly the same grade and performance (Jakobsson, 2000).

4.2. Who and mathematics. For Who and mathematics, most of the statements were ranked as 'No difference’, but seven of them had some
gender differences. These statements are presented in Table 2. All figures have been calculated in percentages to allow comparisons. The response category which got the largest proportions of responses is highlighted with bold text. B stands for 'Boys', ND for 'No difference', G for 'Girls' and p the results from the sign-test:

<table>
<thead>
<tr>
<th>GENDER-ANSWER</th>
<th>B</th>
<th>ND</th>
<th>G</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3: The graphic calculator saves time and work.</td>
<td>52.3</td>
<td>40.9</td>
<td>6.8</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Boys</td>
<td>54.5</td>
<td>43.2</td>
<td>2.3</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>S8: My own reasoning is not a safe strategy.</td>
<td>11.4</td>
<td>31.8</td>
<td>56.8</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Boys</td>
<td>20.5</td>
<td>43.2</td>
<td>36.3</td>
<td>p = 0.05</td>
</tr>
<tr>
<td>S9: It is important to remember every step of a method.</td>
<td>4.5</td>
<td>45.5</td>
<td>50</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Boys</td>
<td>4.6</td>
<td>54.5</td>
<td>40.9</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>S15: The graphic calculator is fast and efficient.</td>
<td>29.5</td>
<td>63.6</td>
<td>6.8</td>
<td>p = 0.01</td>
</tr>
<tr>
<td>Boys*</td>
<td>50</td>
<td>40.9</td>
<td>4.6</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>S20: You should finish a task before starting with a new one.</td>
<td>9.1</td>
<td>31.8</td>
<td>59.1</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Boys*</td>
<td>11</td>
<td>29.5</td>
<td>54.5</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>S23: You work with a mathematical task a limited amount of time. If you have not solved it [within this time limit], you take a new task.</td>
<td>34.1</td>
<td>47.4</td>
<td>18.2</td>
<td>p = 0.11</td>
</tr>
<tr>
<td>Boys*</td>
<td>47.7</td>
<td>38.6</td>
<td>9.1</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>S24: The safest method is the one that the teacher has presented.</td>
<td>11.4</td>
<td>52.3</td>
<td>36.3</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Boys*</td>
<td>9.1</td>
<td>36.4</td>
<td>50</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

Table 2: Who and mathematics

*Two boys (equivalent to 4.5 %) chose not to answer.

Starting with the statement that was thought of as female by both groups, S20: You should finish a task before starting with a new one., which describes an expectation. The majority of both girls and boys ranked this as female.

Two statements were by the largest proportions of girls thought as female whereas most boys chose 'No difference': S8 (My own reasoning is not a safe strategy.); and, S9 (It is important to remember every step of a
method). Statement 8 describes a belief about insecurity, but it is also a negative motivational belief. One third of the boys ascribed this belief to girls. Statement 9 is a belief about expectations, how to do mathematics. Although not the largest proportion, four out of ten boys ranked this statement as female. Both groups seem to agree that S9 is definitely not a male belief.

One statement, S24 (The safest method is the one that the teacher has presented.), was by the largest proportion of boys ranked as female, whereas most of the girls chose 'No difference’. This statement describes something that is considered safe, and it is by the boys attributed to girls. One third of the girls agreed with this attribution.

Statement 3 (The graphic calculator saves time and work.) was by the largest proportion of boys and girls ranked as male. This statement is both about what you expect from the graphic calculator, but also a motivational belief saying why you use the graphic calculator. Both groups agree that this is not a female belief.

Two statements were by the largest proportion boys ranked as male, whereas most girls answered 'No difference': S15 (The graphic calculator is fast and efficient.); and, S23 (You work with a mathematical task a limited amount of time. If you have not solved it [within this time limit], you take a new task.). Just as statement 3, S15 is about what you expect from the graphic calculator. It also works as a motivational belief. Both groups agree to that this is not a female belief. Statement 23 describes what your as a student are expected to do.

Among the statements considered gendered girls seem to be connected to beliefs about a certain aspect of expectations, what you are expected to do. There are also links to insecurity and to what is considered a safe strategy, something that could work as a negative motivational belief. Statement 3 and 15 are assigned to boys. They are both about what you expect from the graphic calculator. They could work as a motivational belief in terms of why you should use it.

4.3. Me and mathematics. Three statements showed gender differences according to Fisher’s exact test: S6 (Answers to mathematical tasks often look similar.); S8 (My own reasoning is not a safe strategy.); and, S20 (You should finish a task before starting with a new one.). One statement was borderline, S11:Mathematical task should be solved with a specific method.). S6, S8, S11 and S20 are presented in table 3. T stands for
‘True’, N for ‘Neutral’, NT for ‘Not true’ and the column FET presents
the results from Fisher’s exact test. The category which got the largest
proportions of answers is indicated with bold text. All figures have been
calculated in percentages to allow comparisons:

<table>
<thead>
<tr>
<th>STATEMENT-GENERO-ANSWER</th>
<th>T</th>
<th>N</th>
<th>NT</th>
<th>FET</th>
</tr>
</thead>
<tbody>
<tr>
<td>S6: Answers to mathematical tasks often look similar.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>17.6</td>
<td>26.5</td>
<td>55.9</td>
<td>p = 0.05</td>
</tr>
<tr>
<td>Boys</td>
<td>32.7</td>
<td>37.9</td>
<td>29.3</td>
<td></td>
</tr>
<tr>
<td>S8: My own reasoning is not a safe strategy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>17.6</td>
<td>8.8</td>
<td>73.6</td>
<td>p = 0.02</td>
</tr>
<tr>
<td>Boys</td>
<td>6.9</td>
<td>31.3</td>
<td>62.6</td>
<td></td>
</tr>
<tr>
<td>S11: Mathematical task should be solved with a specific method.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls*</td>
<td>32.3</td>
<td>23.5</td>
<td>41.2</td>
<td>p = 0.13</td>
</tr>
<tr>
<td>Boys</td>
<td>48.3</td>
<td>29.3</td>
<td>22.4</td>
<td></td>
</tr>
<tr>
<td>S20: You should finish a task before starting with a new one.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls*</td>
<td>20.6</td>
<td>26.5</td>
<td>50</td>
<td>p = 0.02</td>
</tr>
<tr>
<td>Boys</td>
<td>50</td>
<td>20.7</td>
<td>29.3</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Me and mathematics

*One girl (equivalent to 2.9 %) chose not to answer.

According to Fisher’s exact test, girls are more likely to find statement 6 (Answers to mathematical tasks often look similar.) not true compared to boys. Boys responses to this statement are more evenly distributed.

Two statements, S11 and S20, have the opposite largest proportions of responses. For statement 11, most girls answers ’Not true’ whereas most boys ranked this statement true. In this case, Fisher’s exact test is not significant but shows indications for gender differences. For S20, the test is significant and where the largest proportions of boys answer ’True’ most girls answer ’Not true’.

One statement, S8, has similar response pattern for boys and girls in terms of the most chose answer, but the result from Fisher’s exact test shows there are differences. Here the girls have a tendency to the extremes; most of them rank this statement as ’Not true’. Not many boys ranked this statement as ’true’ at all, but one third answer ’Neutral’.

4.4. Comparing the results.
4.4.1. Who and Mathematics and Me and Mathematics. To highlight similarities and differences between the results from the two questionnaire, a comparison was made. First, I looked at the statements considered female by one or both groups:

<table>
<thead>
<tr>
<th>GENDER-ANSWER</th>
<th>B</th>
<th>ND</th>
<th>G</th>
<th>T</th>
<th>N</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S8:</strong> My own reasoning is not a safe strategy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>11.4</td>
<td>31.8</td>
<td><strong>56.8</strong></td>
<td>17.6</td>
<td>8.8</td>
<td><strong>73.6</strong></td>
</tr>
<tr>
<td>Boys</td>
<td>20.5</td>
<td><strong>43.2</strong></td>
<td>36.3</td>
<td>6.9</td>
<td>31.3</td>
<td><strong>62.6</strong></td>
</tr>
<tr>
<td><strong>S9:</strong> It is important to remember every step of a method.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>4.5</td>
<td>45.5</td>
<td><strong>50</strong></td>
<td><strong>82.4</strong></td>
<td>8.8</td>
<td>8.8</td>
</tr>
<tr>
<td>Boys</td>
<td>4.6</td>
<td><strong>54.5</strong></td>
<td>40.9</td>
<td><strong>79.3</strong></td>
<td>12.1</td>
<td>8.6</td>
</tr>
<tr>
<td><strong>S20:</strong> You should finish a task before starting with a new one.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls*</td>
<td>9.1</td>
<td>31.8</td>
<td><strong>59.1</strong></td>
<td>20.6</td>
<td>26.5</td>
<td><strong>50</strong></td>
</tr>
<tr>
<td>Boys**</td>
<td>11</td>
<td>29.5</td>
<td><strong>54.5</strong></td>
<td><strong>50</strong></td>
<td>20.7</td>
<td>29.3</td>
</tr>
<tr>
<td><strong>S24:</strong> The safest method is the one that the teacher has presented.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls*</td>
<td>11.4</td>
<td><strong>52.3</strong></td>
<td>36.3</td>
<td><strong>38.3</strong></td>
<td>35.3</td>
<td>23.5</td>
</tr>
<tr>
<td>Boys**</td>
<td>9.1</td>
<td>36.4</td>
<td><strong>50</strong></td>
<td><strong>38.9</strong></td>
<td><strong>43.1</strong></td>
<td>17.2</td>
</tr>
</tbody>
</table>

*Table 4: Comparison of ‘female’ statements

*One girl (equivalent to 2.9 %) chose not to answer (Me and mathematics).
**Two boys (equivalent to 4.5 %) chose not to answer (Who and mathematics).

Looking at the results from the first questionnaire one statement, S20 (You should finish a task before starting with a new one.), was thought of as female by the largest proportion of both groups. But when comparing this result to Me and mathematics a discrepancy occurs. According to the second study boys are more likely to rank this statement true. Analysing the responses closely, 27.6 % of the boys says this is absolutely true compared to 2.9 % of the girls stressing the gender difference as well as the difference between the two instruments’ results.

Two statements were considered female by the largest proportions of girls in Who and mathematics: S8 (My own reasoning is not a safe strategy.), and, S9 (It is important to remember every step of a method.). A large proportions of boys, around four out of ten, ranked S8 and S9 as female as well. Comparing this to the results from Me and mathematics the majority of girls (and boys) ranked S8 as not true and S9 as true. The result from Fisher’s exact test indicates that girls are more likely to hold S8 not true. For S9, \( p = 0.92 \) stressing that girls and boys’ responses are...
rather similar to each other. There is nothing indicating that girls were more likely to find these two statements more false or true respectively. There is a gap between what girls think of other girls and what they report about themselves.

One statement, S24 (The safest method is the one that the teacher has presented.), was by the largest proportion of boys ranked as female. The largest proportion of boys and roughly one third of the girls ranked this statement as neutral in Me and mathematics. The same number of girls and boys ranked this statement true, leaving us to find the biggest difference (although still a small one) in the number of students who ranked this untrue: 23.5 % of the girls; and, 17.2 % of the boys. There is no evidence from Me and mathematics that S24 should be more female.

The following statements were by one or both groups ranked as male:

<table>
<thead>
<tr>
<th>GENDER-ANSWER</th>
<th>B</th>
<th>ND</th>
<th>G</th>
<th>T</th>
<th>N</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3: The graphic calculator saves time and work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>52.3</td>
<td>40.9</td>
<td>6.8</td>
<td>64.8</td>
<td>23.5</td>
<td>11.8</td>
</tr>
<tr>
<td>Boys</td>
<td>54.5</td>
<td>43.2</td>
<td>2.3</td>
<td>72.4</td>
<td>13.8</td>
<td>13.8</td>
</tr>
</tbody>
</table>

S15: The graphic calculator is fast and efficient.

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls***</td>
<td>29.5</td>
<td>63.6</td>
<td>6.8</td>
<td>70.5</td>
<td>11.8</td>
<td>11.8</td>
</tr>
<tr>
<td>Boys**</td>
<td>50</td>
<td>40.9</td>
<td>4.6</td>
<td>72.4</td>
<td>17.2</td>
<td>10.3</td>
</tr>
</tbody>
</table>

S23: You work with a mathematical task a limited amount of time. If you have not solved [within this time limit], you take a new task.

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls*</td>
<td>34.1</td>
<td>47.4</td>
<td>18.2</td>
<td>23.5</td>
<td>23.5</td>
<td>50</td>
</tr>
<tr>
<td>Boys**</td>
<td>47.7</td>
<td>38.6</td>
<td>9.1</td>
<td>13.7</td>
<td>29.3</td>
<td>57.2</td>
</tr>
</tbody>
</table>

Table 5: Comparison of ‘male’ statements

*One girl (equivalent to 2.9 %) chose not to answer (Me and mathematics).
**Two boys (equivalent to 4.5 %) chose not to answer (Who and mathematics).
*** Two girls (equivalent to 5.9 %) chose not to answer (Me and mathematics).

Statement 3, The graphic calculator saves time and work., was by the largest proportion ranked as male by both girls and boys. In the second study both groups found this statement true, and Fisher’s exact test showed no significant difference with respect to gender.

Two statements were by the largest proportion boys ranked as male in Who and mathematics: S15 (The graphic calculator is fast and efficient.; and, S23 (You work with a mathematical task a limited amount of time. If you have not solved [within this time limit], you take a new task.).
Statement 15 was by most girls and boys ranked as true in the second study and Fisher’s exact test showed no significant difference between the responses. But, analysing how true they ranked it there is a minor difference. More boys than girls (34.5% compared to 17.6%) said this is absolutely true.

There was no difference in girls and boys responses for statement 23. Both groups ranked the statement as not true in Me and mathematics and the result from Fisher’s exact test showed no significant difference.

The following statements had or indicated gender differences in what was ascribed as personal traits by the two groups according to Fisher’s exact test that were not repeated in Who and mathematics:

<table>
<thead>
<tr>
<th>Gender-Answer</th>
<th>B</th>
<th>ND</th>
<th>G</th>
<th>T</th>
<th>N</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>S6: Answers to mathematical tasks often look similar.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls***</td>
<td>25</td>
<td>56.8</td>
<td>15.9</td>
<td>17.6</td>
<td>26.5</td>
<td>55.9</td>
</tr>
<tr>
<td>Boys</td>
<td>29.5</td>
<td>61.4</td>
<td>9.1</td>
<td>32.7</td>
<td>37.9</td>
<td>29.3</td>
</tr>
<tr>
<td>S11: Mathematical task should be solved with a specific method.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls*</td>
<td>9.1</td>
<td>54.5</td>
<td>36.4</td>
<td>32.3</td>
<td>23.5</td>
<td>41.2</td>
</tr>
<tr>
<td>Boys**</td>
<td>15.9</td>
<td>56.8</td>
<td>22.8</td>
<td>48.3</td>
<td>29.3</td>
<td>22.4</td>
</tr>
</tbody>
</table>

Table 6: Comparison of ‘neutral’ statements

*One girl (equivalent to 2.9%) chose not to answer (Me and mathematics).
**Two boys (equivalent to 4.5%) chose not to answer (Who and mathematics).
***One girl (equivalent to 2.3%) chose not to answer (Who and mathematics).

Statement 6 (Answers to mathematical tasks often look similar.) was by most girls thought of as not true according to the second study. This was no indication of a potential gender difference of this in Who and mathematics. The majority of boys and girls (61.4% and 56.8% respectively) chose ‘No difference’. The same tendency goes for statement 11 (Mathematical task should be solved with a specific method.) which boys according to Me and mathematics were more likely to rank as true. In Who and mathematics the majority of girls (54.5%) and boys (56.8%) chose ‘No difference’.

4.4.2. Self-evaluation and Me and mathematics. In order to find out more about boys and girls self-concept, a comparison was made between the results from the self-evaluation and the responses to Me and mathematics. Despite girls being more likely to rank their performances lower than boys,
assuming that their grades don’t differ to the average population, the result from *Me and mathematics* indicates that they are as confident as boys in terms of their capacity passing the courses in mathematics (S14). The was no difference between boys and girls’ responses to this statement; 76.5% of the girls and 75.9% of the boys say this statement is absolutely true, and the result from Fisher’s exact test showed no significant differences. Turning to the moral view of the goal, S7 (*I should do well in mathematics*), Fisher’s exact test gives a result of \( p = 1.00 \) showing no significant differences between girls and boys’ responses. This statement could be interpreted as an intrinsic motivation or an expectation I set on myself.

Overall, the results indicate that girls at the Natural Science programme are as confident as boys, but they rate their performance lower.

### 4.5. Summary.

This study aimed to investigate secondary school students’ gender stereotyping of beliefs describing aspects about safety, expectations and motivation, and if this gender stereotyping differs from the traits the students ascribe to themselves. Most statements in the first study (*Who and mathematics*) were considered neutral by the students. According to the largest proportions of the students there is no difference between boys and girls in these statements. But for seven of the statements some gender differences were identified. Among the statements that were considered gendered, girls seem to be connected to beliefs about aspects of expectations and safety: what you are expected to do and what is considered a safe strategy. This could be seen as a negative motivational belief. Boys are assigned beliefs about what you can expect from the graphic calculator. This could work as a motivational belief about why you should use it.

When comparing the gendered statements to the statements considered neutral in *Who and mathematics* there are few clear conclusions to be drawn. The statements considered female talk about carefulness: this is what you should do in order to stay safe. This is further stressed with S8: *My own reasoning is not a safe strategy*. The other three statements in the questionnaires that deal with similar issues, S1 (*A well-known method is the safest one*), S4 (*If a method I have chosen doesn’t work, I choose a new one that feels safe*), and S17 (*I can’t reason to a solution myself*), were by the largest proportions of students ranked as neutral. This shows that statements describing safety or expressing insecurity are not automatically ranked as female. But to the question why some statements about safety combined with expectations are female and others not, I can
only speculate. One possibility is that these statements, S20 (You should finish a task before starting with a new one.) and S9 (It is important to remember every step of a method.), both describe what you are expected to do using words as 'should' and 'important'. Thereby, they stress an element of 'rule-following'.

Two of the three statements ranked as male are about the graphic calculator. They have a positive motivational aspect as to why you should use this tool. There are two more statements about the graphic calculator in the questionnaire which are ranked as neutral by the largest proportions of students, S10 (The graphic calculator is a safe choice.) and S16 (You don't learn as much mathematics if you use the graphic calculator.). S10 has an positive tone to graphic calculators and S16 has a negative one. It seems possible that it is not the word 'graphic calculator' that makes a statement male. But, if it it is the motivational aspect which is thought of as male in these cases I do not know. Another possible explanation is that S3, S15 and S23 (the three statements ranked as male) are about proceeding quickly when solving tasks.

Summarising the comparison of the results from the two instruments, the discrepancy of how statement 20 (You should finish a task before starting with a new one.) was ranked from a general view compared to boys and girls' individual perspective stands out. Both groups were more likely to gender stereotype this statement as female in Who and mathematics, but the second study showed a different result.

The connection between the graphic calculator and boys that was indicated in the first study did not have the same impact in Me and mathematics where girls and boys' response pattern were almost similar including the minor difference in statement 15. Looking at all the statements that refer to the graphic calculator (S3, S10, S15 and S16) the responses are very similar.

The view of girls associated with statements about insecurity (i.e what is considered a safe strategy) and expectations concerning what you are supposed to do did not repeat itself Me and mathematics. There were no indications that girls find these statements more true or untrue than boys or vice versa. Indeed, as a contradiction we can note that more boys ranked statement 11 (Mathematical task should be solved with a specific method.) true than girls. Looking closer at self-evaluation and self-concept, girls appear to be as confident as boys in Me and mathematics while evaluating their overall performance lower than boys do.
5. Discussion

Even though the results from *Who and mathematics* indicated partly similar masculinities and femininities as previous research (Brandell et al., 2005; Sumpter, 2009), *Me and mathematics* did not confirm these conceptions. Girls did not rank statements about safe strategies more true than boys, and boys were not more likely to find the graphic calculator more useful than girls. There was a gap between what was gender stereotyped and what is ranked from an individual perspective. As an example, one of the results indicated that boys found the statement saying that mathematical tasks should be solved with a specific method more true than girls. The gender stereotyping followed traditional discourses and ascribed this trait to girls. For one statement (S20: *You should finish a task before starting with a new one.*) the result was the absolute opposite showing us that the gap between perceptions of others and of oneself could be rather big. Also, girls in the Natural Science programme were as confident about their own capacity as the boys although not evaluating their performance as high.

There is of course the possibility that the students were only answering the questions to *Who and mathematics* with girls and boys in general in mind and excluding their own personal situation. This could explain the differences between the results from the two versions of the questionnaire. It could also be a case of different groups of students. Öhrn (2002) concludes that there is a transaction taking place in the class room where new feminities are taking more space in the educational context. This is not a case of new female gender identities replacing the old ones. Rather, a new type of girl, a more bold and out-spoken one, appears with the quiet girls still existing in the class room. I cannot completely rule out the possibility that classes answering *Me and mathematics* were dominated by the new type of girls and the classes answering *Who and mathematics* by the quiet girls. I would consider this unlikely, however, since the study was conducted over 8 classes and such an effect would require big differences between the classes chosen. Furthermore, similar gaps between stereotyping and individual perspective have been found in previous research (Brandell and Staberg, 2008; Volman and Ten Dam, 1998). It thus appears highly likely that these gaps are about the differences between the personal gender identity and the perceived masculinity and femininity (Volman and Ten Dam, 1998), rather than statistical anomalies.
This gap produces interesting questions. Why do girls downgrade girls ability such as in S8 (My own reasoning is not a safe strategy.), especially when they so strongly hold it false from an individual perspective? Why do students continue to hold on to such beliefs? I will now discuss these questions by using different theoretical standpoints.

A case of different belief clusters
The gap between beliefs about self and of others should not necessarily be seen as irrational or perceived as a contradiction since, according to the theory of belief systems, the relationship between different beliefs don’t have to be logical (Green, 1971). In this quasi-logical structure, the arrangement is made by the individual herself according to how she sees them and it could be done without any questioning. If I perceive A to be true and judge B to be true as well and it turns out that A and B contradicts each other, then this contradiction doesn’t have to start a process where I look for evidence to find the failing link. I can choose, consciously or not, to neglect this contradiction and put A and B in two different set of beliefs. I can also hold A and B with different psychological strength and thereby increasing the distance between them. Therefore, the discrepancy between what the student gender stereotype and the personal traits that she ascribes herself doesn’t have to produce a conflict. It could just be a result from having two different belief clusters.

A coping strategy
It could also be a question of a coping strategy (Volman and Ten Dam, 1998). Given the view of mathematics as a male domain, in order to avoid the risk of being a victim in their female identity with all negative gender symbol attached to it, there is a need to separate the traditional discourse from the personal identity: ”Girls are disinclined to identify with ’a group that is lagging behind.’” (Ibid. p.541) I then, as a female student in mathematics, identify myself to non-female attributions such as graphic calculator and being confident and reject insecurity and rule-following. But is this identification just a facade or do I really believe this? This is when self-evaluation becomes interesting. Self-evaluation is not just about the actual grade or performance; it is how you value your own performance. It is an additional way of looking at how students view themselves. Just as previous findings (Brandell et al., 2005; Kimball, 1994; Jakobsson, 2000), relative to boys, the female students show indications
of evaluating their own performance as worse despite the pro-female responses to *Me and Mathematics*. Again, the gap becomes perceptible.

**Pressure to conform**
Given such stereotypic beliefs, women may feel a pressure to conform to such gender norms including them being led to downgrade their own performances. According to the system justification theory it is possible that the stigmatized group adapt the negative assumptions that are stereotyped to them by the dominant group (Jost and Banaji, 1994). This would mean that even though girls might feel, think or experience there is no gender difference in the bigger society, it is possible that they incorporate the gender stereotyping that is projected in the sub-domain (mathematics). This would lead to girls rating their ability lower – that activating gender stereotypes can lower self-evaluation (Guimond and Roussel, 2001).

**Legitimize myths**
Another way of looking at this would be using social dominance theory (Sidanius and Pratto, 1999). In a group-based social hierarchy the dominant and hegemonic group (here males) would enjoy the social power and privilege just because of a particular membership in a socially constructed group. This hierarchy is affected by legitimizing myths that “consist of attitudes, values, beliefs, stereotypes, and ideologies that provide moral and intellectual justification for the social practices that distribute social values within the social system” (p.45). Events such as an experience in the classroom could then be interpreted as supporting evidence when holding gender stereotypic views (Eccles and Jacobs, 1986). As previous research has indicated (Brandell et al., 2005), male students are more likely to gender stereotype (and to their favour) which could be explained as them holding on to and anchoring the myths.

Considering these theoretical views on social dominance and system of justification, how do you change such stereotypic conceptions? The results from *Me and mathematics* indicate that it is probably not a question about changing individuals’ own perception about themselves. Is there a way of boosting girls confidence when research results indicate that they already are confident? The discrepancy between the two questionnaires could also suggest that in a complex area such as ‘Mathematics as a gendered domain’, one quantitative questionnaire does not provide enough data in order to make broad conclusions. We cannot simply conclude that
‘mathematics is a male domain’ or ‘girls are confident’. Looking at the bigger picture implies that further research is required.

One if not the most important questions with respect to gender and mathematics is why girls avoid careers in mathematics. This question has not been treated in this study, but the results indicate that if we address this question through questionnaires we may obtain different results if we ask about girls in general or if we ask about girls’ conceptions about themselves. There are also indications that discrepancies can occur when looking at a concrete situation compared to an abstract one. In Sumpter (2008) students’ arguments for central decisions made when solving school tasks were analysed, and one of the results was an algorithmic view based on the statements that were given as arguments for decisions. In this present article the students were asked to rank the truthfulness of these statements. The results of this ranking did not repeat this algorithmic view to the same extent as in the earlier study. Since this question was not the focus of this article, more research is required in order to investigate this issue further.
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