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► **To cite this version:**

Lovisa Sumpter, David Sumpter, Milena Tsvetkova. Upper secondary school students' gendered self-evaluation in mathematics. Twelfth Congress of the European Society for Research in Mathematics Education (CERME12), Feb 2022, Bozen-Bolzano, Italy. hal-03745863

**HAL Id: hal-03745863**

**<https://hal.science/hal-03745863v1>**

Submitted on 4 Aug 2022

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# Upper secondary school students' gendered self-evaluation in mathematics

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*Self-evaluation is considered one of the key concepts when trying to understand motivation, and it is gaining more interest especially when looking at the age span 15-18 years. Previous studies in self-evaluation and mathematics tend to use data from international large scales assessments, arriving with rather ambiguous conclusions, and smaller studies tend to use only one measure without control factors. The aim of this paper was to test the hypothesis that boys are more confident than girls in mathematics, while using Swedish as a control subject. A questionnaire was handed out to 399 upper secondary school students from different regions in Sweden, both vocational programmes and programmes preparing for further studies. Using both non-parametric analysis and linear regression, the results support the hypothesis. The relationship to the idea of confidence gap is discussed.*

*Keywords: Gender, mathematics, self evaluation, upper secondary school.*

## Introduction

One of the key concepts in affect in general and motivation in particular is self-evaluation (Nagy et al., 2010; Pajares, 2005). It contributes to perceived self-efficacy (Bandura, 1997), and can be seen as students' self-perceptions of their competence or ability. Previous studies have concluded that students base their mathematics self-concept largely on their experiences and history of achievement (Usher, 2009), and sex differences in grades cannot explain the gendering of career choices (Dekhtyar et al., 2018). In addition, meta-studies have concluded that girls most often have higher grades than boys, with the largest difference in language and smallest difference in mathematics (e.g. Voyer & Voyer, 2014), meaning that differences in self-concept most likely are not only due to grades. On a micro-level, self-evaluation as a concept is relevant since studies indicate that when students are asked to self-evaluate their capabilities or progress in learning a particular task, it encourages them to develop a higher level of competence and their self-efficacy beliefs are strengthened (Ramdass & Zimmerman, 2008). On a macro-level, some gender patterns have been identified where the overall conclusion is that boys tend to report higher levels in measures of self-evaluation (OECD, 2013), but studies also report that gender differences in mathematics self-concept are smaller in more egalitarian countries (Goldman & Penner, 2016), and that students' mathematical self-concept was strongly linked to their mathematical achievement, and that students that have low scores were the ones who overestimated their mathematical competence (Chiu & Klassen, 2010). It appears to be no unified picture how gender, mathematics, and self-evaluation is connected. The specific age span (15-18 years) is also of interest since this is when children/ adolescents are developing their academic self-perception, something that is gaining more attention especially with respect to gender differences

(Nagy et al., 2010). One interesting case is Sweden, a country with a reputation of its gender equality: Sweden is a country that is both wealthy and egalitarian, and a possible conclusion is that students should either have little gender differences and indicate low self-concepts (e.g. Goldman & Penner, 2016), or close connections with self-concept and achievement (e.g. Chiu & Klassen, 2010). Previous research signal mixed finding (e.g. Frid et al., 2021; Sumpter, 2012), including indications of gender confidence gap (e.g. Zander et al., 2020). This paper aims to look closer at upper secondary school students' self-evaluation in mathematics with respect to grades. We test the hypothesis that boys are more confident than girls in mathematics, a hypothesis that functions as the research question.

## **Background**

The starting point for the overview of the concept self-evaluation here is Festinger's (1954) theory of social comparison processes, where the focus is on social standards with the conclusion that there are no objective standards. The focus then was mainly on interpersonal comparisons, which was extended to include intergroup comparisons (Tajfel, 1974), that group membership provides a basis for self-evaluation. Other concepts describing similar aspects are self-concept (Shavelson, et al., 1976), and self-beliefs specific to one's perceived capability which includes, for instance, task-specific self-concept, self-concept of ability, and academic self-concept (Pajares, 2005). Here, the focus will be on self-evaluation, emphasising the process of evaluation: "the evaluation or judgment of 'the worth' of one's performance" (Klenowski, 1995, p. 146). Looking at gender, the chosen theoretical stance is that gender is a social construction, more than just a consequence of a biological sex (Connell, 2006). It means that gender is a pattern of social relations, which means that definitions of women and men depend on the context and under constant negotiation. In order to understand these patterns, one can divide gender into four different aspects: structural, symbolic, personal, and interactional gender (Bjerrum Nielsen, 2003). Structural gender covers social structures, and symbolic gender focus on the gender as attributed symbols and discourse. The symbols could be attributed in both ways. It can be that an object or an abstract concept that is considered male or female, such as the idea of mathematics as a male domain (e.g. Brandell & Staberg, 2008). It could also be about how men and women are perceived such as the 'the hard working female' and 'the male genius' (Leslie et al. 2015). Such symbols inform us what is considered normal and what is deviant (Bjerrum Nielsen, 2003). The third aspect, personal gender, focuses on how the individuals perceive the structure and the different symbols, which includes self-evaluations. The fourth aspect, interactional gender, covers interactions of individuals that take place within this context that comprises the structure and symbols.

Regarding the process of determine one's value, studies have shown that students are using multiple frames of reference when evaluating their mathematics ability and these self-evaluations are pretty robust (Skaalvik & Skaalvik, 2004a). Self-evaluations that were made using other students in class as an external frame of reference, and on comparison of mathematics achievement with achievement in other school subjects which function as an internal frame of reference, were both strong predictors to mathematics self-concept and self-efficacy. This implies that when studying self-evaluation in one subject, such as mathematics, using other school subjects as well calibrates the evaluations. Recent studies have shown that social economic status can play a role (e.g. McConney & Perry, 2010), but due to space the focus here is on gender. When following students from grade 7 and onwards, in the beginning boys expressed more positive self-concept and these differences persisted over time (Nagy

et al., 2010). Studies on older students reported similar results (e.g. Skaalvik & Skaalvik, 2004a). Others confirm the gender confidence gap: despite having higher or similar grades, girls reported lower self-evaluation/ self-efficacy and self-esteem in mathematics (Brandell & Staberg, 2008; Sumpter, 2012; Zander et al., 2020), but there is also indication that there is no significant difference looking at students (age 15) at lower secondary school (Frid et al., 2021). Further, when comparing mathematics with language, studies has indicated that male students, with respect to mathematics, signalled not only higher self- concept, intrinsic motivation, and self-enhancing ego orientation but also higher performance expectations compared to the female students (Skaalvik & Skaalvik, 2004b). However, when the focus was on language, women expressed higher intrinsic motivation.

## **Methods**

The data was generated through an online questionnaire that was part of a study of upper secondary school students and their work with a mathematical model exploring segregation (see Tsvetkova et al. (2016) for more information of the full study). In the study, a questionnaire was included with questions such as “How would you evaluate yourself in mathematics?” and a control question using an equally important subject, Swedish. The scale was Very good/Good/ Average/ Below average/ Weak, the same scale as in previous research allowing us to make comparisons (e.g. Brandell & Staberg, 2008; Frid et al., 2021). There was also a question about which grade they got in mathematics and Swedish in their latest course. There were also questions about factors related to their social economic status such as what their parents worked with and if they were planning to go to university. These questions are not analysed in the present study. In total, 399 participants (233 boys, 166 girls) from 20 upper secondary school classes were part of the study. The classes came from three different regions in Sweden (east, middle and west), covering all three grades meaning the age span was 16-19. Each class had between 13 to 25 students and they came from different educational programmes, both vocational ones and programmes preparing for university studies. The data were analysed in two stages. In the first stage we adopted a non-parametric approach, looking at the difference in proportion of combined answers to the two questions. For each self- grade, we calculated the proportion of girls and the proportion of boys who gave each of the five possible answers to the “How would you evaluate yourself in mathematics?” question. We then took the difference and expected a strong correlation between self-reported grades and self-evaluation, and by looking at differences within each grade division we could visualise differences for each grade independently. In the second stage, the data were analysed using linear regression to predict self-evaluation from self-reported grades, stated gender, and whether one parent (or more) was born in Sweden. In order to perform the regression, we converted both the self-reported grades and the self-evaluations to a numerical scale. Such a transformation is never entirely justifiable (hence the first stage of the analysis) but they can be seen as reasonable given the nature of the grade scale and self-reporting. Again, we expected that self-evaluation to be correlated with self-reported grades, so we included the variable in order to see how much additional predictive power gender has over and above this relationship. The background of parent was included as a control variable, allowing us to see whether one factor linked to social economic status could play a role (e.g. McConney & Perry).

## Results

The first results are about the responses about students' stated grades in mathematics and Swedish, see Table 1:

**Table 1: Distribution of stated grades in mathematics and Swedish, n(%)**

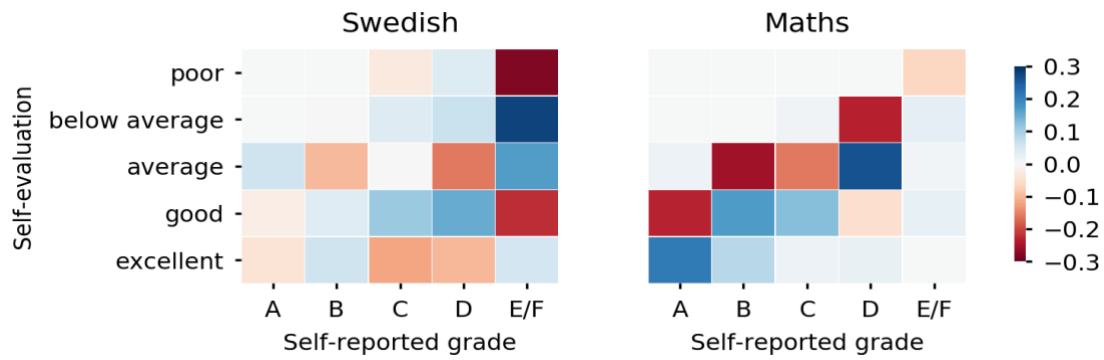
Subject/ Grade	A	B	C	D	E/F	No reply	Total
Mathematics	79 (19.8)	73 (18.3)	100 (25.1)	72 (18.0)	57(14.3)/ 8(2.0)	10 (2.5)	399
Boys	43 (18.5)	39 (16.7)	53 (22.7)	47 (20.2)	43 (18.4)		233
Girls	36 (21.7)	34 (20.5)	47 (28.3)	25 (15.1)	22 (13.2)		166
Swedish	92 (23.1)	123 (30.8)	115 (28.8)	34 (8.5)	20(5.0)/ 1(0.3)	14 (3.5)	399
Boys	37 (15.9)	64 (27.5)	80 (34.3)	24 (10.3)	18 (7.7)		233
Girls	55 (33.1)	59 (35.5)	35 (21.1)	10 (6.0)	3 (1.8)		166

In Table 1, Grade E and F is joined since so few students reported F. Girls report higher grades both in mathematics and in Swedish. The distribution of the self- evaluation was the following (Table 2):

**Table 2: Distribution of self-evaluation with respect to gender, n(%)**

Subject/ Self-evaluation	Excellent	Good	Average	Below average	Weak	No reply	Total
Mathematics	60 (15.0)	134 (33.6)	147 (36.8)	36 (9.8)	12 (3.0)	10 (2.5)	399
Boys	39 (16.7)	75 (32.2)	84 (36.1)	20 (8.6)	7 (3.0)		233
Girls	21 (12.7)	59 (35.5)	63 (37.9)	16 (9.6)	5 (3.0)		166
Swedish	85 (21.3)	165 (41.3)	116 (39.1)	15 (3.8)	4 (1.0)	14 (3.5)	399
Boys	38 (16.3)	95 (40.8)	75 (32.2)	13 (5.6)	2 (0.8)		233
Girls	47 (28.3)	70 (42.1)	41 (24.7)	2 (1.2)	2 (1.2)		166

Table 2 illustrates that boys tend to rank themselves higher compared to girls in Mathematics, but vice versa in Swedish. To analyse the different distribution presented in Table 2, which is only descriptive, we looked at students' self-evaluation in mathematics and stated grades in relation to expressed gender. As a calibration of the results, Swedish is used as a comparison. The results are from the calculation of the proportion of girls and boys evaluating in each category for each grade, then taking the difference. The darker blue colour indicates a more common answer by boys, whereas a darker red colour means a more common answer by girls, see Figure 1:



**Figure 1: Difference in proportion of boys minus girls' self-evaluations for each self-reported grade**

Figure 1 shows how the difference in self-evaluation between boys and girls depended on grade for both Swedish and Mathematics. For mathematics, we see that girls with a self-reported grade 'A' were more likely to rank themselves as 'good' than boys, while boys were more likely to rank themselves as 'excellent' than girls. Similarly, boys with a self-reported D were more likely to report themselves as 'average' than girls. The same pattern was repeated over all grades except E/F. In Swedish, the control factor, no such pattern was observed, with the possible exception of the self-reported grade 'E/F', where boys took 'below average' and girls took 'weak'. Based on this analysis, the conclusion is that girls under-valued themselves or boys over-valued themselves. The limitations are the small numbers, and therefore the next step is to validate these results using linear regression:

**Table 3: Titles of tables, figures, diagrams, are in the style FigTitle, no dot at the end**

Mathematics: Self-evaluation	Coefficient	Std. Error	t	<i>p</i>
Reported grade	0.512	0.031	16.20	< 0.001
Male	0.206	0.059	3.50	0.002
Swedish parent	-0.030	0.105	-0.28	0.782
Constant	1.83	0.127	14.32	< 0.001
Swedish: Self-evaluation				
Reported grade	0.454	0.045	10.04	< 0.001
Male	-0.015	0.076	-0.19	0.848
Swedish parent	-0.016	0.076	-0.20	0.841
Constant	2.20	0.210	10.47	< 0.001

The linear regression, Table 3, showed a strong relationship between self-reported grades and self-reported confidence in both mathematics ( $t = 16.20$ ;  $p < 0.0005$ ) and Swedish ( $t = 10.04$ ;  $p < 0.0005$ ). This reflects the correlation we see in Figure 1, model R-squared of 0.520. Only in mathematics did the 'boys' factor statistically significant in predicting self-reported grades ( $t = 3.50$ ;  $p = 0.002$ ). Table

3 provides non-standardized coefficients so we could reasonably interpret being male is associated with an average increase in self-evaluation of 0.206 points (where 1 point indicates a shift from average to good, or from average to excellent, etc.). In Swedish, being male was not statistically significant ( $t = -0.19$ ;  $p = 0.848$ ). The model R-squared was lower at 0.343. A control variable, whether the respondents had a Swedish-born parent, was not statistically significant in either regression. Taken together, these results strongly support the hypothesis that boys give themselves a higher level of self-evaluation compared to girls in relation to stated grades in mathematics.

## Discussion

The aim of this paper was to study upper secondary school students' self-evaluation with respect to stated grade and gender. The overview of the grades show that they are higher for girls, both in mathematics and Swedish, which is in line what have been reported earlier (e.g. Voyer & Voyer, 2014). The hypothesis that we tested was that boys are more confident than girls in mathematics. Just as in previous studies, both national (e.g. Brandell & Staberg, 2008; Sumpter, 2012) and international (e.g. Nagy et al., 2010; OECD, 2013; Skaalvik & Skaalvik, 2004a), the results, from the non-parametric analysis and linear regression, confirmed that boys choose higher self-evaluation in relation to stated grades compared to girls. The results are to some degree in contrast to Frid et al. (2021), and compared to the PISA study (i.e. Chiu & Klassen, 2010), boys overestimated their ability at all levels or girls undervalued themselves. It indicates that several studies are needed in order to understand the concept self-evaluation from a gender perspective: since individuals are using multiple frames of reference when they judge their evaluations (e.g. Skaalvik & Skaalvik, 2004a), such discrepancies can be related to which frame that is in focus (e.g. Sumpter, 2012). Given that the present study used a limited scope of the definition of self-evaluation compared to Klenowski (1995), there are room for further development of the instrument that was used.

Nevertheless, combining the results from the present study and previous research, the conclusion is that boys appear to over-value themselves or girls tend to under-value themselves. This supports the so-called confidence gap (Zander et al., 2020). In the present study and the results from the non-parametric analysis, the confidence gap was visible mainly in mathematics and only partly in Swedish where in the group of self-reported grade 'E', boys more often picked 'below average' and girls more often took 'weak'. Here, the results differ slightly from what has been previously reported regarding girls and language (e.g. Skaalvik & Skaalvik, 2004b). This could be interpreted as an indication of patterns within a more general pattern in self-evaluation. Also, if students construct their mathematics self-concept on their experiences and history of achievement (e.g. Usher, 2009) and girls have better grades (Voyer & Voyer, 2014), the history of achievement appears to be cancelled out. If we, for instance, want to understand why we have gendered careers (e.g. Dekhtyar et al., 2018), we need to look beyond grades. The confidence gap is nonetheless an interesting phenomenon especially if used to blame girls for being not confident enough, given that they are already confident (e.g. Sumpter, 2012) or not having good enough grades (e.g. Dekhtyar et al., 2018). This is important when ideas such as 'the hard-working female' and 'the male genius' (e.g. Leslie et al. 2015) still exists.

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