Gender differences in boys’ and girls’ perception of teaching and learning mathematics

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ABSTRACT
Gender differences between boys and girls in the perception of the classroom setting, and their relationship to achievement in mathematics and aspects of self-regulated learning skills are the focus for this article. Throughout the component analysis of answers from 6758 Swedish students we found some differences in how boys and girls perceive their classroom setting and some differences in boys’ and girls’ relationship to mathematics. According to the classroom setting, we found that boys feel that they use group work more than the girls do. Boys also feel that they have an influence over the content and are more involved during the lesson than girls. With respect to students’ relations to mathematics we found that boys perceive mathematics to be more important than girls do. One implication for teachers from the study points out how different aspects of a perceived learning environment affect students’, boys’ and girls’, achievement in mathematics.

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Introduction
The aim of this study is to investigate some gender differences between boys and girls in their perception of the classroom setting, and perception of classroom settings in relation to achievement in mathematics and aspects of self-regulated learning skills. In this introduction we therefore discuss mathematics as a gateway subject that separates students with respect to gender. Students’ perceptions of the classroom setting affect their beliefs in mathematics; we therefore discuss how different beliefs affect teaching and learning in the mathematics classroom. To conclude, we discuss the classroom setting and achievement in mathematics.

Gender differences in teaching and learning mathematics
Several researchers worldwide have discussed mathematics as a gateway subject that separates students despite their social background and their gender (Walkerdine, 1998; Weaver-Hightower, 2003). Some of the research on performance in mathematics has highlighted a traditional gender gap in favour of boys (Aunola, Leskinen, Lerkkanen, & Nurmi, 2016).
Explanations for the gender gap between boys and girls have focused on different factors. Traditionally, girls’ lower performance in mathematics was explained as relating to both internal and external contextual factors – for example, lower perceived support for learning mathematics (Eccles, 2011). Other studies attributed the girls’ drop in performance to their mathematics feelings that their classrooms were unattractive, uncomfortable and hostile. Factors of importance for girls’ performance in mathematics were teacher and peer support (Riegle-Crumb, Farkas, & Muller, 2006). Such results concerning mathematics are supported by general findings indicating that teacher and peer support are positively connected to academic attitudes, achievement, emotions, learning, motivation and self-efficacy (Danielsen, Wiium, Wilhelmsen, & Wold, 2010; Eccles & Roeser, 2011).

Gherasim, Butnaru, and Mairean (2013) found gender effects in such variables as achievement goals, classroom environments and achievement in mathematics among young adolescents showing that girls obtained higher grades in mathematics than boys. Girls reported (a) higher classroom support, lower performance-avoidance goals (Shim, Ryan, & Anderson, 2008) and (b) more mastery of the learning materials (Pekrun, Elliot, & Maier, 2006). Another important aspect found by researchers was teaching practice, especially the behaviour of the teacher, such as (a) being responsive and helpful (Patrick, Ryan, & Kaplan, 2007; Puklek Levpsucsek & Zupancic, 2009) (b) being supportive (Ahmed, Minnaert, van der Werf, & Kuyper, 2010). Yet another aspect, students’ attitudes, was studied by Jones and Young (1995), who found that boys had more favourable attitudes towards mathematics and science than girls. Emotions towards mathematics were studied by Frenzel, Pekrun, and Goetz (2007) who found that girls experienced less enjoyment and pride than boys. Boys, on the other hand, experienced less anxiety and less hopelessness towards mathematics than girls. They also found that girls felt slightly more shame than boys (Frenzel et al., 2007).

As Gherasim et al. (2013) argue, there is a need for more studies on gender differences in order to fill the gaps regarding mechanisms that are conducive to mathematical performances. The aim of this study is to interpret boys’ and girls’ experiences and perceptions of different aspects of the classroom setting in relation to their actual performances in math as reflected in their grades.

Beliefs and teaching mathematics

After McLeod and Adams’s (1989) work was presented, attitudes towards mathematics formed a central research topic in the affective domain (attitudes, beliefs and emotions). In recent research, focus has shifted from attitudes towards beliefs. In this study, we understand beliefs to be an individual’s subjective knowledge and emotions concerning mathematics (cf. Lester, Garofalo and Kroll, 1989); these relationships are based on their personal experiences (Pehkonen and Kaasila, 2011). How students are taught in mathematics will therefore have an impact on their beliefs (Pehkonen, 2001). Since beliefs
are the filter that regulates thinking and actions in mathematics-related situations, researchers can – by investigating students’ beliefs in mathematics – get an insight into what happens in the mathematics classroom (Pehkonen, 2001). Pehkonen (1995) divides students’ beliefs in mathematics into four subgroups: (a) beliefs on mathematics as subject, (b) beliefs on one’s ability to do mathematics, (c) beliefs on mathematics teaching and (d) beliefs on how to learn mathematics. The beliefs of teachers as well as students become an important factor which have a substantial impact on the quality of the teaching and learning process (Spangler, 1992; Pehkonen, 1995). Ernest (1991) describes five educational ideologies in mathematics while claiming that teachers’ views on the subject of mathematics affect their teaching and thereby student learning affordances. The first ideology is called the ‘industrial trainer’; in this ideology teachers see mathematics as a set of truths and rules. Teaching involves authoritarian processes, such as transmission and drill. Students’ learning is regarded as hard work, effort, practice and rote learning. The second ideology is called the ‘technological pragmatist’. In this ideology, mathematics is seen as an unquestioned body of useful knowledge. The teacher works as a skill instructor and motivates mathematics through its relevance to work. Learning is characterised by accumulating skills and practical experience. Ernest (1991) called the third ideology ‘old humanist’; the view of mathematics in this ideology is as a body of structured pure knowledge. Teachers explain, motivate and try to pass on the subject’s structure so that the student can understand and use mathematics and its applications. The fourth ideology, the ‘progressive educator’, is characterised by a teaching process in which teachers facilitate personal exploration and try to prevent failures. The learning process is marked by activity, play and exploration. The view of mathematics is a process view – personalised mathematics. The fifth and final ideology is called the ‘public educator’. Teachers using this ideology see mathematics as social constructivism where teaching involves discussions, cognitive conflicts, questioning of content and pedagogy. Students learn by questioning, decision-making and negotiation.

Thus, students’ beliefs on mathematics can teach us more about what teaching and learning practice they are involved in.

The classroom setting and achievement in mathematics

There are very few studies focusing on how different the classroom setting affects students’ procedural knowledge and conceptual understanding as well as self-regulated learning skills, but there are several studies that focus on closely related areas.

For learning in general, Granström (2006) showed that different teaching approaches in classrooms influenced the outcomes for students in different ways. Settings where students were allowed and encouraged to cooperate with classmates and teachers gave the students more opportunities to understand and succeed. Similarly, Oppendekker and Van Damme (2006) stressed that good teaching involves communication and building relationships with students. Boaler (1999, 2002) reported that practices such as working through textbook exercises or discussing and using mathematical ideas were important vehicles for developing flexible mathematical knowledge. One result of Boaler’s research was that students who had worked in textbooks performed well in similar textbook situations; they found it difficult, however, to use mathematics in open, applied or discussion-based situations. The students who had learned mathematics through group-based
projects were more able to apply their knowledge in a range of situations. Boaler’s research provided evidence for theory that context constructs the knowledge that is produced.

In a review of successful methods of teaching mathematics, Reynolds and Muijs (1999) discussed American as well as British research. One result of their review was that effective teaching was marked by a high number of opportunities for learning. The opportunity for learning was related to factors such as the length of school day and year, and the number of hours for mathematics classes. It was also related to the quality of classroom management, especially how much time was spent on-task during lessons. According to research in the area, achievement improved when teachers created classrooms that included (a) substantial emphasis on academic instruction and students’ engagement in academic tasks (Brophy and Good, 1986; Griffin and Barnes, 1986; Lampert, 1988; Cooney, 1994), (b) whole-class instruction (Reynolds and Muijs, 1999), (c) effective question–answer sessions and individual practices (Brophy, 1986; Brophy and Good, 1986; Borich, 1996), (d) a minimum of disruptive behaviour (Evertsson, Andersson, Andersson, & Brophy 1980; Brophy and Good, 1986; Lampert, 1988; Secada, 1992), (e) high teacher expectations (Borich, 1996; Clarke, 1997) and (f) substantial feedback for students (Brophy, 1986; Brophy and Good, 1986; Borich, 1996). Aspects of successful teaching are found in a traditional classroom (lecturing and drill) with one major exception. In successful teaching, teachers actively asked a great deal of questions, and students were involved in different sorts of class discussion. With the addition of active discussion, students were kept involved in the lesson and the teacher had a chance to continually monitor students’ understanding of the concept being taught.

On the other hand, negative relationships have also been found between teachers who spend a high proportion of time communicating with pupils individually and students’ achievements (Mortimer, Sammons, Stoll, Lewis, & Ecob, 1988; OFSTED, 1996). Students’ performance in mathematics was low when they practiced too much repetitive number work individually (OFSTED, 1996). A traditional direct-instruction/active teaching model seems to be more effective than a teaching model that focuses on independent work.

Another teaching model discussed in some literature is one dependent on cooperative, small-group work. The advantage of problem-solving in small groups lies in the ‘scaffolding’ process, whereby students helped each other advance in the Zone of Proximal Development (Vygotsky, 1934/1986). Giving and receiving help and explanations can broaden students’ thinking skills, and verbalising can help students structure their thoughts (Leiken and Zaslavsky, 1997). The exchange of ideas may encourage students to engage in higher order thinking (Becker and Selter, 1996). Students who worked in small groups developed an understanding of themselves and learned as well that other students have both strengths and weaknesses. Programmes that attempted problem-solving in small groups as a teaching method reported good results, such as improved conceptual understanding and higher scores on problem-solving tasks (Goos and Gailbraith, 1996; Leiken and Zaslavsky, 1997).

Samuelsson (2008) used a split-plot factorial design with group (i.e. traditional, independent work and problem-solving) as an intersubject factor, and time (i.e. before and after a 10-week intervention) as an intrasubject factor. In this design, the traditional approach meant that the teacher explained methods and procedures on the chalk board at the start of the lessons, and that the students then practised with textbook questions.
Independent work meant that students worked individually on problems from a textbook without a teacher’s introduction to the lesson; teachers just helped the students who asked for it. Problem-solving meant that students were introduced to different ideas and problems that could be investigated and solved using a range of mathematical methods. Students worked in groups of four; they discussed and argued mathematical questions with each other and with the teacher, both in groups and in whole-class discussions. There were a total of seven dependent variables in the study: three measures of mathematics abilities (a total score of mathematics ability, calculation and conceptual understanding), and measures related to self-regulated learning skills such as internal and instrumental motivation, self-concept and anxiety. The results showed that there were no significant interaction effects between group and time according to total mathematical ability and calculation. Differences in students’ progress in conceptual understanding could be explained by the teaching method. Traditional work as well as problem-solving seems to have more positive effects on students’ development of conceptual understanding than independent work does.

According to Samuelsson (2008), teachers seeking to develop aspects of self-regulated learning skills would be advised to use traditional work or problem-solving. The latter appeared to be more effective in developing students’ interest and enjoyment of mathematics than either traditional work or independent work. In addition, traditional work and problem-solving were more effective than independent work for students’ self-concept.

Thus, different teaching methods also seemed to influence students’ self-regulated learning skills such as interest, view of the subject’s importance, self-perception and attribution (Boaler, 2002). Students who were expected to cram for examinations described their attitudes in passive and negative terms. Those who were invited to contribute with ideas and methods described their attitudes in active and positive terms that were inconsistent with the identities they had previously developed in mathematics (Boaler, 2002). A negative attitude towards mathematics could be influenced, for instance, by too much individual practice (Tobias, 1987) as well as by teachers who investigates students’ insecurities. Students who did well in school (Chapman and Tunmer, 1997) demonstrated appropriate task-focused behaviour (Onatsu-Arvillomi and Nurmi, 2002), and they had positive learning strategies. If the students were reluctant in learning situations and avoided challenges, they normally displayed low achievement (Midgley and Urdan, 1995; Zuckerman, Kieffer, and Knee, 1998).

As a result, the choice of teaching method not only affected achievement in mathematics but also students’ self-regulated learning skills.

Predictions and specific research questions

The overall purpose of this study was to disclose some of the gender differences between boys’ and girls’ perceptions of the classroom setting. This included investigation of the relationship between perceptions of the setting and achievement in mathematics and aspects of self-regulated learning skills. We assumed that a number of interactional conditions are important for students’ achievement in math. There are certainly individual differences with respect to intellectual qualifications; in this study, however, we concentrated on contextual aspects in the sense of educational preconditions. A basic assumption was that these aspects were related to the students’ performances. The following
predictions and specific research questions were examined in relation to gender differences in students’ perceptions of the classroom setting and the relationship of these settings to achievement in mathematics, internal motivation and self-concept.

Our first aim was explorative and drew attention to differences in boys’ and girls’ perceptions of the classroom setting, internal motivation and self-concept. Thus, some predictions could be made: girls perceive greater classroom support than boys (Shim et al., 2008) and that boys perceive higher motivation and self-concept than girls (Frenzel et al., 2007). The research question was formulated as: Were there any differences between boys’ and girls’ perceptions of the classroom setting and relationship to mathematics?

Our second aim drew attention to the relationship between student’s perceptions of the classroom setting and achievement in mathematics. We predicted a relationship between students’ perceptions of the classroom setting and achievement in mathematics with respect to grades (Reynolds and Muijs, 1999; Boaler, 1999; Samuelsson, 2008). We also wanted to find out the extent to which students’ perceptions of the classroom setting predicted performance in mathematics with respect to grades for students in general and for boys and girls specifically. This research question was formulated as: To what extent do students’ perceptions of different classroom settings predict performance in mathematics?

Method
Participants

In order to investigate our research questions formulated above, we needed information about the students and the classroom setting, as well as their actual achievements. Using results from a national survey study covering 120 different comprehensive schools, data from 6758 students (school year nine, age about 16 years) were utilised. The data were selected from a larger questionnaire administrated by the Swedish National Agency of Education. This national investigation included questionnaires to teachers and parents as well; this study, however, was restricted to the students’ opinions.

Component analysis

In addition, although the entire questionnaire comprised about one hundred statements, we only used items relevant to our research questions. Twelve questions concerned the students’ relationship with mathematics. Thirty-five items gave information about the students’ perception of the learning environment. All items in the questionnaire were presented as statements to which the students had to respond on a four-point scale (disagree = 1; totally agree = 4). Students’ grades were collected from Statistics Sweden. The usual procedure is to look for the highest loadings, in order to produce the factor name (Magnusson, 2007); this procedure was used in the present study also. A Cronbach’s α reliability test was conducted on each factor.

Students’ relationship with mathematics: An entire section of the questionnaire, 12 items in all, dealt with students’ relationship to mathematics as a school subject. The principal component analysis, supplemented by a Varimax rotation factor analysis, resulted in two factors (49.2% of the variance was explained, eigenvalues were 3.9 and 2.0). Six items could be grouped under the heading ‘Mathematics is important’ (α = 0.83), a
factor that contains both internal and external aspects of motivation (cf. OECD, 2004). Six items comprised a factor called low self-concept in mathematics ($\alpha = 0.69$); these items indicate a negative relationship with mathematics. This factor contains questions about students’ choice of learning strategies (cf. OECD, 2004) (Table 1).

The classroom setting: Teachers arranged the classroom setting in different ways in order to facilitate learning and practice, which could be seen as part of the learning environment. The questionnaire accounted for the students’ perceptions of such learning conditions. As many as 35 items were relevant to this study. The principal component analysis followed by Varimax rotation on all 35 items investigated seven factors (54.3% of variance explained; eigenvalues = 8.1; 3.3; 1.8; 1.6; 1.4; 1.1; 1.1). The factors were labelled as shown below. The 35 items and the factor loadings are presented in Table 2.

1. Supportive environment: This factor was defined as a perception of supportive classroom conditions where students help each other, the teacher gives encouragement and there was a positive and fair atmosphere ($\alpha = 0.84$).
2. Participation: This factor indicates that the students were invited to influence their work conditions ($\alpha = 0.87$).
3. Objectives are communicated: High values show that the teacher clearly communicates objectives and expectations ($\alpha = 0.75$).
4. Group work: High values indicate that the teacher used a variety of work methods, such as projects, group tasks and authentic materials, and low values showed that students were mainly practicing individually ($\alpha = 0.63$).
5. Noisy and disorderly classroom: This concerns off-task behaviour in the classroom ($\alpha = 0.76$).
6. Teacher-centred classroom: High values showed that teachers used whole-class lessons to talk and discuss with the students ($\alpha = 0.72$).
7. Great demands: High values meant great demands and pronounced expectations from the teacher ($\alpha = 0.54$).

Students’ achievement: The Swedish school system is goal oriented, which means that education is governed by objectives. The students’ grades are to be related to these

Table 1: Items related to different factors influencing a student’s relationship to mathematics as a school subject

| Components          | Question                                                                 | Loading |
|---------------------|--------------------------------------------------------------------------|---------|
| Mathematics is interesting | (1) I’m interested in mathematics                                        | 0.892   |
|                     | (2) Math knowledge is important                                          | 0.805   |
|                     | (3) Adults think math is important                                       | 0.695   |
|                     | (4) Math knowledge is important in future education                     | 0.793   |
|                     | (5) Math knowledge is important in future work                          | 0.737   |
|                     | (6) I am going to use the math I learn in school                         | 0.747   |
| Mathematics is difficult | (1) I only work with math to prepare for the tests                      | 0.630   |
|                     | (2) I spend too much time learning math                                 | 0.507   |
|                     | (3) Math is a difficult subject                                         | 0.652   |
|                     | (4) I give up if the task is too difficult                              | 0.735   |
|                     | (5) I could have been better in math if I had tried more                | 0.574   |
|                     | (6) I’ve learned a lot of unnecessary things in math                    | 0.590   |
Objectives, which are competencies important in a subject like mathematics. Data accounted for students’ grades in mathematics and were divided into four categories: fail (1), pass (2), pass with distinction (3) and superior (4).

Data analysis

In order to answer our first aim an independent t-test was run with the intent of comparing means between boys’ and girls’ perceptions of the classroom setting, motivation and self-concept. Our second aim concerned the extent to which students’ perception of the classroom setting predicted performance in mathematics with respect to grades for students in general and boys and girls specifically. In order to answer our second aim, three multiple-regression analyses were conducted: one for students in general, and one each for boys and girls. The regression is a procedure used to estimate the relationship between multiple independent variables to one dependent variable. Each of the factors in the perception of the classroom setting was used as an independent variable, and achievement in math was

### Table 2: Items related to different factors in the learning environment at school.

| Components                        | Question                                                                 | Loading |
|-----------------------------------|--------------------------------------------------------------------------|---------|
| **Supportive environment**        | (1) I am pleased with the support I have received in grades 7–9          | 0.665   |
|                                   | (2) We have a nice, positive classroom environment                       | 0.445   |
|                                   | (3) My suggestions are taken seriously                                   | 0.493   |
|                                   | (4) I speak to the teacher if I have a problem with math                 | 0.522   |
|                                   | (5) I receive the support I need                                         | 0.761   |
|                                   | (6) The teacher has time to help me if I need help                       | 0.727   |
|                                   | (7) Math is a subject where students help each other                      | 0.487   |
|                                   | (8) The teacher supports and encourages me                               | 0.699   |
|                                   | (9) It is possible to show my skills in math                            | 0.653   |
|                                   | (10) The teacher gives me correct grades                                 | 0.608   |
|                                   | (11) I have learned most of my math skills in school                     | 0.404   |
| **Participation**                 | (1) The teacher plans the activities with students                       | 0.607   |
|                                   | (2) The students influence the selection of content                       | 0.808   |
|                                   | (3) The students influence the selection of method                       | 0.782   |
|                                   | (4) The students influence how long they will work with a task           | 0.803   |
|                                   | (5) The students influence the math tests                               | 0.669   |
| **Objectives are communicated**   | (1) The teacher investigates students’ math skills before he/she starts to teach a new topic | 0.452   |
|                                   | (2) The students are informed of what they should learn according to the national curriculum | 0.753   |
|                                   | (3) The teacher communicates his/her expectations to students            | 0.744   |
|                                   | (4) The students are informed of what they should do to earn different grades | 0.734   |
|                                   | (5) The teacher and student communicate about the student’s achievement in math | 0.357   |
| **Group work**                   | (1) The students work in groups                                          | 0.726   |
|                                   | (2) The students work with individual tasks                              | −0.411  |
|                                   | (3) The students work on projects                                        | 0.725   |
|                                   | (4) The students work on tasks out of the textbook                      | 0.517   |
| **Noisy and disorderly classroom**| (1) The students do not listen when teacher talks                        | 0.777   |
|                                   | (2) Our classroom is noisy and disorderly                                | 0.840   |
|                                   | (3) It takes a long time to start working during lessons                 | 0.793   |
| **Teacher-centred classroom**     | (1) The teacher talks, and the students listen                           | 0.835   |
|                                   | (2) The teacher talks and asks questions, and the students answer        | 0.845   |
|                                   | (3) Teachers and students discuss math problems                          | 0.543   |
| **Great demands**                | (1) I have been working with too many easy tasks in grades 7–9           | −0.280  |
|                                   | (2) I have been working with too many difficult tasks in grades 7–9      | 0.625   |
|                                   | (3) The teacher places demands that are too high on me                    | 0.589   |
used as dependent variables in the regression equations. The relationship between different environmental aspects and achievement in math can thus be scrutinised.

Our first research question was how different samples, boys and girls, compared in the perceptions of their classroom setting and motivation and self-concept. This was performed on raw scores across the entire sample. The alpha level was set to \( p < .001 \). This alpha level is rather lenient for comparisons of each factor between the samples. Because of the total sample size for mean comparison between boys’ and girls’ perception of their classroom setting, rather small and unimportant differences between samples may be statistically significant. We therefore also calculated the magnitude of mean differences between samples using Cohen’s \( d \) as an effect size measure. Cohen’s \( d \) estimations between 0 and .3 are considered to be small and moderate; effect sizes above .3 were commented on.

Because of all the tests done in the regression and the total sample size of students’ perceptions of their classroom setting, rather small correlations may be statistically significant, \( p < .05 \). Therefore we also applied a Bonferroni correction for setting the alpha level \( p < .05 \). The outcome of Bonferroni’s test suggested an alpha level lower than \( p < .007 \). With the support of the Bonferroni test, we only commented on correlations on a significant level (\( p < .007 \)).

**Results**

The result will be presented in two sections: (a) gender differences in perception of the classroom setting, and (b) perception of classroom setting in relation to achievement in math.

**Gender differences in perception of the classroom setting**

Descriptive statistics and effect size estimates for mean differences between samples are given in Table 3. Mean comparisons on individual measures indicated significant sample differences in six of seven factors: (a) supportive environment, (b) participation, (c) communication of objectives, (d) group work, (e) teacher-centred classroom and (f) great demands. After Cohen’s effect size test there were just two factors left to discuss, participation and group work. The predominating pattern for the significant factors is that boys > girls. Boys felt that they were more invited to influence their work conditions than girls,

| Classroom setting                  | Boys       | Girls      | \( d \)    |
|------------------------------------|------------|------------|------------|
| Supportive environment             | 1.84 0.36  | 1.79 0.38  | 0.13***    |
| Participation                      | 1.60 0.56  | 1.44 0.49  | 0.31***    |
| Communication of objectives        | 1.79 0.39  | 1.68 0.41  | 0.28***    |
| Group work                         | 0.48 0.40  | 0.34 0.34  | 0.38***    |
| Noisy and disorderly classroom     | 2.29 0.54  | 2.30 0.53  | 0.03 ns    |
| Teacher-centred classroom          | 2.12 0.52  | 2.05 0.52  | 0.15 ***   |
| Great demands                      | 0.44 0.33  | 0.51 0.31  | 0.23 ***   |

\( ***p < .001 \)
and they felt that mathematics learning contained a greater portion of group work than girls.

We also wanted to analyse if there were any differences in students’ relationship to mathematics with respect to motivation and self-concept. The results showed a significant difference between how boys and girls perceive their relationship to mathematics with respect to the importance of the subject and its difficulty. Thus, Cohen’s $d$ indicates only a small or moderate effect size.

**Perception of the classroom setting related to achievement in math**

In the third analysis, students’ perceptions of their classroom setting were regressed on their achievements with respect to grades. All standardised regression coefficients for the equation are given in Table 4. The multiple regression coefficient is $R = 0.41$, $F(7.4940) = 141.2$, $p < .001$.

Perceptions of a supportive environment, participation, communicated objectives, group work and a teacher-centred classroom seemed to have a positive impact on students’ achievement in this regression equation. The strongest predictor was supportive environment, which that predicted grades twice as much (.25) as participation (.10), well communicated objectives, (.14) and group work (.12). Participation, properly communicated objectives and group work predicted almost three times more than teacher-centred classrooms (.04). If the students perceived great demands, it had a negative effect on their achievement.

In the fourth analysis, boys’ perceptions of the classroom setting were regressed onto their achievement. All standardised regression coefficients for the equation are given in Table 6. The multiple regression coefficient is $R = 0.41$, $F(7.2423) = 70.406$, $p < .001$. A supportive environment, properly communicated objectives and group work significantly influenced boys’ grades in mathematics in a positive way. One predictor negatively affected boys’ achievement in mathematics: great demands.

In the fifth analysis, girls’ perceptions of the classroom setting were regressed on their achievement. All standardised regression coefficients for the equation are given in Table 5 as well. The multiple regression coefficient is $R = 0.41$, $F(7.2509) = 71.019$, $p < .001$. A supportive environment, students’ participation, properly communicated objectives and group work influenced girls’ achievement in mathematics. Once again, great demands were a negative predictor for students’ achievement, this time for the girls.

There are some differences in the regression equations for boys and girls that could explain differences in achievement in mathematics. A supportive group environment for girls seemed to predict high grades in math in a greater way than a supportive group

| Relationship to mathematics | Boys | Girls | $d$ |
|----------------------------|------|-------|-----|
| Mathematics is important   | 2.32 | 2.27  | 0.12*** |
| Mathematics is difficult   | 1.61 | 1.63  | 0.07*** |

**Table 4**: Means and standard deviation of boys’ and girls’ perception of different aspects of their relationship to mathematics and effect size estimation for differences between samples

***$p < .001$
environment for boys. Participation, as well as properly communicated objectives, affected
girls’ achievement in a more positive way than boys. Boys were more sensitive to great
demands and group work than girls were. In the next part of the article, these differences
are discussed in relation to earlier research in associated areas.

Discussion

The overall aim of this study was to investigate whether there were gender differences
with respect to students’ perceptions of the classroom setting, their relationship to math-
ematics and how perceptions of the classroom setting were related to performance in
mathematics. The following two research questions were examined: (a) Were there any
differences between boys’ and girls’ perceptions of the classroom setting and relationship
to mathematics, and (b) to what extent do students’ perceptions of different classroom
settings predict performance in mathematics?

The beliefs of teachers as well as students became a significant element with consider-
able influence on the quality of the teaching and learning processes in the mathematics
classroom (Spangler, 1992; Pehkonen, 1995). Studying students’ subjective knowledge
and emotions concerning mathematics can give researchers an insight into what
happens in the mathematics classroom (Pehkonen, 2001). The results of this study show
that boys and girls perceive mathematics instruction differently, constructing different
filters that regulate thinking and actions in mathematics-related situations (cf. Pehkonen,

Table 5: Regression coefficients of students’ perception of their classroom setting and achievement in mathematics

|                                | B     | t     |
|--------------------------------|-------|-------|
| Supportive environment        | 0.25  | 14.18*** |
| Participation                 | 0.10  | 5.8*** |
| Objectives are communicated   | 0.14  | 8.14*** |
| Group work                    | 0.12  | 7.84*** |
| Noisy and disorderly classroom| 0.01  | 0.61 ns |
| Teacher-centred classroom     | 0.04  | 2.45*  |
| Great demands                 | -0.28 | -20.39*** |

*p < .05  
***p < .001

Table 6: Regression coefficients of boys’ and girls’ perception of their learning environment and achievement in math

| The classroom setting                     | Boys     | t    | Girls  | t    |
|-------------------------------------------|----------|------|--------|------|
| Supportive environment                    | .22      | 8.81*** | .27    | 11.06*** |
| Participation                             | .08      | 3.09**  | .12    | 5.11*** |
| Objectives are communicated               | .13      | 5.11*** | .15    | 6.14*** |
| Group work                                | .14      | 6.12*** | .10    | 4.61*** |
| Noisy and disorderly classroom            | .01      | 0.50 ns | .03    | 1.33 ns |
| Teacher-centred classroom                 | .03      | 1.65 ns | .03    | 1.66 ns |
| Great demands                             | -.28     | -14.75***| -.27   | -14.24*** |

**p < .01  
***p < .001
Students’ perceptions of the classroom setting – perceptions that construct their beliefs – also predict their grades. These results are consistent with other studies (Spangler, 1992; Pehkonen, 1995), which show that beliefs in teaching and learning mathematics are an important factor for students’ performance in mathematics.

There are critics who argue that there is a low correlation between teaching factors and students’ achievement (Dunkin and Biddle, 1984), and it is reasonable to believe that there is an even lower correlation between beliefs in mathematics and students’ achievement. The proportion of variance explained in students’ perceptions of the learning environment ranged around 17% on achievement in math. Factors that affect students’ achievement are thus additive; this means that a change in one area could be an important improvement in the students’ learning (Davies and Thomas, 1989). The classroom setting seems to affect boys and girls in the same proportion, around 17%.

**Gender differences**

We found some differences in how boys and girls perceive their classroom setting and some differences in boys’ and girls’ relationship to mathematics. According to the classroom setting, we found that boys feel that they use group work more than the girls do. Boys also feel that they have an influence over the content and are more involved during the lesson than girls. Such perceptions could be explained by the fact that teachers usually interact more with boys than with girls (Kelly, 1988). This is often done for several reasons, such as classroom management, where instructions directed towards boys, who traditionally are believed to be more disruptive, function as a way to prevent them from going off-task. According to teachers’ beliefs, on the other hand, girls are more often thought of as self-regulating and on-task. Girls who are less involved or not involved at all in the classroom setting tend to focus even more on their own work, neither offering help nor seeking it from others (Gherasim et al., 2013). According to earlier research (Lubienski, Robinson, Crane and Ganley, 2013), girls are also believed to have better mathematical proficiency than boys. In a classroom setting based on such a belief, girls get less attention and are not involved in classroom communications to the same degree as boys, which could be a reason they feel that they have less influence about what is done and which mode is used. These gender differences could reflect the extent to which boys and girls perceive teachers as supportive (Gherasim et al., 2013).

As regard relationship to mathematics, we found that boys perceive mathematics to be more important than girls do. Even if boys are more often considered to be representatives of anti-school culture, recent findings (Nyström, 2012) showed that boys also value knowledge and good grades. Boys’ relationship with mathematics could be understood as if they have realized the necessity for knowing and handling mathematics in order to be able to work in professions such as engineer, architect or scientist – all still seen as more ‘male’. We found some differences in how boys’ and girls’ perceive their classroom settings and relationship to mathematics. Such findings could be understood as an effect of teachers’ beliefs on girls as frequently more able than boys to focus and keep on-task on their own. The perception of mathematics as difficult could be strengthened by the fact that girls are not as involved as boys and not as often a part of communications about mathematics as boys are, a conclusion in line with earlier research (Jones & Young, 1995). It could also be
understood as an expression of girls having low beliefs in their own competence (Frenzel et al., 2007).

**The classroom setting and achievement in mathematics**

Boys’ and girls’ perceptions of the classroom setting predict grades. Their perceptions explain 16% of the variation in grades. The strongest predictor with respect to perceiving the classroom setting was a supportive group environment, with a small but statistically significant positive contribution to students’ (.25), boys’ (.22) and girls’ (.25), achievement in math. These results are consistent with earlier research that argues for the importance of a supportive group environment (Danielsen et al., 2010; Eccles, 2011; Eccles & Roeser, 2011). A supportive group environment seems to predict achievement in mathematics slightly better for girls than for boys.

It is statistically significant that students who feel that they participate in decisions regarding working methods in classroom and what content should be taught perform better than students who do not participate in these types of decisions. Such results are in contrast to earlier findings (Gherasim et al., 2013) who found no significant correlation between the availability of teacher support and better grades. Such a result could be understood as boys’ perceptions that they are seen and heard in the classroom, as an aspect of being offered more communication with teachers, affect the sense of participation that have a certain influence or at least being involved in decision-making.

The relationship between group work and achievement in mathematics indicates a small positive contribution to student’s achievement in math. This study does not support Crocker’s (1986) findings that the most effective learning method in mathematics is traditional mathematics teaching, where teachers talk and students sit alone and practice their skills. In this study, group work predicted grades three times more accurately than the traditional mathematics teaching described by Crocker (1986). One explanation is that teachers who teach using group work draw attention to other qualities important to students’ mathematical proficiency, such as adaptive reasoning and communicative ability, than just procedural knowledge (Case, 1996).

An important predictor of achievement in mathematics is the teacher’s communication of objectives and expectations. Earlier research (cf. Gherasim et al., 2013) has shown the importance of knowing the goals of an activity for being successful. It is also reasonable to believe that if we know what we are looking for, it should be easier to find it. The results of this study showed a positive relationship between the factor – properly communicated objectives – and achievement in mathematics.

A learning environment that is felt to be characterised by too great demands negatively affects students’ achievement – both boys’ and girls’ – in mathematics. In the Swedish National Curriculum in the early 1960s, one could read of the importance of choosing the right examples. Teachers had to consider the students’ knowledge in the subject before they decided what content they should be taught and how. The same thoughts returned in the National Curriculum of 1980. To be able to start in a new area, students must show sufficient knowledge of earlier parts. The results of this study therefore reinforce the importance of how the teacher chooses content and put reasonable demands on their students. It is obvious that teachers make a difference (Behets, 1997;
It is the teacher who chooses examples that affect the learning environment, and potential encounters between students and the subject.

**Implications for teachers**

We agree with earlier research (Behets, 1997; Evertson, 1986; Evertson, Hawley, and Zlotnik, 1985; Fetler, 2001; Gherasim et al., 2013; Hofmeister and Lubke, 1990; Ma, 1999; Patrick et al., 2007; Puklek Levpuscek & Zupancic, 2009; Shim et al., 2008) arguing that teachers make a difference, since they are responsible for the interactional conditions in classroom. The results of this study point out how different aspects of a perceived learning environment affect students’, boys’ and girls’ achievement in mathematics.

Effective mathematics instruction seems to be the same for both boys and girls. A classroom setting in which they perceive a supportive group environment, properly communicated objectives, participation and reasonable demands are positive factors in achievement in mathematics.

This study also tells us something about how to help boys and girls achieve higher grades. Teachers need to help girls participate more in classroom decisions and help boys work individually, since the classroom setting is a positive factor in achievement in mathematics.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

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