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Classroom disciplinary climate of schools and gender - evidence from the Nordic countries

BENT SORTKÆR^{1,2} & DAVID REIMER¹

¹*Department of Education, Aarhus University, Denmark*

²*VIA University College*

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Abstract

Classroom disciplinary climate has emerged as a crucial factor with regard to student achievement. However, most previous studies have not explored potential gender differences in both students' perceptions of the classroom disciplinary climate and the association between classroom disciplinary climate and student learning. Using data from the OECD Programme for International Student Assessment 2012 for the Nordic countries, we found a significant association between the perceived classroom disciplinary climate of schools and students' mathematics performance across countries. Based on an analysis of a pooled sample consisting of all five Nordic countries, we found that the correlation between classroom disciplinary climate of schools and maths achievement is significantly stronger for boys than girls. Further analyses showed that this finding may partly be attributable to gender differences in the perception of the disciplinary climate of schools, whereby boys seemed to perceive the classroom disciplinary climate of schools more positively than girls.

Keywords: Classroom disciplinary climate of schools, Student perceptions, Mathematics, PISA, Gender differences

Introduction

According to general learning theories, student learning is influenced by the surroundings (Vygotsky, 1978). As such, an orderly classroom environment can be considered a key prerequisite enabling student learning in schools. Research on various aspects of the disciplinary climate in schools and classrooms supports this assumption. A number of meta-analyses have established that the disciplinary climate in schools and classrooms is an important factor in relation to student achievement (Hattie, 2009; Scheerens, Witziers, & Steen, 2013; Wang, Heartel, & Walberg, 1993), and numerous studies have reported statistically significant and substantively important effects of disciplinary climate on student achievement (Arum & Velez, 2012; Figlio, 2007; Marks, 2010; Ning, Van Damme, Van Den Noortgate, Yang, & Gielen, 2015; Teodorović, 2011). For example, recent reports published by the Organisation for Economic Co-operation and Development (OECD) (2010, 2013b), as well as Ning et al. (2015), all based on data from the Programme for International Student Assessment (PISA) 2009, reported a sizable association between classroom disciplinary climate of schools and student performance. In the latter study, the authors found that 11 % of the between-school differences in reading achievement across countries could be explained by the classroom disciplinary climate of schools, even if the association between classroom disciplinary climate of schools and achievement varied in important ways between national contexts.

While scholars tend to agree on the importance of classroom disciplinary climate for learning outcomes, gender differentials in the association between classroom disciplinary climate and academic achievement have received very little attention so far. This is surprising given the considerable focus on gender differentials in academic achievement in the research literature in recent years (Diprete & Buchmann, 2013; Klein, 2007; OECD, 2015; Weaver-Hightower, 2003). The issue of a so-called “boy crisis” (Duckworth & Seligman, 2006; Husain & Millimet, 2009; Jóhannesson, Lingard, & Mills, 2009;

Watson, Kehler, & Martino, 2010; Weaver-Hightower, 2003)¹, i.e. the fact that boys seem to be overrepresented among students with low academic achievement, has often been linked to issues related to discipline and attention span that are particularly prevalent among boys. Boys are, for example, much more likely to be diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) (Ramtekkar, Reiersen, Todorov, & Todd, 2010). Furthermore, there is an emerging body of literature on peer effects which has shown that boys seem to be more susceptible to peer effects than girls (Anderson, 2008; Anelli & Peri, 2016; Legewie & DiPrete, 2012; Stevenson, 2015). The focus on boys' scholarly problems has already had important political ramifications. In Denmark, for example, special "boy academies" were recently founded in order to support the reintegration of boys with very poor academic performance into the school system (Andersen, Nissen, & Poulsen, 2016).

It follows that the goal of the current paper is, firstly, to explore whether there is a relationship between classroom disciplinary climate of schools and mathematics achievement in the Nordic countries, and secondly, to find out to what extent the relationship between classroom disciplinary climate of schools and student achievement varies across student gender. Finally, a third goal of this paper is to explore whether possible gender differences can be attributed to gender specific perceptions of the classroom environment, given that girls might view the classroom climate more positively than boys do (Goh & Fraser, 1998).

¹ It should be mentioned, however, that Husain & Millimet (2009) have disputed that there is a sizable difference between boys' and girls' academic achievement in the United States.

For our analysis, we used PISA data from 2012² and focused on the five Nordic countries: Denmark, Finland, Iceland, Norway and Sweden. These countries are well-suited for classroom climate analysis as they have very similar school systems with “late tracking”; i.e. students are not sorted into different school tracks at the time of their participation in PISA (at age 15) (Brunello & Checchi, 2006). In educational systems that sort students at an earlier point in their schooling, the relationship between classroom disciplinary climate of schools and student achievement could be a result of the homogeneity of schools (Kaplan, Gheen, & Midgley, 2002). Another advantage of focusing on the Nordic countries is that they are relatively similar to each other with respect to school resources (OECD, 2013a), as well as questions regarding attitudes towards gender equality (Inglehart & Norris, 2003). Limiting the analysis to these countries also reduced the likelihood of response bias; e.g. the problem that concepts based on Likert scales measurement might provide culturally biased estimates (Kjærnsli & Lie, 2011; Ning et al., 2015, p. 4). However, even within the Nordic countries, cross country comparisons must be interpreted with caution given important differences in the organization of schooling (e.g. Modin, Karvonen, Rahkonen, & Östberg, 2015).

The remainder of the paper is organized as follows: next, we review the literature on the relationship between classroom disciplinary climate and learning outcomes, focusing on gender disparities; then we describe the data, methods and measures used in the analyses; after that, we present the results of our analyses; finally, in the last section, we summarize the results and discuss the implications for research and practice.

² As a consequence of PISA’s sampling procedure (see section on data), perceptions of the classroom climate can only be aggregated at the level of schools. While classroom-level analyses would be preferable, we argue that schools share a common culture as well as other characteristics which allow for reliable school-level analyses (also see Ning et al., 2015, p. 18). The school-level intra-class correlations ICC(1) further support this assumption (from .08 in Finland to .17 in Iceland).

Literature review

In recent years, a multitude of studies have focused on the disciplinary climate in schools and classrooms. However, how disciplinary climate has been defined and operationalized varies considerably across these studies. Some studies viewed the disciplinary climate as a part of the broader concept of school climate (Ma & Klinger, 2000; Ma & Willms, 2004; M. Wang & Degol, 2016), while others saw it as related to incidents of bullying, victimizing, fighting, absenteeism and suspension (Arum & Velez, 2012; Goh & Fraser, 1998; Marks, 2010). Here, we consider disciplinary climate to be an isolated everyday phenomenon as perceived by the students inside the classroom. We describe the classroom disciplinary climate in terms of disruption, noise and disorder, and students not listening to what the teacher says - all of which happens inside every classroom on a more or less frequent basis. In the following, we report results from studies using an aggregated measure of the classroom disciplinary climate either at the classroom level (classroom disciplinary climate: CDC) or at the school level (classroom disciplinary climate of schools CDS). Drawing on the same set of PISA data items³ as this paper (see the paragraph on measures below), several studies have examined the relationship between CDS and student achievement (Cheema & Kitsantas, 2014; OECD, 2005; Shin, Lee, & Kim, 2009). These studies all found a significant relationship between CDS and student learning outcomes. Shin et al. (2009), for example, found a significant relationship between CDS and achievement in mathematics in Korea, Japan and the US. In an Australian longitudinal study, Marks (2010) combined PISA 2003 data with tertiary education entrance performance (“ENTER score”) to explore which aspects of schooling are related to tertiary education entrance performance and found a significant association between the CDS at the age of 15 and the individual student’s ENTER score two or three years later.

³ available in the 2000, 2003, 2009, 2012 and 2015 cycles of PISA

A variety of studies have studied the relationship between classroom disciplinary climate and learning outcomes for students at earlier stages using other data sources than the PISA studies (Blank & Shavit, 2016). Teodorović (2011), for example, used classroom level data and found that an orderly classroom climate (students paying attention and/or not arguing with each other) in Serbian primary schools was associated with higher achievement in both mathematics and Serbian language. Goh & Fraser (1998) defined the classroom disciplinary climate in terms of fighting and being unkind and found that, in Singaporean classrooms, a better CDC was associated with both higher student achievement and higher student affective outcomes (students aged 10-11). In a Canadian study, Ma & Klinger (2000) found the CDS in fourth grade (rules and compliance) to be significantly related to achievement in mathematics, science and writing, but not in reading.

A related body of literature has identified relationships between classroom management and student performance. The operationalization of classroom management in these studies draws on some of the same (or similar) items used by PISA to measure the classroom disciplinary climate. These studies used classroom-level data from both the primary (Baumert et al., 2010; Fauth, Decristan, Rieser, Klieme, & Büttner, 2014; Kunter et al., 2013) and secondary school level (Klieme, Pauli, & Reusser, 2009) and found significant associations between classroom management and student achievement.

In summary, the relationship between classroom disciplinary climate of schools and classrooms and achievement is well established across different countries, different student age groups and with different constructs of the classroom disciplinary climate. Despite this evidence of a link between classroom disciplinary climate and academic achievement and the considerable attention to gender differentials in academic achievement cited above, only few studies have examined whether the relationship between classroom disciplinary climate and achievement is heterogeneous across student gender. A handful of studies have explored gender differentials in the perception of classroom climate,

while very few studies have examined whether the classroom disciplinary climate has a gender-specific effect on student achievement.

Following the first strand of research, as to whether boys and girls *perceive* the disciplinary climate differently, most of the available studies have found that girls perceive the disciplinary climate more positively than boys do (Goh & Fraser, 1998; Koth, Bradshaw, & Leaf, 2008; Kuperminc, Leadbeater, Emmons, & Blatt, 1997; Ma & Willms, 2004). However, all of these studies measured the disciplinary climate using indicators related to fighting, not being safe and bullying, and hence measured other aspects of the disciplinary climate than the level of noise and disruption. While these studies agree that girls perceive the disciplinary climate more positively than boys, a Swedish study by Samuelsson & Samuelsson (2016) and a US study by Fan, Williams & Corkin (2011) found no difference in the perception of classroom disciplinary climate between boys and girls. Finally, based on qualitative interviews in upper secondary schools in the UK, Warrington, Younger & Williams (2000) concluded that the boys in their study claimed to be less bothered by noise and disruptive behaviour than girls.

The second strand of research addresses whether there is a gender differentiated *effect* of the classroom disciplinary climate (Cheema & Kitsantas, 2014; Younger, Warrington, & Williams, 1999). Cheema & Kitsantas (2014) used US data from PISA 2003 to explore possible gender differentiated effects of CDS on mathematics achievement, but found no such differences. In a second study, based on classroom observations in secondary schools in the UK, Younger et al. (1999) found that boys are more easily distracted than girls. It thus seems that boys are more easily distracted than girls and therefore might be more affected by the classroom disciplinary climate than girls, although the authors of this study did not report if such distractions had an effect on achievement. This conclusion is partly supported by Legewie & DiPrete (2012) which showed that boys are more affected by favourable as opposed to unfavourable classroom SES composition than girls. They argued that students with high motivation and

achievement from high-SES backgrounds form an academically oriented environment in schools that “suppresses boys’ negative attitudes toward school, and facilitates academic competition as an aspect of masculine identity” (Legewie & DiPrete, 2012, p. 468). Even though Cheema & Kitsantas (2014) were not able to find any significant gender differentiated effects of classroom disciplinary climate on achievement, we tentatively hypothesize that boys are more affected by the classroom disciplinary climate than girls – in part because we expect boys to view the classroom disciplinary climate more negatively than girls.

However, none of these existing studies has investigated both strands of research in combination; that is, whether a differentiated *effect* of the classroom disciplinary climate is due to gender specific *perceptions* of the classroom disciplinary climate. We used student reports on the classroom disciplinary climate to cast some light on this issue, firstly by analysing whether the association between CDS and student achievement was different for boys and girls and secondly by exploring whether boys and girls experienced the CDS differently.

Data, methods and measures

Data

We drew on data from the Programme for International Student Assessment (PISA) study from the year 2012, which offered a unique insight into the relationship between CDS and student achievement among 15-year-olds. PISA is a triennial large-scale international assessment study performed by the OECD aimed at testing the skills and knowledge of 15-year-olds from all over the world. Other large-scale international assessment studies, such as TIMSS (Trends in International Mathematics and Science Study) or PIRLS (Progress in International Reading Literacy Study), also include some measures for the

disciplinary climate. However, the disciplinary climate measures in these studies focus more on bullying or experiences of victimization rather than indicators for a classroom disciplinary climate that provides an orderly atmosphere for teaching. Besides focusing on the mathematical ability of the students, PISA 2012 included information on a range of student and school characteristics, as well as on how students perceived the disciplinary climate in the classroom during maths lessons. This information was gathered from questionnaires completed by students and headmasters. These properties made PISA 2012 well-suited for our analyses.

PISA 2012 used a two-stage sampling design where the first stage sampling units were schools with 15-year-old students enrolled and the second stage sampling units were 15-year-old students.

We selected the Nordic countries, Denmark, Sweden, Norway, Iceland and Finland, for our analysis. As mentioned earlier, these countries share the characteristic of having very heterogeneous schools in terms of student population. The Nordic countries have in common that none of them track students before the age of 16; they have a low degree of grade repetition; they have few students outside the modal starting age; and they have a low proportion of schools that group students by ability in all lessons (Brunello & Checchi, 2006; European Communities, 2003; OECD, 2010). These structural conditions should ensure a sufficient degree of heterogeneity among students in every classroom in terms of their cognitive ability. Furthermore, these countries are all highly developed Western nations with extensive education systems, thereby minimizing problems related to the comparability of country-specific findings.⁴

PISA 2012 used a rotation design for their student questionnaire, meaning that only two thirds of the student sample answered the relevant questions concerning the classroom disciplinary climate. As a

⁴ According to the Human Development Index, all five countries were among the top 24 most developed societies in 2012 (UNDP, 2014).

result, 9,887 observations were removed from our sample. We also removed students not attending the modal grade level from the sample (2,135 observations) to avoid unnecessary noise in the measurement of CDS. In Denmark, for example, this resulted in the exclusion of all students not attending 9th grade. We likewise excluded 166 schools (1,070 observations) with less than ten students in the sample to reduce possible outlier biases and ensure a reliable aggregated classroom CDS construct (Kunter & Baumert, 2007)⁵, resulting in an analytic sample based on 16,148 observations (55 % of the original sample) in 970 schools.

Methods

We ran multi-level models to address dependence among observations within the same school and to deal appropriately with individual-level and school-level variance components (Snijders & Bosker, 2012). Furthermore, multi-level models allowed for the estimation of cross-level interactions between, for example, individual and school-level variables (Aguinis, Gottfredson, & Culpepper, 2013). The individual student was regarded as level one in the model and the grade and school as level two. The measure for the CDS was considered a level two variable since it was compiled as an aggregate of all students in the same grade at a given school. We started by running a null model containing only the dependent variable, mathematic achievement, to estimate the within-, and between-school variance in order to calculate the intraclass correlation (ICC(math)), before adding covariates on both analytic levels. Our model then looked like this:

$$Y_{ij} = \beta_0 + \beta_1 CDS_j + \beta_2 gender_{ij} + \beta_3 SC_j + \beta_4 ST_{ij} + \mu_j + \varepsilon_{ij} \quad (1)$$

⁵ 155 schools (958 observations) were dropped due to school samples with less than 10 observations. An additional 11 schools (112 observations) had to be excluded because fewer than 10 students had provided answers to the classroom disciplinary climate items.

where γ_{ij} is the maths score of student i in school j , CDS_j is a measure of the CDS in school j , $gender_{ij}$ is the gender of student i in school j , SC_j are school level characteristics, ST_{ij} are student level characteristics, μ_j are unobserved characteristics of school j , and ε_{ij} are unobserved characteristics of student i within school j . To check for gender specific differences in the relationship between CDS and maths score, we added a cross-level interaction between CDS and gender to the model:

$$\gamma_{ij} = \beta_0 + \beta_1 CDS_j + \beta_2 gender_{ij} + \beta_3 CDS_j * gender_{ij} + \beta_4 SC_j + \beta_5 ST_{ij} + \mu_j + \varepsilon_{ij} \quad (2)$$

The model was calculated separately for each country. Stata (SE) 14.2 was used for all analyses.

Measures

Our main dependent variable was the PISA maths test score of the students. The scale was derived from five plausible values and the weighted average OECD mean of these values was 500 with a standard deviation of 100 (OECD, 2014). All models were calculated with each of the five plausible values as dependent variable and we reported the average coefficient estimates, standard errors and significant levels (Rutkowski, Gonzalez, Joncas, & von Davier, 2010).

The measure for the disciplinary climate was based on student responses on how often the following things happened in their mathematics lessons: “students don’t listen to what the teacher says”; “there is noise and disorder”; “the teacher has to wait a long time for students to quieten down”; “students cannot work well”; and “students don’t start working for a long time after the lesson begins”. These answers were used to build a student-level classroom disciplinary climate index, which was standardized and

centred with a grand mean of zero and a variation of one. A higher number indicates a more positive classroom disciplinary climate. The index had acceptable reliability coefficients with Cronbach's Alphas between .88 and .90 in all countries.⁶ To construct the aggregated grade level averages, we used information from all students in the relevant grade who reported a value for the relevant variable in the data set, not just the students in our final sample. By using this procedure, we lowered the sampling error in our aggregated disciplinary climate measure that is due to non-respondents (Lüdtke, Marsh, Robitzsch, & Trautwein, 2011). This procedure combined with PISA 2012's high response rate⁷ lead to a relatively low level of sampling error. The aggregated grade level classroom disciplinary climate construct was likewise standardized and centred with a grand mean of zero and a variation of one.

To capture key characteristics that are typically associated with academic achievement, we controlled for gender, language spoken at home, country of birth, socioeconomic status (SES), school type and school mean SES. In a Canadian study, Frempong, Ma & Mensah (2012) identified a relationship between CDS and access to postsecondary education in an initial analysis. However, this relationship disappeared when the control variables just described were added to the model. We also controlled for the size of the city in which the school is located, given that previous research from Denmark has documented regional differences in the prevalence of negative disciplinary climate (Egelund & Hansen, 1997). We controlled for student and family characteristics at the student level and grade and school characteristics at the school level (Table 1).

⁶ We conducted principal component factor analyses in STATA 14.2 for each gender and each country separately to test whether the CDS scale performed equally well for the male and female samples and for each of the five Nordic countries. Factor loadings for each of the five items were almost identical across genders and countries.

⁷ Weighted student participation rates after replacement are: Denmark 96 %, Finland 99 %, Iceland 99 %, Norway 95 %, and Sweden 99 % (OECD, 2014, p. 186).

Table 1. Descriptive statistics

Variable	Denmark		Finland		Iceland		Norway		Sweden	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Dependent variable										
scoreMATH	515.37	128.02	529.73	131.55	495.32	113.43	488.78	154.30	481.10	130.30
Independent variables										
Student characteristics										
Female	.54	.50	.51	.50	.49	.50	.49	.50	.49	.50
SES	.09	.98	-.03	.90	.47	.95	.04	.92	-.18	.97
speak test-language	.96	.18	.97	.18	.96	.20	.92	.27	.91	.28
born test-country	.96	.20	.98	.14	.91	.29	.93	.26	.93	.25
School characteristics										
CDS	.39	.96	-.44	.85	.28	.98	.18	.92	-.16	.93
meanSES	.07	.47	-.06	.34	.47	.41	.03	.36	-.18	.41
Urban	2.47	1.06	2.83	.90	2.80	1.07	2.54	.97	2.70	1.03
Public	.73	.44	.97	.18	1.00	.00	.99	.11	.87	.34
Number of students	3,417		4,682		2,096		3,016		2,937	
Number of schools	253		278		83		180		176	

Source: PISA 2012, Own calculations.

The variables for gender, language spoken at home, country of birth and school type (public vs. private) were dummy coded and the variable urban, ranging from 1 (rural) through 5 (a large city with >1,000,000 inhabitants), was placed on an ordinal scale, whereas the variables measuring SES at the individual and at the school level were continuous. SES was a composite measure based on the student's response regarding parental educational level (coded as years of schooling according to the International Standard Classification of Education), parental occupational status (based on the International Socio-Economic Index of Occupational Status) and number of household possessions, including books in the home (OECD, 2014, p. 351). The student level SES measure was standardized with a grand sample mean of zero and a variation of one. The variable mean SES was an aggregated school level average of the SES variable.

Missing data

Overall, the proportion of missing values was not high for most variables⁸, which is why we chose a simple imputation approach. Following the procedure suggested by OECD (2009, p. 317), the missing values on SES were replaced by the school-level average. For the dichotomous variables country of birth, language spoken at home, and school type, we treated missing values as another category in order to keep these observations in the multivariate analyses. Coefficient estimates for these missing categories were not reported in the regression tables. Finally, missing values on the urban variable were replaced by the country modus.

⁸ Missing values: SES: 85, country of birth: 77, language spoken at home: 545, and urban and school type: 441 (due to 33 school leaders who did not complete the school questionnaire).

Results

Before turning to our multivariate analysis, we consider the prevalence of different aspects of disciplinary climate in mathematics lessons in the selected countries as reported by the students based on the variables used to construct the CDS index. There were considerable differences between the five selected countries and, based on Figure 1 below, it seems obvious that CDS - or the lack thereof – was an issue in all of the selected countries, although values were not too different from the OECD average.

Figure 1. Percentage of the students who report that these incidents happen in most or every lesson

Likelihood ratio test statistics comparing our multi-level null models to single-level null models showed strong evidence of school effects ($X^2 = 99$ to 308 , $df = 1$, $p < 0.05$). This indicates that multi-level models are appropriate. From these multi-level null models, we obtained the between and within school variation in maths score and, on this basis, calculated the intraclass correlation ($ICC(\text{math})$), as displayed in Table

2. The intraclass correlation in maths of the five Nordic countries was relatively low compared to the rest of the OECD countries participating in PISA 2012. The average ICC(math) in the Nordic countries was .11 whereas the average for the rest of the participating countries was .44 (min: .21 in Ireland, max: .71 in the Netherlands), indicating that the selected countries did indeed have very heterogeneous schools in terms of mathematics achievement. As expected, the relationship between the CDS and maths achievement did not seem to be the result of sorting mechanisms leading to schools with either high performing and well behaving students or low performing and disruptive students.

Table 2. Within- and between school variance. Full Sample. PISA-score in math as dependent variable

	Denmark	Finland	Iceland	Norway	Sweden
τ^2 : between groups	712.08	387.05	812.65	1016.65	912.52
σ^2 : within groups	4974.80	5661.31	7377.20	6620.20	6433.02
Total	5686.88	6048.36	8189.85	7636.85	7345.52
ICC(math)	.13	.06	.10	.13	.12

Multi-level model estimates for the relationship between CDS and maths achievement were reported in Table 3 (Model 1). The estimates for Denmark, Iceland, Norway and Sweden showed a significant and nontrivial association between the CDS and the students' mathematics performance, while the parameter estimate for Finland was not statistically different from zero. A coefficient estimate of 8.75 in Sweden, for example, translates to an improvement of 8.75 points in the PISA test for all students in the grade if the CDS were to improve by one standard deviation, holding all other independent variables fixed. The estimates in Denmark, Iceland and Norway were 9.86, 9.27 and 10.70 respectively.

Table 3. Multilevel regression models on student achievement in mathematics

	Denmark		Finland		Iceland		Norway		Sweden		Pooled sample	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Intercept	469.88*** (9.79)	469.86*** (9.80)	524.57*** (14.00)	526.57*** (14.09)	437.89*** (14.73)	437.83*** (14.71)	495.28*** (19.69)	495.38*** (19.63)	433.36*** (11.63)	434.29*** (11.60)	459.02*** (6.28)	459.33*** (6.26)
Student characteristics												
Female	-19.76*** (2.85)	-19.71*** (3.19)	-7.69** (2.65)	-10.08*** (2.95)	2.74 (4.95)	3.90 (5.65)	-3.21 (3.21)	-3.27 (3.36)	-1.30 (3.02)	-2.37 (2.99)	-6.30*** (1.55)	-6.42*** (1.54)
SES	22.78*** (1.65)	22.77*** (1.64)	19.97*** (1.77)	19.98*** (1.78)	19.88*** (2.22)	19.82*** (2.22)	20.79*** (2.03)	20.79*** (2.03)	19.11*** (1.78)	19.09*** (1.77)	20.27*** (.92)	20.25*** (.92)
speak test-language	26.67*** (6.88)	26.66*** (6.88)	28.46*** (4.89)	28.34*** (4.87)	33.29** (12.06)	33.20** (12.05)	19.33* (7.79)	19.33* (7.79)	29.29*** (6.22)	29.28*** (6.22)	26.04*** (3.46)	26.01*** (3.45)
born test-country	25.31*** (6.60)	25.31*** (6.60)	5.97 (6.69)	5.92 (6.66)	8.14 (7.13)	8.10 (7.16)	12.04† (6.91)	12.04† (6.91)	19.37** (6.47)	19.72** (6.45)	17.05*** (3.48)	17.08*** (3.47)
School characteristics												
CDS	9.86*** (1.92)	9.94*** (2.11)	2.58 (2.00)	5.31* (2.63)	9.27*** (2.70)	11.48* (4.46)	10.70*** (2.13)	10.55*** (3.12)	8.75*** (2.07)	12.22*** (2.82)	5.85*** (1.25)	8.06*** (1.55)
meanSES	14.94*** (4.31)	14.94*** (4.31)	14.68** (5.01)	14.75** (5.03)	23.73*** (7.15)	23.75*** (7.14)	32.84*** (6.45)	32.85*** (6.45)	17.09** (5.77)	17.09** (5.78)	19.72*** (3.09)	19.71*** (3.09)
Urban	-1.29 (1.50)	-1.29 (1.50)	-5.05** (1.93)	-5.18** (1.93)	2.96 (2.57)	2.88 (2.58)	3.04 (2.44)	3.04 (2.44)	4.74* (2.15)	4.62* (2.15)	2.89* (1.21)	2.87* (1.20)
Public	4.77 (4.59)	4.77 (4.59)	-7.38 (9.45)	-7.77 (9.56)	0 (omitted)	0 (omitted)	-43.65** (14.89)	-43.72** (14.75)	5.18 (5.28)	4.83 (5.31)	.80 (3.52)	.60 (3.52)
Cross level interaction												
CDS#girl		-14 (2.46)		-5.40* (2.74)		-4.12 (5.46)		0.30 (4.02)		-6.70* (3.01)		-4.35** (1.52)
Number of students	3,417	-	4,682	-	2,096	-	3,016	-	2,937	-	16,148	-
Number of schools	253	-	278	-	83	-	180	-	176	-	970	-
Derived estimates												
R ²	.23	.23	.11	.11	.14	.14	.16	.16	.19	.19	.17	.17
R ² - student level	.16	.16	.09	.09	.07	.07	.09	.09	.13	.13	.11	.11
R ² - school level	.72	.72	.40	.40	.75	.76	.60	.60	.63	.63	.47	.47

Note: Models estimated by maximum likelihood. Standard error in parentheses. The coefficient for public could not be estimated due to an insufficient number of private schools in the Icelandic sample.

† p<0.10; * p<0.05; ** p<0.01; *** p<0.001 (two-tailed tests).

Estimates for the other independent variables in the model pointed in the expected direction; e.g. SES had a statistically significant and positive relationship with student achievement in all countries, whereas not speaking the test language at home had a significant and negative relationship with student achievement in all countries. Not being born in the country of the test language was associated with lower mathematics scores in some of the selected countries. Boys did better in mathematics than girls in Denmark and Finland while there was no gender difference in the other countries.

Looking at the school level variables, students seemed to do much better in mathematics if they attended a school with a high mean SES. The variable urban was negatively related to maths achievement in Finland and positively related to maths achievement in Sweden. Attending a public sector school was negatively associated with student achievement in Norway; however, as there were only two private schools in the Norwegian sample, this result should not be given much attention.

Differences between male and female students

In the next model (Model 2), we added a cross-level interaction between gender and CDS. As outlined previously, we expected boys to be more susceptible to a negative disciplinary climate. The sign of the interaction was negative in all but one country (Norway). However, only in Finland and Sweden were the coefficients estimated precisely enough to reach statistical significance.

Figure 2. The relationship between classroom disciplinary climate of schools and mathematics performance by gender. Pooled sample

Given that the size and direction of the interaction between gender and CDS seemed to be similar across countries (except for Norway), we ran the same model (Model 2) with a pooled sample comprising all students from the Nordic countries (Table 3). The coefficient estimates for the interaction in this model indicated that, across all countries, boys were significantly more affected by the CDS than girls were; for each unit on the CDS index, boys' mathematics scores changed by an additional 4.35 points in

the PISA maths test compared to girls. The differential slopes for girls and boys are illustrated in figure 2. This finding might thus be in line with the findings of Younger et al. (1999) that boys are more easily distracted than girls and thus more affected by the CDS.

Gender differences in the perception of CDS

To explore whether the gender differentiated relationship between CDS and student achievement (in Finland and Sweden as well as in the pooled sample) was due to a gender difference in the perception of the classroom disciplinary climate, we used the student level classroom disciplinary climate index as the dependent variable in a multi-level random intercept model and tested whether girls and boys experienced the classroom disciplinary climate differently (Table 4). We assumed that boys and girls were equally distributed among schools⁹.

In all five countries, boys seemed to perceive the classroom disciplinary climate more positively than girls did, even if none of the country specific gender coefficients were statistically significant. However, the relationship between gender and perceived classroom disciplinary climate was significant in the pooled sample, indicating that, across the Nordic countries, boys were experiencing a more positive classroom disciplinary climate than girls in spite of attending the same school/grade and potentially the same class. This finding is quite surprising given that the majority of previous studies found the opposite pattern (Goh & Fraser, 1998; Koth et al., 2008; Kuperminc et al., 1997). However, this difference could potentially be related to different operationalizations of the classroom disciplinary climate. While we used the classroom disciplinary climate as defined above, Koth et al. (2008) applied a school climate measure that consisted of items measuring student safety and student fighting, and Kuperminc et al. (1997) used a measure for school climate which included items such as student-teacher relations, fairness

⁹ There are only very few exceptions from this assumption in our data.

and parental involvement alongside items measuring order and discipline. This implies that our result

Table 4. Multilevel regression on classroom disciplinary climate as perceived by the individual student as dependent variable

	Denmark	Finland	Iceland	Norway	Sweden	Pooled
Female	-.05 (.04)	-.05 (.04)	-.05 (.05)	-.05 (.03)	-.04 (.04)	-.05* (.02)
Number of students	3,360	4,611	2,031	2,919	2,857	15,778
Number of schools	253	278	83	180	176	970

Note: Models estimated by maximum likelihood. Standard error in parentheses. In all five countries we controlled for mathematics performance, SES, spoken language, country of birth, urban, school type and meanSES.

† p<0.10; * p<0.05; ** p<0.01; *** p<0.001 (two-tailed tests).

might only be partially comparable to these previous studies.

To learn more about how gender differences in the perception of classroom disciplinary climate might influence gender differences in the relationship between CDS and mathematics achievement, we conducted an explorative analysis based on the pooled sample of all Nordic countries. In order to eliminate the difference in perception between genders, we constructed gender-specific CDS indices for each school by using only the male (female, respectively) responses regarding classroom disciplinary climate. In other words, we considered our results in two counterfactual scenarios in which only boys' and then only girls' perceptions of classroom disciplinary climate were considered as indicators for the disciplinary climate for the entire grade. The results of these two analyses (Appendix, Table A1) revealed, firstly, that the main effects of CDS were significant and almost equal in size if considering either the male or female CDS index in isolation. The cross-level interaction, however, was -6.78 and significant in the model based on the boys-index, indicating that the CDS had a larger effect on boys than on girls, and this effect was larger using the boys-index than the original CDS index. The opposite pattern can be observed for the interaction with the girls-index. Here the coefficient was $-.68$ and non-significant, indicating that there was no differentiated effect of CDS. While a precise interpretation of this result is quite complex, we tentatively conclude that gender differences in perception of classroom disciplinary climate and the measurement of CDS in general are essential for conclusions regarding whether or not boys and girls are differentially affected by classroom environment factors. Overall, the issue of whether and why boys and girls perceive the classroom environment differently certainly needs more attention in future research.

Discussion and conclusion

Using data from PISA 2012, we found a statistically significant and nontrivial relationship between classroom disciplinary climate of schools (CDS) and mathematics test achievement among 15-year-old students attending the same grade in Denmark, Iceland, Norway and Sweden, indicating that, in these countries, a more positive CDS was associated with better performance in the PISA maths assessment, net of other relevant individual and school-level factors.

Adding a cross-level interaction between gender and CDS to the model, we examined whether there was a gender difference in the magnitude of the relationship between CDS and student achievement. We found that, in Finland and Sweden, boys were more affected by the CDS than girls were, while there was no significant relationship in the other Nordic countries. However, a pooled sample revealed a statistically significant gender difference across all five Nordic countries. To simplify, improving the CDS might have a larger impact on boys than on girls. If this finding was true across all school subjects, improved CDS could contribute to a reduction of the achievement gap between boys and girls – at least in Finland and Sweden. Contrary to findings from previous studies on gender differences in the perception of school and classroom climate, we did not find that girls perceive the disciplinary climate more positively than boys. A pooled sample of all Nordic countries actually indicated the opposite: namely, that boys perceived the classroom disciplinary climate more positively than girls did.

As is the case for most analyses based on large-scale assessment data such as the PISA study, there are some concerns related to the validity of the findings we present. Due to the cross-sectional nature of the analysed data, reciprocity between disciplinary climate and learning is quite possible (Zimmermann, Schütte, Taskinen, & Köller, 2013). Furthermore, omitted variables might mediate the relationship between classroom climate and learning. The CDS might thus be the result of other underlying explanatory factors, such as disorganized teaching or the absence of classroom management.

But, even if that were the case, we consider the CDS to be an important mediating variable for students' learning outcomes. A country/school-level implication of this finding is an increased focus on teacher training in the complicated task of cultivating a positive CDS, as this might indirectly influence student achievement.

While these methodological concerns are not new, the presented analyses raise important questions in relation to school environment research. In light of the gender differences we discovered, it seems to be advisable to account for relevant group differences in perception and effects of the classroom environment in future research. Furthermore, we only studied gender differentials in maths achievement, a subject in which boys typically outperform girls. Future research will have to address whether these differentials can be replicated in other subjects and grade levels. Furthermore, in addition to student gender, socioeconomic background, ethnicity and other stratification variables might lead students to experience the classroom in different ways and thus mediate the effects of classroom environment.

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Table A1. Multilevel regression on student achievement in mathematics. Pooled sample

	Shared perspective	Girls' perspective	Boys' perspective
<i>Model without interaction</i>			
CDS	5.85*** (1.25)	4.70*** (1.18)	4.31*** (1.22)
<i>Model with interaction</i>			
CDS#girl	-4.35** (1.52)	-.68 (1.39)	-6.78*** (1.55)
Number of students	16,148	16,148	16,137
Number of schools	970	970	969 ¹

Note: Models estimated by maximum likelihood. Standard error in parentheses. We controlled for mathematics performance, SES, spoken language, country of birth, urban, school type and meanSES.

¹ One school has no boys in the sample, and is therefore not included in this model.

† p<0.10; * p<0.05; ** p<0.01; *** p<0.001 (two-tailed tests).