# Chapter 10
# Can Teachers' Instruction Increase Low-SES Students' Motivation to Learn Mathematics?

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**Abstract** Students' motivation in mathematics has been shown to predict their achievement and whether they pursue a later career in STEM (science, technology, engineering, and mathematics). To sustain equity in education, it is important that students are motivated for the STEM fields, independent of their background characteristics (e.g., gender and SES). Previous research has revealed that students' motivation declines from primary to secondary school. The present study investigates whether this unwanted development may be related to students' SES, and more importantly, what aspects of teachers' instruction are related to student motivation for low, medium, and high-SES student groups in grade 5 and 9. We use data from students in grades 5 and 9 and their teachers who participated in TIMSS 2015 in Norway. Multilevel (students and classes), multi-group structural equation modelling is used to answer the research questions. In line with previous research from Germany and the USA, the results showed that SES is more important to student motivation in secondary than primary school, that low SES students' motivation depends more on their teachers' instructional quality than high SES students and that this dependency is stronger in secondary school than in primary school. The implications and contributions of the study are discussed.

**Keywords** Instructional quality · Student motivation · Socio-economic status · TIMSS

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High performance and more positive attitudes towards schooling among disadvantaged 15-year-old students are strong predictors of success in higher education and work later on (Organisation for Economic Cooperation and Development [OECD], 2018.

## 10.1 Introduction

Various research studies have reported strong positive correlations between students' intrinsic motivation to learn mathematics and factors such as academic proficiency, the cultivation of science, technology, engineering, and mathematics (STEM) careers, and the fostering of feelings of well-being in school (Jansen, Schroeders, & Lüdtke, 2014; Mullis, Martin, Foy, & Hooper, 2016; Watt & Eccles, 2008; Wigfield et al., 2015). Apart from intrinsic motivation's importance for improving test scores and future career choices, it is one of the preconditions for shaping a positive learning process at school (Organisation for Economic Cooperation and Development [OECD], 2012) and is a non-cognitive skill related to later success in life, determining adolescents' socio-economic outcomes (Korbel & Paulus, 2018). We also know that parental socio-economic status (SES) has a positive effect on students' academic proficiency and motivation (Kriegbaum, Jansen, & Spinath, 2015; Sirin, 2005; Tenenbaum & Leaper, 2003).

In short, enhancing *all* students' intrinsic motivation is viewed as critical to sustaining equity in education (Mullis et al., 2016; Musu-Gillette, Wigfield, Harring, & Eccles, 2015; OECD, 2018; Simpkins, Davis-Kean, & Eccles, 2006; Spinath & Steinmayr, 2012).

A robust and problematic finding across studies is that while children have high levels of intrinsic motivation to learn mathematics when they enter school—and it remains relatively high throughout elementary school—by the end of lower secondary school, they tend to have considerably less motivation (Corpus, McClintic-Gilbert, & Hayenga, 2009; Fauth, Decristan, Rieser, Klieme, & Büttner, 2014; Gottfried, Fleming, & Gotfried, 2001; Mullis et al., 2016; Steinmayr & Spinath, 2009). This drop in students' motivation may negatively affect their decision to continue with upper secondary education and discourage them from choosing STEM careers (OECD, 2012). Although this decline in intrinsic motivation is well documented, it remains unclear what factors are involved in this unwanted development. For instance, few studies have investigated whether high- and low-SES students experience the same drop in intrinsic motivation to learn mathematics during the aforementioned period. There are even fewer studies that have investigated whether students from different SES groups profit to the same extent from high-quality instruction.

Indeed, students' intrinsic motivation has been found to be affected by teachers' instructional quality (InQ), which is an important agenda embedded in educational policies (Farrington et al., 2012; Korbel & Paulus, 2018). Various studies have examined the association between dimensions of InQ and intrinsic motivation, and some promising results have been reported. Kunter, Baumert, and Köller (2007) found that higher levels of classroom management may positively affect students' intrinsic subject-based motivational development in mathematics. Other instructional aspects, such as providing a supportive classroom climate and affording high levels of instruction clarity and cognitive challenges, have also been found to enhance student motivation to learn mathematics (Baumert et al., 2010; Klieme, Pauli, & Reusser, 2009; Scherer & Nilsen, 2016; Seidel, Rimmele, & Prenzel, 2005; Wigfield et al., 2015). Such findings suggest that aspects of InQ are important in seeking to heighten students' intrinsic motivation to learn mathematics. However, little research attention has been paid to analysing whether students from different SES groups profit to the same extent from high-quality instruction. Kyriakides, Creemers, and Charalambous (2019) argued that from an equity perspective, it is extremely important to examine whether factors that are found to contribute to better student outcomes positively affect all groups of students similarly, including those who are more disadvantaged. They claim that such analyses could make a valuable contribution to designing educational systems that improve opportunities for low-SES students to succeed in school. Our study addresses this thematic challenge.

The present study's aim is twofold: First, it investigates how the SES of students in Norway is associated with intrinsic motivation to learn mathematics in the fifth grade compared to the ninth grade. Second, for these two grade levels, it examines how InQ is associated with students' intrinsic motivation among different SES groups of students.

## 10.2 Theoretical Framework

In this section, we will present the key concepts used in our overall framework, namely *equity*, *InQ*, and *motivation.* We will also provide a short review of previous research relevant to our analysis, particularly research into how motivation and InQ are related to SES and student outcomes.

### *10.2.1 Equity*

In distinguishing between the concepts of 'equality' and 'equity' as used in the educational discourse, Espinoza (2007) argues that while equality is funded upon ideas from the French Revolution (liberty, equality and fraternity), asserting sameness in treatment for all people, equity is related to aspects of fairness and justice in the provision of education, or what could also be labelled 'social justice' (see Chap. 2). He contends that the equity concept allows for individual considerations and treatment and claims that in certain situations the concepts of equality and equity may seem to be mutually 'opposed' to one another (Espinoza, 2007). For example, achieving greater equity within a school system by affording students individually adapted support may sometimes entail a reduction of equality when understood as the same treatment for all students (see Chap. 2 for an elaboration of these concepts). In line with these considerations, Kyriakides and Creemers (2011) argue that there is general agreement that equity does not imply everyone is the same or should achieve the same outcomes. However, differences in outcomes should not be attributable to factors related to student SES.

In line with the previously described studies, equity in our chapter implies that development of motivation towards mathematics is not linked to a student's background. In order to achieve this, some students may be provided with adapted resources, such as high-quality teachers.

One of the most important objectives in many educational systems worldwide is to provide equitable opportunities and fair learning environments to *all* students to ensure that they have the chance to realize their academic potential, regardless of gender, ethnicity, or SES (Opheim, 2004). Within this context, when schools provide fair and inclusive teaching practices and fairly distribute educational tools and resources, they play a central role in compensating for unjustifiable differences in student outcomes that are attributable to their background (Field, Kuczera, & Pont, 2007; OECD, 2012). These two equity dimensions—fairness and inclusion—reflect the principal idea of effective schooling behind such large-scale international surveys as the *Trends in International Mathematics and Science Study* (TIMSS) and the *Programme for International Student Assessment* (PISA), which, among other school factors, emphasize the teacher's role in helping children overcome their socio-economic barriers to reach their full learning potential (Field et al., 2007; OECD 2012, 2018).

However, analyses of TIMSS and PISA have proved that many challenges remain in efforts to ensure equity in students' learning outcomes (Field et al., 2007; Gustafsson, Nilsen, & Hansen, 2016; OECD, 2012, 2018; Schmidt, Burroughs, Zoido, & Houang, 2015). It is important to examine the individual mechanisms that may undergird the association between students' SES and learning outcomes, as well as *whether* and *how* school-related factors—school organization, curriculum, recruitment of teachers and students, and InQ—can positively impact these mechanisms (Creemers & Kyriakides, 2008; Scheerens, 2014).

To sum up, with educational policies across several countries addressing the issue of enhancing student motivation as an outcome in itself, a need still exists for more knowledge about the relationship between students' SES and their intrinsic motivation. The present study will address this literature gap. Additionally, in light of Espinoza's (2007) definition of equity, along with the foregoing and the insight from Creemers and Kyriakides (2008) that more research is needed into how school factors may compensate for students' SES, selected InQ dimensions will be analysed to investigate *whether* and *how* they may contribute to students having equitable and fair opportunities to succeed.

### 10.2.2 Instructional Quality (InQ) and Its Relationship to Student Outcomes

In the educational research field, it has been acknowledged that the InQ construct should be viewed as having various aspects or dimensions (Fauth et al., 2014; Kane & Cantrell, 2010; Klette, 2015; Wagner et al., 2015). Baumert et al. (2010) and Klieme et al. (2009) have been particularly influential in developing InQ scales that have been used in several European educational studies, including PISA and TIMSS. In the present study, four InQ dimensions are measured: *classroom management,; supportive climate, clarity of instruction, and cognitive activation*.

#### 10.2.2.1 Classroom Management

This InQ dimension focuses on classroom rules and procedures, how the teacher copes with disruptions, and how efficiently transitions are managed (Fauth et al., 2014). Such characteristics are viewed as essential to providing students with opportunities to learn (Dorfner, Förtsch, & Neuhaus, 2018; Pianta & Hamre, 2009). In several meta-studies, efficient time and classroom management have been found to be associated positively with student outcome measures, particularly achievement (Hattie, 2009; Seidel & Shavelson, 2007). Baumert et al. (2010) contend that this dimension is viewed as a particularly robust InQ measure.

#### 10.2.2.2 Supportive Climate

The description of this InQ aspect builds on reports from motivational research studies, covering certain important aspects of the teacher–student relationship, such as constructive feedback and a generally positive approach to student misconceptions and errors. It also includes a teacher's caring behaviour toward students (Good & Brophy, 2000; Klieme et al., 2009). An important finding related to research of this dimension is that teacher support and scaffolding are crucial elements for heightening student engagement in insightful learning processes (Pianta, Nimetz, & Bennet, 1997). Thus, a supportive climate has been found to predict student interest and stimulate the development of a student's intrinsic motivation (Fauth et al., 2014; Klieme et al., 2009).

#### 10.2.2.3 Clarity of Instruction

This InQ aspect is understood as a teacher's ability to provide clear and coherent presentations of content, goals, and tasks, which can be done through, for example, overviews, advance organizers, outlines, and periodic summaries (Brophy & Good, 1986). Another key feature of this dimension is linking instruction to students' prior knowledge to allow new information to be integrated into existing knowledge structures (Duit, 2009). Positive relationships between clarity of instruction and student outcome measures have been reported in various studies (Creemers & Kyriakides, 2008; Scherer & Gustafsson, 2015). As for motivation, Seidel et al. (2005) found that a clear and coherent lesson structure was associated with a more positive student perception of supportive learning conditions, stimulating self-determined forms of learning motivation, including intrinsic motivation.

#### 10.2.2.4 Cognitive Activation

Baumert et al. (2010) describe the level of cognitive activation as being determined mainly by the kinds of math problems presented to students and how the teacher implements them. An important aspect of this dimension is asking students to explain their answers and encouraging them to evaluate their solution's validity. Such classroom practices are viewed as a way to stimulate students' cognitive engagement and, consequently, lead to deeper and more elaborate knowledge (Klieme et al., 2009). Scholars have argued that cognitive activation is connected closely to subject matter (Baumert et al., 2010; Seidel & Shavelson, 2007). Results have been somewhat mixed in attempts to find associations between cognitive activation and student outcome measures (Hiebert & Grouws, 2007; Seidel & Shavelson, 2007). Regarding motivation, Fauth et al. (2014) found that primary students' cognitive activation ratings predicted their development of subject-related interest.

### *10.2.3 Instructional Quality (InQ) and Equity*

As described above, the four InQ dimensions have been shown to influence student outcomes positively in terms of both achievement and motivation. A few studies have also investigated relationships between InQ and equity. Rjosk et al. (2014) found that cognitive activation in language instruction (German) mediated the effects of classroom SES composition on achievement. This was attributed in particular to teachers focusing less on challenging language instruction in low-SES classrooms. In a study using data from PISA 2006, Willms (2010) found that schools' SES effects were mediated by the quality of instruction and time allocated to science lessons. Using data from 50 countries that participated in TIMSS 2011, Gustafsson et al. (2016) investigated whether school characteristics, including InQ, moderated the relationship between student SES and mathematics achievement. Their findings were mixed in that InQ was found to generate compensatory effects in some countries and anti-compensatory effects in others. Compensatory national school systems tended to have relatively high achievement levels, and it was concluded that these systems can reduce the relationship between achievement and student SES through certain key factors, including high InQ.

### 10.2.4 Intrinsic Motivation

Motivational research is a broad and complex field of study. Within educational research, theories related to motivation systematically deal with one very important issue in particular: students' reasons for engaging in various kinds of achievement tasks (Eccles & Wigfield, 2002). Intrinsic motivation is a key concept frequently paired with and explained in relation to extrinsic motivation. *Intrinsic motivation* is defined as engaging in an activity for its inherent satisfactions rather than for some separable consequence (Ryan & Deci, 2000)—or to put it slightly differently, engaging in an activity for its own sake, such as for enjoyment, the challenge, interest in the activity, or natural fulfilment of curiosity (Barry & King, 2000). Thus, when a person is motivated intrinsically, learning can be viewed as a side effect of being engaged in the relevant actions (Weidinger, Steinmayr, & Spinath, 2017). In the mathematics classroom, students who are driven by a desire to learn—and who enjoy learning math—can be viewed as intrinsically motivated. Differently, extrinsic motivation is defined as activities that are pursued for expected external rewards unrelated to the activity itself (Eccles & Wigfield, 2002; Ryan & Deci, 2002). With mathematics, such external rewards can be higher grades, getting to the top of the class, or pleasing parents or teachers.

Ryan and Deci (2000) argue that humans are active, inquisitive, curious, and playful creatures who do not require extraneous incentives to learn and explore. However, it is clear that not all individuals are motivated intrinsically to engage in the same activities and tasks. Within pedagogical theory, the nurturing of a student's intrinsic motivation is a crucial part of teacher responsibilities. It is assumed that enhancing and sustaining students' intrinsic motivation for learning is critical to preparing children for successful mastery of future challenges, and such motivation should be viewed as a highly desirable developmental outcome (Ryan & Deci, 2009; Spinath & Spinath, 2015).

### 10.2.5 Motivation and Equity

To discuss and draw any causal link between students' SES and their intrinsic motivation or interest, it is necessary to understand the relationship that this theoretical construct has with other similar non-cognitive constructs, namely academic self-beliefs, which are often investigated in regard to their connection to a child's SES. Interest was initially treated as the affect component of academic self-concept or self-belief. Eccles's expectancy-value theory (EVT; Eccles et al., 1983; Eccles, 2009) separated it through a hierarchy of self-beliefs and subjective task values that are different, but positively interrelated, components of academic motivation. Subsequently, Marsh, Craven, and Debus (1999) found interest to be empirically distinguishable from academic self-concept. Further empirical studies of relationships between self-concept and intrinsic motivation found self-concept to be the strongest factor affecting students' subsequent interest in the relevant subject (Cheung, 2018; Häussler & Hoffmann, 2000; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005a; Viljaranta, Tolvanen, Aunola, & Nurmi, 2014). These findings extended a variety of possible mechanisms through which parents' SES may impact their children's intrinsic motivation, thereby allowing us to discuss it in a broader theoretical and empirical context.

The development of students' intrinsic motivation takes place within multiple learning environments. The family is the first cultural and social milieu in which characteristics might exert a lasting effect on the way a child interprets other educational contexts, thereby shaping his or her academic interests and aspirations (Bandura, 2012; Boudon, 1974; Bourdieu, 1986; Eccles, 2009). For example, Eccles's EVT model refers to parents as socializers (along with teachers, peers, etc.), and children's achievement-related activities and choices are the product of a continuous negotiation of meanings in the hierarchy of learning environments. According to Bandura's socio-cognitive perspective, students' self-beliefs and academic motivation are shaped by parents' familial belief systems, which are influenced by their SES (Bandura, 2012; Bandura, Barbaranelli, Caprara, & Pastorelli, 2001). To take it further, the reproduction theories argue that high-SES parents provide their children with more stimulating environments and use complex linguistic codes that might enhance their children's motivation and ability to succeed academically (Bernstein, Bernstein, & MacRae, 1971; Bourdieu, 1986).

The somewhat limited empirical research on the association between SES and intrinsic motivation generally finds it to be significant, with some variation in effect size. This variation is mainly due to the SES indicator used, with parents influencing motivation in different academic domains to varying extents (Kriegbaum et al., 2015; Tenenbaum & Leaper, 2003). For example, fathers' SES was found to be a strong predictor of math-specific motivational constructs such as self-concept, self-efficacy, and interest.

## 10.3 Present Study

Against the backdrop of what was described earlier and the still-scarce knowledge about how motivation, students' home backgrounds, and InQ are linked, we examine this link within the example of Norway, using the opportunities provided through the TIMSS 2015 study. Norway was the only Nordic country that decided to include the items measuring InQ as part of their national options section in the TIMSS 2015 Student Questionnaire. Although data are not available for other Nordic countries, we see Norway as a typical representative of the principles exemplified in what is known as the Nordic model (see Chap. 2 in this volume for details). Thus, results from an analysis of the Norwegian data should be considered highly relevant in a broader Nordic perspective.

The research questions of our chapter are the following:

*RQ 1: How is a student's SES associated with the intrinsic motivation to learn mathematics in fifth and ninth grade in Norway?*

*RQ 2: How is InQ associated with the intrinsic motivation to learn mathematics among low-SES, medium-SES, and high-SES student groups in the fifth and ninth grades in Norway?*

## 10.4 Methodology

### *10.4.1 Data, Sample, and Measurements*

Our study is based on achievements and questionnaire data from 4329 fifth-grade students and 4697 ninth-grade students who participated in TIMSS 2015 in Norway. Primary school in Norway encompasses grades 1 through 7 (7 years), while lower secondary school includes grades 8 through 10 (3 years). As already mentioned, Norway is the only Nordic country that measured all InQ dimensions through the national options[1] in TIMSS 2015, but some other countries, such as Germany and Belgium, included the same items for measuring InQ. These measures, based on previous research, were also piloted, and the psychometric properties worked well in Norway, Germany, and Belgium (Bellens, Van Damme, Van Den Noortgate, Wendt, & Nilsen, 2019).

In the present study, we measured InQ through four latent variables: classroom management, teacher support, cognitive activation, and clarity of instruction. These items are presented in Table 10.1.

Mathematics achievement was measured using students' achievement (gauged using five plausible values) on almost 250 mathematics items. These items capture the breadth of the domain as well as the range of cognitive dimensions: knowing, applying, and reasoning (Grønmo, Lindquist, Arora, & Mullis, 2015). The standard deviation for mathematics achievement was set at 100.

SES was measured by students' ratings of their parents' education, number of books at home, and the educational resources available at home. We used the composite variable created with item response theory.[2]

Intrinsic motivation was measured as a latent variable. Students were asked "How much do you agree with these statements about learning mathematics?" They rated items on a Likert scale that ranged from 'Disagree a lot' to 'Disagree a little'. The items included 'I enjoy learning mathematics'; 'I wish I did not have to study mathematics'; 'Mathematics is boring'; 'I learn many interesting things in mathematics'; 'I like mathematics'; 'I like any schoolwork that involves numbers'; 'I like

[1] Each country may include some of its own questions on the TIMSS questionnaires. These items, referred to as national options, are not part of the international questionnaire.

[2] See: http://timssandpirls.bc.edu/timss2015/international-results/timss-2015/mathematics/home-environment-support/home-resources-for-learning/

**Table 10.1** The Norwegian TIMSS 2015 national option items measuring Instructional Quality (InQ)

| Classroom management | Supportive climate | Clarity of instruction | Cognitive activation |
|---|---|---|---|
| Students do not listen to what the teacher says<br>There is noise and disorder<br>Our mathematics teacher has to wait a long time for students to quiet down<br>Students cannot work well<br>Students do not start working for a long time after lessons begin<br>*Our mathematics teacher:*<br>Makes students follow classroom rules for behaviour<br>Calms down students who disrupt the lesson | *Our mathematics teacher:*<br>Shows an interest in every student's learning<br>Provides extra help when students need it<br>Helps students with their learning<br>Continues teaching until the students understand<br>Gives students the opportunity to express opinions | *Our mathematics teacher:*<br>Sets clear learning goals<br>Explains what he or she expects us to learn<br>Asks questions to check whether we understand the content of the lesson<br>Explains at the start of a class how new topics relate to previous lessons<br>Summarizes what we have covered at the end of the lesson | In our mathematics lessons, we are working on tasks that I must think about very thoroughly<br>*Our mathematics teacher:*<br>Asks questions that I must think about very thoroughly<br>Gives us tasks that seem difficult at first glance<br>Asks me what I have understood and what I have not<br>Asks what we know about a new topic<br>Gives us tasks that I like to think about<br>Wants me to be able to explain my answers |

to solve mathematics problems'; 'I look forward to mathematics class'; and 'Mathematics is one of my favourite subjects.'

### *10.4.2 Data Analysis*

Three-group, multilevel structural equation models (SEMs) for low-, medium-, and high-SES student groups were estimated for both grade levels. For the cut-off points, the low-SES group included the 25% of students with the lowest SES, the medium-SES group included the 50% of students with medium-SES backgrounds, and the high-SES group comprised the 25% of students with the highest SES.

As students are nested within classes, we employed a two-level model, with students at the within level and classes at the between level.

### *10.4.3 Structural Equation Model (SEM)*

SEM is a multivariate statistical analysis technique that includes confirmatory factor analyses (CFA). CFA generates the factor loadings of indicators on an underlying latent factor. Together with the model fit indices, factor loadings provide a measure of reliability and validity (Byrne, 2012). SEM also allows for examining the relationships between multiple observed and unobserved variables, while providing explicit estimates of error variance parameters. It further enables complex modelling (e.g. multi-group) and complex patterns with intervening variables between the independent and dependent variables; independent variables may also function as dependent variables (Preacher, Zyphur, & Zhang, 2010).

A further great advantage of SEM is the possibility for multilevel approaches in which it is possible to simultaneously model at all levels.

Our main interest lies in the relationship between InQ and motivation at the class level and whether these relationships vary among different groups of students (high-SES, medium-SES, and low-SES). Additionally, we also included the relationship between InQ and motivation at the student level to remove the noise of students' variations in reporting InQ (Lüdtke, Robitzsch, Trautwein, & Kunter, 2009). We further controlled for student achievement at both levels, as shown in Fig. 10.1.

We made one model for each InQ dimension to avoid multi-collinearity. All models were estimated in Mplus Version 8 using the robust maximum likelihood (MLR) estimation. MLR also takes care of the missings (there were 93 missings). Prior to adding any structure, a CFA was conducted to ensure reliable and valid measurement models. The regression coefficients provided in the Results section of this chapter w standardized to allow for comparisons. To evaluate model fit, we referred to common guidelines (CFI $\geq 0.95$, TLI $\geq 0.95$, RMSEA $\leq 0.08$, and SRMR $\leq 0.10$ for an acceptable model fit; Marsh, Hau, & Grayson, 2005b).

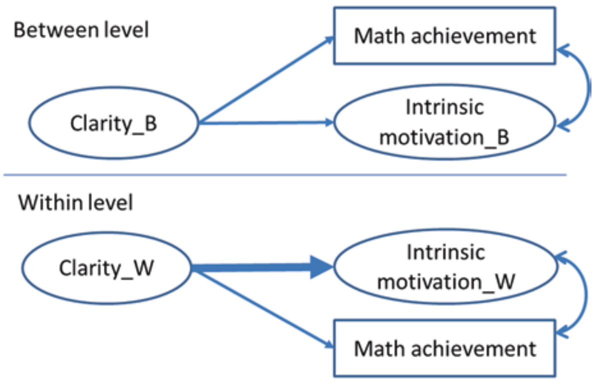


**Fig. 10.1** Model of the relationship between aspects of teacher InQ (in this case, clarity of instruction) and student motivation, controlling for mathematics achievement

## 10.5 Results

In this section, we will present the results of our analyses of (1) the relationship between SES and student motivation, and (2) the relationship between InQ and intrinsic motivation for the three student groups (low-, medium-, and high-SES) at the between level.

First, we investigated whether SES is a predictor of intrinsic motivation to learn mathematics among Norwegian students in the fifth and ninth grades. The model fit was quite high. Our analyses revealed different results for fifth and ninth-graders. In the fifth grade, we found that the relationship between SES and intrinsic motivation was insignificant, but in the ninth grade, the relationship between SES and intrinsic motivation was 0.153 at the between level (standardized regression coefficient) and significant.

Second, we calculated the regression coefficients for the four InQ dimensions on intrinsic motivation to learn mathematics at the between level for both fifth- and ninth-grade students, controlling for achievement. These coefficients are presented in Tables 10.2, 10.3, 10.4 and 10.5.

**Table 10.2** Standardized regression coefficients for classroom management on intrinsic mathematics learning motivation, by Socio-Economic Status (SES)

| Class level | Low SES | Medium SES | High SES |
|---|---|---|---|
| Grade 5 | 0.416* | 0.17 | 0.15 |
| Grade 9 | 0.61* | 0.516* | 0.502* |

*Note*. Standardized regression coefficients were calculated for classroom management's effects on intrinsic motivation to learn mathematics among the different SES groups at the class level. An * indicates significance at the.05 level

**Table 10.3** Standardized regression coefficients for supportive climate on intrinsic mathematics learning motivation, by Socio-Economic Status (SES)

| Class level | Low SES | Medium SES | High SES |
|---|---|---|---|
| Grade 5 | 0.549* | 0.35* | 0.414 |
| Grade 9 | 0.843* | 0.578* | 0.422* |

*Note*. Standardized regression coefficients were calculated for supportive climate's effects on intrinsic motivation to learn mathematics among the different SES groups at the class level. An * indicates significance at the.05 level

**Table 10.4** Standardized regression coefficients for clarity of instruction on intrinsic mathematics learning motivation, by Socio-Economic Status (SES)

| Class level | Low SES | Medium SES | High SES |
|---|---|---|---|
| Grade 5 | 0.77* | 0.4* | 0.46 |
| Grade 9 | 0.879* | 0.719* | 0.702* |

*Note*. Standardized regression coefficients were calculated for clarity of instruction's effects on intrinsic motivation to learn mathematics among the different SES groups at the class level. An * indicates significance at the.05 level

**Table 10.5** Standardized regression coefficients for cognitive activation on intrinsic mathematics learning motivation, by Socio-Economic Status (SES)

| Class level | Low SES | Medium SES | High SES |
|---|---|---|---|
| Grade 5 | 0.815* | 0.427 | 0.276 |
| Grade 9 | 0.928* | 0.944* | 0.885* |

*Note*. Standardized regression coefficients were calculated for cognitive activation's effects on intrinsic motivation to learn mathematics among the different SES groups at the class level. An * indicates significance at the.05 level

As revealed in Table 10.2, the regression coefficient for classroom management on intrinsic motivation to learn mathematics was generally higher for ninth-grade students in comparison to fifth-grade students for all three SES groups. In addition, for both grade levels, the regression coefficient was highest for the low-SES student groups. Furthermore, the regression coefficients for the medium- and high-SES student groups in fifth grade were quite low and insignificant at the .05 level. The regression coefficients for the low-SES student group in fifth grade and the three SES groups in the ninth grade were all significant at the.05 level.

Table 10.3 presents the corresponding regression coefficients for the dimension supportive climate. As can be seen in the diagram, the overall picture was quite similar to the preceding one. First, the regression coefficients are generally somewhat higher for ninth grade (G9) than for fifth grade (G5). Second, the regression coefficients have a declining tendency from low-SES, via medium-SES, to high-SES student groups and are particularly high for low-SES students within each grade level. The regression coefficient for high-SES students in fifth grade is insignificant.

Table 10.4 gives the regression coefficients for the dimension clarity of instruction on students' intrinsic motivation to learn mathematics in relation to student SES groups. The same pattern as the previously presented dimensions can be seen. The regression coefficients are particularly high for the low-SES student groups in both grades, and a declining tendency exists from low-SES via medium-SES to high-SES student groups. This tendency is more distinct in the fifth grade than in the ninth.

In Table 10.5, the regression coefficients for the dimension cognitive activation on intrinsic motivation are presented. The regression coefficients are extremely high for the ninth-grade student SES groups, and they are also quite high for the low-SES student group in the fifth grade. As for the medium- and high-SES student groups in the fifth grade, the regression coefficients were insignificant at the.05 level. In fifth grade, the difference between the regression coefficients for low-SES students and medium/high-SES students is considerable, but this is not the case for the ninth-grade students.

## 10.6 Discussion

The discussion of our findings will be done in relation to our research questions. Our first research question addresses how a student's SES is associated with their intrinsic motivation to learn mathematics in the fifth and ninth grades in Norway.

In our analyses, we found a significant association between students' SES and intrinsic motivation among ninth-grade students, but not among fifth-grade students. With ninth-graders, this association had a standardized regression coefficient of 0.153 and was significant at the.05 level. Even though this association is not very strong, these results clearly indicate that SES is more strongly associated with students' intrinsic motivation in lower secondary school than in primary school. We know from previous research that intrinsic motivation is generally quite high in primary school and considerably lower in secondary school (Fauth et al., 2014; Mullis et al., 2016). This goes for most nations participating in TIMSS and is also reported in the Norwegian 2015 TIMSS report (Bergem, Kaarstein, & Nilsen, 2016a). Interpreting our findings in light of this well-established knowledge, we can conclude that all students in the fifth grade in Norway, regardless of family background (SES), enjoy a relatively high intrinsic motivation to learn mathematics. However, this seems to change during the period between the fifth and ninth grades. When students are in ninth grade, their intrinsic motivation to learn mathematics is not only substantially lower than in elementary school but is also significantly associated with family background (SES). *Why is this so? Why does family background predict students' intrinsic motivation to learn mathematics in the ninth grade, but not in the fifth grade?* We would like to point out a few factors that seem relevant in trying to interpret these findings. First, in an international context, Norwegian classrooms are rather heterogeneous in terms of both SES and achievement. There is no streaming in either elementary or lower secondary school. However, marks are introduced in eighth grade, so this makes a difference between fifth-grade and ninth-grade students. Several international studies have reported a positive relationship between intrinsic motivation and marks (e.g. Corpus et al., 2009; Gottfried, 1990). Another robust finding in international studies is the positive correlation between students' SES and achievement in all countries (Mullis et al., 2016; OECD, 2016). Therefore, the introduction of marks between fifth and ninth grade in Norway may positively influence the correlation between students' SES and their intrinsic motivation to learn mathematics in the ninth grade as compared to the fifth grade, and ninth-grade low-SES students may lose their intrinsic motivation to a greater extent after receiving lower marks than high-SES students.

Second, both Eccles's EVT model and Bandura's socio-cognitive perspective accentuate the important role of parents in socializing their children (Bandura, 2012; Bandura et al., 2001; Eccles, 2009; Eccles et al., 1983). A key element of this process is influencing and shaping children's interest in learning. It has been noted that families' value systems, which are linked closely to family SES, are fundamental in these processes. Taken together with Bourdieu's (1986) reproduction theory, there are reasons to assume that the importance of a family value system that stimulates and encourages academic work and perseverance and positively evaluates the effort that children put into their schoolwork will increase from elementary to secondary school, in line with the higher demands that students face as they enter higher grades. However, such value systems characterize high-SES families to a larger extent than low-SES families (Bandura, 2012; Bourdieu, 1986; Eccles, 2009) and, therefore, can be assumed to affect the correlation between students' SES and their intrinsic motivation, making it higher in lower secondary school than in primary school.

Through the formulation of our second research question, we set out to investigate whether Norwegian schools can possibly influence and counteract the unwanted trajectory of students' intrinsic motivation to learn mathematics over the school years, with family SES being more important for this motivation in ninth grade than in fifth grade. We did this by examining the association between the four InQ dimensions and students' intrinsic motivation to learn mathematics for low-SES, medium-SES, and high-SES student groups in these two grades. Although our analyses of these relationships between InQ, intrinsic motivation, and SES revealed some similarities of the fifth and ninth grades, some distinct differences were also found. In the following, these traits will be presented and discussed.

First, for the high-SES students in the fifth grade, none of the calculated regression coefficients was found to be significant. As mentioned above, at this grade level, we know that high-SES students' level of intrinsic motivation to learn mathematics is quite high in Norway (Kaarstein & Nilsen, 2016). Our analyses indicated that InQ is not a decisive factor in determining these levels. However, for fifth-grade low-SES students, we found a positive relationship between intrinsic motivation to learn mathematics and each of the measured InQ aspects. This finding will be further elaborated on later.

Second, as seen in Tables 10.2, 10.3, 10.4 and 10.5, the regression coefficients for the four InQ dimensions on intrinsic motivation to learn mathematics were generally higher for ninth-grade students than those in the fifth grade. Our interpretation of this finding is the following: *High InQ seems to be particularly important for strengthening and consolidating the intrinsic motivation to learn mathematics in lower secondary school and much more so than in primary school.*

Third, and perhaps most importantly, the regression coefficients for the InQ dimensions on intrinsic motivation to learn mathematics are highest for low-SES students, and with a few exceptions, as related to the medium-SES group, are lowest for high-SES students in both fifth and ninth grade. This goes for all four dimensions. We interpret this finding as follows: *High InQ is particularly important for low-SES students in both the fifth and ninth grades in relation to strengthening and consolidating their intrinsic motivation to learn mathematics*. This means that in both elementary and lower secondary school, a teacher's InQ can contribute to higher levels of equity. In other words, to provide equitable opportunities for all students to succeed in mathematics, which is a prominent aim in Norway's educational system (Kunnskapsdepartementet, 2006), it is particularly important to ensure that low-SES students receive high-quality mathematics instruction. If teacher education contributed to enhancing the InQ of teachers, it would boost both high- and low-SES students, but according to our results, low-SES students would benefit more from such circumstances. More high-quality teachers would thus result in reducing the gap between low- and high-SES students. It would also reduce the gap between schools, as classes in low-SES schools would benefit more from such teachers. This is also in line with previous studies (Gustafsson et al., 2016).

This last finding corresponds well with reports from other studies related to associations between InQ and student outcomes. Using achievement as the outcome measure, Baumert et al. (2010) found that differences in teachers' pedagogical content knowledge in mathematics, mediated mainly by levels of cognitive activation and learning support (supportive climate), made the greatest impact in low-SES classes. Other studies have also reported positive associations between InQ dimensions and student outcome measures, but this mainly entails measures of student achievement, not the aspect of motivation (Bergem, Nilsen, & Scherer, 2016b; Rjosk et al., 2014; Willms, 2010).

## 10.7 Limitations and Future Research

We would like to point out a few limitations to the conclusions that can be drawn from our study. Our data set was taken from a study with a cross-sectional design; thus, no causal inferences should be drawn. In addition, as only TIMSS data from Norway have been used, we do not know whether our findings could be repeated with data sets from other nations. As the decline in students' intrinsic motivation to learn mathematics from primary to lower secondary school is an international phenomenon, using our study design on data sets from other countries would make for highly interesting research. Furthermore, associations between dimensions of the InQ construct, SES, and intrinsic motivation are investigated in relation to only one subject: mathematics. It remains to be seen whether the current findings could be replicated in other subject areas. While the current analyses focus on fifth and ninth-grade students, further investigation is required to determine whether the same relationships hold in other age groups.

To strengthen the claims made in the current study, the aforementioned limitations could be addressed in future research. Our study design would then need to be copied using representative data sets from other nations and analysed for other age groups and subjects. Most importantly, if our research design were used in longitudinal studies, more robust inferences could be drawn. One cannot draw causal inferences from cross-sectional data, which only capture a moment in time, and inferences made from cross-sectional data may be invalid due to challenges related to omitted variables and reversed causality (Gustafsson, 2013). Longitudinal data reduce such risks. With longitudinal studies, it would be possible to investigate, for instance, whether InQ is related to *changes* in student outcomes. Examples of such studies include longitudinal extensions of PISA (e.g., Krauss, Baumert, & Blum, 2008) and TIMSS with additional classroom observations (Nilsen, 2019).

In TIMSS 2019, more emphasis is put on InQ, and more extensive scales that measure different InQ dimensions are included on the student questionnaire. This will allow for better InQ validity, and countries need not include national options to measure this construct anymore.

## 10.8 Implications

Few studies have investigated the relationships between InQ and equity in Nordic countries (Nilsen, Scherer, & Blömeke, 2018). Therefore, the present study's findings will extend knowledge about relations between InQ, SES, and key student outcome measures that are particularly pertinent in school equity debates.

Our main findings indicate that high InQ is more important for stimulating and maintaining students' intrinsic motivation in ninth grade than in fifth grade, and it is especially critical for low-SES student groups, regardless of grade level. These findings should be highly relevant within various strands of educational research, including mathematics education, teacher education, and the field of educational equity. It seems particularly important that teachers and teacher students get introduced to results from research that indicate a close association between students' SES and the development of their intrinsic motivation to learn mathematics, as well as high InQ's key role in compensating for this association. A comprehensive understanding of these issues may motivate teachers to prioritize aspects of their teaching to ensure that all children, regardless of their SES, can tap into their potential and succeed in school to a greater extent. This is also in line with Espinoza (2007), whose understanding of equity is the distribution of resources according to students' needs (see Chap. 2). In our case, resources refers to high InQ.

Additionally, but closely related to the above argument, our findings could be used to inform discussions about education on a policy level. Our findings provide evidence in support of those educational policies that aim to recruit well-qualified teachers who can implement high-quality instruction in their classrooms. This can be done by prioritizing advanced teacher education and high-quality professional development courses. Our findings suggest that such measures not only have the potential to counteract declining intrinsic motivation to learn mathematics in lower secondary school but would also be highly relevant for addressing one of the most important issues in education in Norway at all levels: providing equitable opportunities for *all* students to succeed in school.

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