Preparing Indonesian Youth

A Review of Educational Research

Anne Suryani, Isabella Tirtowalujo and Hasriadi Masalam (Eds.)

Preparing Indonesian Youth: A Review of Educational Research offers insights into the challenges and prospects in preparing Indonesian youth for 21st century living. The chapters feature empirically-based case studies focusing on three key aspects of education in Indonesia: teachers and teaching; school practices, programs, and innovations; and the social contexts of youth and schooling.

The case studies also represent different vantage points contributing to an enriched understanding of how larger social phenomenon—for example, education decentralisation in Indonesia, (rural-urban and transnational) migration, international benchmarking assessments, and the global feminist and women's movement—impact and interact with enacted visions of preparing all youth educationally for work, as well as for meaningful participation in their respective communities and the Indonesian society at large.

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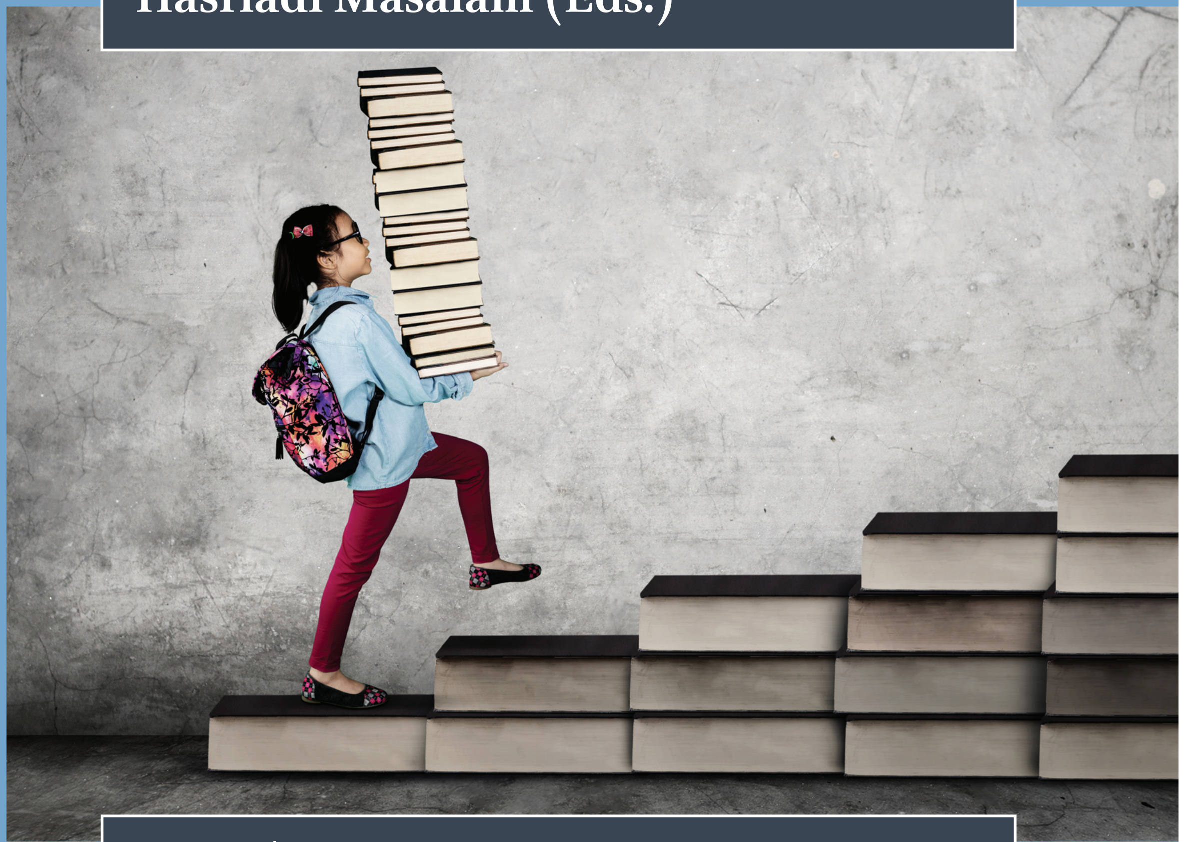

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CHAPTER 2

Science Teaching Practices in Indonesian Secondary Schools: A Portrait of Educational Quality and Equity-Based on PISA 2015

Anindito Aditomo

Abstract

This study seeks to identify instructional practices which have positive effects on Indonesian students' scientific literacy, and examine whether those practices mitigate the impacts of family socio-cultural-economic background and improve equity. Drawing upon the 2015 cycle of the Programme for International Student Assessment (PISA), this study applies multilevel regression to nationally representative data from 6,513 students from more than 200 schools. Three instructional practices were examined: interactive teaching, inquiry-based learning, and traditional lecture. Interactive teaching is an approach that encourages students to debate and explain their ideas, in combination with teacher explanations of how concepts relate with and can be applied to daily life. The second approach, inquiry-based learning, refers to the use of activities related to scientific investigations which are enacted independently by students. The third approach, traditional lecture, reflects teacher-centred exposition of content. The study finds little difference in the frequency of implementation of these instructional approaches across the types of schools examined. Consistent with constructivist theories, interactive teaching was found to be associated with higher scientific literacy. In contrast, both inquiry and traditional teaching were associated with lower literacy. None of the three instructional approaches moderated the effect of family socio-cultural-economic background on students' scientific literacy.

Keywords

science teaching – international assessment – science literacy – constructivism (learning) – instructional effectiveness

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1 Introduction

> Teaching is recognised as among the most important determinants of educational quality. (Muijs et al., 2014)

This chapter discusses teaching quality issue in the context of science education in Indonesian secondary schools. Research on educational effectiveness in developing countries often focuses on input variables such as expenditure, school facilities, and teacher qualifications (Scheerens, 2001). Comparatively few studies examine teaching practices in nationally representative samples of schools and students. To help remedy this gap, this chapter aims to generate insights about what characterises good science teaching in Indonesia.

The issue of teaching quality is addressed from two complementary perspectives. First, good teaching should be positively associated with important learning outcomes. In other words, good teaching is characterised by practices which facilitate the overall level of achievement and other learning outcomes. Second, good teaching can be defined in terms of equity, i.e. effectiveness for students from different Socio-Economic Status (SES). Decades of research has shown that low SES is associated with poorer learning outcomes (Entwisle, Alexander, & Olson, 2010; Sirin, 2005; van Ewijk & Sleegers, 2010). Thus, good teaching should at least be equally effective for all students and in various schools, regardless of their level of SES. Better still would be teaching practices which are especially effective for lower-SES students and schools, thereby reducing the influence of family background on learning outcomes.

This chapter addresses two questions:

1. What kinds of teaching practices are associated with better science achievement in Indonesian secondary schools?
2. Are these practices equally effective for students from various SES backgrounds?

These are addressed by capitalising on the 2015 cycle of the Programme for International Student Assessment (PISA) which provided rich data on teaching practices and students' literacy in science (OECD, 2016b). Before elaborating on this study's method, the following sections clarify what is meant by "teaching", how teaching should relate to science learning, the notion of equity in education, and how teaching may influence educational equity.

1.1 *Dimensions of Teaching*

The practice of teaching is complex and multidimensional. While it can be characterised in various ways, this chapter focuses on three important dimensions: classroom management, emotional climate, and instruction.

This description is based on a framework developed in observational studies of teaching quality in mathematics, but it can be applied to other domains including science (Fauth, Decristan, Rieser, Klieme, & Büttner, 2014; Klieme, Pauli, & Reusser, 2009; Neumann, Kauertz, & Fischer, 2012). I will discuss each dimension briefly, beginning with classroom management.

Classroom management refers to teachers' actions intended to establish and maintain order. Much of early research on teaching focused on classroom management because an orderly classroom was considered to be a pre-requisite for student learning (Brophy, 1983). In a disorderly classroom, teachers are forced to spend more time on controlling disruptions which would divert attention away from the main learning agenda. Orderly classrooms enable students to focus on learning tasks and allow teachers to attend to students who need more individual feedback. In short, the basic assumption is that orderly classrooms can increase "time on task", which should improve students understanding of the content and subsequently influence their achievement.

If classroom management is more about behaviour, emotional climate has more to do with how the classroom is perceived to support students' psychological needs. To create a supportive emotional climate in the classroom, teachers need to attend to three basic needs: autonomy, belongingness, and competence (Deci, Ryan, Vallerand, & Pelletier, 1991; Ryan & Deci, 2000). Autonomy refers to a students' need to feel that they have control over learning activities in the classroom. Belongingness refers to feelings of being safe and of having positive personal relations among students and teachers. Competence has to do with feelings of mastery, of having the ability to accomplish important goals. When students feel that they have autonomy, that they belong to the classroom community, and that they can increase their competencies, they should be engaged and enjoy the learning activities (Ryan & Deci, 2000). The more students are intrinsically engaged, the more likely they are to understand and improve their academic performance.

The third dimension of teaching, instruction, refers to teachers' actions intended to facilitate interactions between students and curriculum content. Traditionally, instruction has meant transmitting or "delivering" content to students. Contemporary theories of learning make clear that this traditional model of instruction is erroneous. Knowledge cannot be transferred from teachers to students. Rather, knowledge must be actively constructed by the student through a process in which new information is made sense of based on prior knowledge (Bransford, Brown, & Cocking, 2000; Derry, 1996). From this constructivist view, instruction can be defined as actions intended to activate cognitive processes which produce learning. Instruction should be effective when it elicits relevant prior knowledge and provides adequate structure/

guidance which help process new information and build deeper, more powerful understandings.

Of these dimensions, classroom management and emotional climate are defined more as domain-general, meaning that good practices associated with them are similar across various subject matter. Instruction has both domain-general and domain-specific aspects. One can use questions to elicit a students' relevant prior knowledge; this is a prime example of a domain-general aspect of good instruction. Educators can also use analogies to help students connect prior knowledge to new information and can be applied across all domains. Yet another method is to provide timely and relevant feedback to help students recognise gaps in their knowledge.

In addition, each subject often has "signature pedagogies" or unique instructional forms. For science, it is instruction that incorporates aspects of scientific inquiry: formulating questions and hypotheses, designing and conducting systematic observations and experiments, as well as collecting and analysing data. Participation in inquiry activities can help students see how abstract concepts can help explain natural phenomena and predict future events (Chinn & Malhotra, 2002; Windschitl, Thompson, & Braaten, 2008). Experimental studies have generally shown that inquiry-based instruction is more effective than more traditional ones (Furtak, Seidel, Iverson, & Briggs, 2016; Lazonder & Harmsen, 2016). However, inquiry activities can pose heavy cognitive load which hamper learning (Aditomo, 2009; Kirschner, Sweller, & Clark, 2006). For inquiry-based instruction to be effective, they need to incorporate adequate structure and guidance, e.g. in the form of conceptual explanations, epistemic scaffolds, or help with group roles and collaborative processes (Hmelo-silver, Duncan, & Chinn, 2007).

1.2 *Educational Equity*

Educational equity is the idea that every student, regardless of their background, has equal right to learn in schools. This implies not only equal opportunity to access education, but also to benefit from schooling. The value of educational equity is closely linked to the ideal of a meritocratic society in which a person's position is determined more by their talent and effort, rather than their family's wealth, occupation, and social standing. Schools are quite often seen to play a critical role to achieve this meritocratic ideal by providing the opportunity for all members of society to acquire the knowledge and skills needed to lead a successful life. In other words, schools should enable poor but talented and hardworking students to climb up the socio-economic ladder.

From this "equal opportunities" perspective, equity can be quantified by estimating the relationship between students' socio-economic status (SES) and some measure of important learning outcomes (most often, achievement test scores which represent the mastery of a curriculum's content). SES is an umbrella concept meant to capture a person's relative position within the social hierarchy. A student's SES is typically operationalised as a composite measure of the parents' level of education and occupational prestige, possession of cultural resources at home, and overall family income and wealth. Many studies indicate that higher SES is associated with higher academic performance at both the student/individual and school/collective levels (Aditomo & Hasugian, 2018; Entwisle et al., 2010; Sirin, 2005; van Ewijk & Sleegers, 2010). The stronger this association, the lower/poorer equity is in an educational system.

Several mechanisms have been proposed to explain the link between SES and academic outcomes at the individual level. First, students from higher SES families tend to have access to more cultural resources at home (De Graaf, De Graaf, & Kraaykamp, 2000; Edgerton & Roberts, 2014). This is more a reflection of "taste" or ways of thinking rather than income or wealth (economic capital). Thus, high SES families invest more in cultural products (e.g. books, news media, encyclopaedia) and experiences (visits to museums, libraries, new places). These things are not necessarily expensive, but they expose children to the academic language and enable them to see the world through the lenses of knowledgeable others. These experiences also cultivate an interest in knowledge and enjoyment of learning, which are important motivational resources for academic life.

Another mechanism has to do with how parents interact with their children. High SES parents tend to engage in more verbal interactions with their infant children. Higher SES parents also often model and encourage ways of thinking and problem solving which are in line with the academic culture (Entwisle et al., 2010). For example, when solving problems together, high SES parents often allow their children to try alternative solutions, provide more specific and positive feedback, use more complex language, and are more receptive to questions (Bee, Van Egeren, Pytkowicz Streissguth, Nyman, & Leckie, 1969; Hess & Shipman, 1965). As a result of such interactions, by the age of 6–7 years, children from high SES families tend to have a larger vocabulary and are more familiar with the ways of talking, thinking, and behaving expected in schools. Compared to lower SES students, they are better prepared to perform in school from the very start. Such early successes further strengthen positive academic self-concept and self-efficacy, as well as foster higher aspirations.

Beyond the family, the wider community and societal contexts also shape socialisation processes in ways which contribute to inequalities in educational outcomes. The influence of these wider contexts is especially pertinent when learning is considered from sociocultural perspectives (Sfard, 1998). According to these perspectives, learning is not so much an individual process of acquiring abstract knowledge, but more a process of enculturation into communities of practice. Learning to participate in the academic practices valued at school entails seeing one's self as a (future) scientist, mathematician, literary critique, etc. Without the development of such identities and aspirations, schoolwork tends to be experienced as mechanical chores which are bereft of meaning. This observation is crucial for the present discussion; that the development of academic identities is facilitated and constrained by the kinds of cultural resources that are available in a student's home and wider community (Esmonde, 2009; Sirin, Diemer, Jackson, & Howell, 2004). One can surmise that this process would be considerably more difficult for students coming from low SES communities; that they would be unfamiliar with professions that require higher levels of academic knowledge (professors, scientists, lawyers, etc.).

At the school level, at least two mechanisms have been proposed to explain why high SES schools tend to perform better than lower SES ones (Armor, Marks, & Malatinszky, 2018; van Ewijk & Sleegers, 2010).

The first mechanism operates through school or institutional factors. In higher SES schools, parents can provide more financial contributions and also exert higher academic expectations, which in turn improve the school resources, teacher qualifications, and curriculum/teaching quality (Agirdag, 2018; Agirdag, Van Houtte, & Van Avermaet, 2012).

The second mechanism operates through factors related to student characteristics. Students in lower SES schools have, on average, lower aspirations, motivation, and academic self-concept. Overall, this tends to create a poor academic climate which drags down students who may have initially high motivation/aspirations/self-concept. Conversely, peer pressure and competition may encourage students with initially lower motivation to work harder and adopt better learning strategies.

Studies have confirmed that there is a positive association between school SES and student achievement (van Ewijk & Sleegers, 2010). Based on cross-sectional data from Programme for International Student Assessment (PISA) and (Trends in International Mathematics and Science Study) TIMSS, school SES composition is estimated to have a moderate effect on achievement in many countries. For example, an analysis of 28 countries in PISA 2003 found substantial effects of a school's SES using a composite score (reflecting the combination of various indicators such as parental education, home cultural resources, and overall wealth) (Liu, Van Damme, Gielen, & Van Den Noortgate, 2015). An analysis of the TIMSS 2003 data showed that school-level SES still predicts math scores even after controlling individual differences in motivation and family SES (Dumay & Dupriez, 2007). Longitudinal studies, which take into account prior achievement, indicate the effect of school SES on performance from cross-sectional studies may be over-estimated, but still significant (Dumay & Dupriez, 2008; Rjosk et al., 2014).

1.3 *Teaching and Educational Equity*

Good teaching practices are defined as practices that reliably facilitate student learning. As described previously, with regards to classroom management this refers to practices which create an orderly climate where students can focus on learning-related activities. With regards to emotional climate, good teaching refers to practices which fulfil students' needs for autonomy, belongingness, and competence. With regards to instruction, good teaching is reflected in practices which elicit relevant prior knowledge and provide the necessary structure to help students make sense of new information.

Furthermore, good teaching should be effective for all students in all schools, regardless of their SES background. The relevant question here is whether there are reasons to suggest that the effects of teaching depend on students' SES. With regards to classroom management, theoretical considerations suggest that an orderly classroom is a prerequisite for learning and thus should benefit all students (Brophy, 1983; Emmer & Stough, 2001). Similarly, because autonomy, belongingness and competence are regarded as universal psychological needs (Ryan & Deci, 2000), a supportive emotional climate should also benefit students from different SES backgrounds. However, a recent review suggests that a positive emotional climate may benefit lower SES students more than for their affluent peers (Berkowitz, Moore, Astor, & Benbenishty, 2017).

A few studies have suggested that student-centred instruction may benefit students from affluent families but can be detrimental for lower SES students (Andersen & Andersen, 2017). This argument is based upon sociological theories regarding the incompatibility between the school's linguistic/cultural codes and the linguistic/cultural codes of lower SES families (Sadovnik, 1991). According to this argument, student-centred instruction represents an "invisible pedagogy" in which norms, expectations, and criteria of evaluation are rendered implicit to encourage students to self-regulate their learning. This may benefit high SES students because they are more intrinsically motivated and already possess the necessary dispositions for academic self-regulation. However, students from low SES backgrounds may fail to profit from student-centred instruction as they lack these dispositions. Andersen and Andersen (2017) found that student-centred instruction is negatively associated with mathematics achievement among low SES Norwegian high school students, but not among their higher SES peers.

Unfortunately, there is scant research on how instructional effects are influenced by students' SES. Moreover, the research results are inconsistent. Contrary to the findings of Andersen and Andersen (2017), a study of kindergarten students in the US found that student-centred group/collaborative learning methods are effective in increasing math achievement, regardless of SES background, and even reduced the SES gap among African-American students (Bodovski & Farkas, 2007). Thus, the current study is designed to contribute by examining this issue in the context of science learning in Indonesia.

1.4 *The Current Study*

To investigate links between teaching, SES, and science learning outcome, this study utilises the Indonesian sample from PISA 2015. Coordinated by the Organisation for Economic Cooperation and Development (OECD), PISA is a tri-annual international study which assesses reading, math, and science literacy among 15-year-old students in participating countries. PISA also collects data on a student's background, their school characteristics and educational processes (including teaching practices) for a target domain. In 2015, the target domain was science (OECD, 2016b).

For PISA 2015, science literacy referred to a students' ability to understand and reason using scientific concepts and information to solve problems in various contexts. This definition was driven by PISA's interest in how well education prepares young people to participate in the 21st-century economy and society. Consequently, PISA's cognitive tests are not tied to (school) curriculum content; rather, they are based on contexts relevant to contemporary issues and problems.

As for teaching practices, this study examines PISA data which reflects on classroom management, emotional climate, and the four instructional practices (teacher feedback, teacher-directed instruction, interactive instruction, and inquiry-based instruction). These dimensions were assessed from the students' perception, i.e. by asking students to report their feelings, thoughts, or experiences of certain classroom activities. The use of student perceptions to assess teaching quality has advantages, especially regarding efficiency. Compared to collecting observational data, assessing students' perceptions is much cheaper and quicker. In addition, student perception is arguably the most appropriate source of information regarding a classroom's teaching climate. On the other hand, students can only be asked to report observable events; they cannot comment on things like pedagogical intent which drives certain learning tasks. Overall, student perceptions of teaching produce useful and reliable data (Lüdtke, Trautwein, Kunter, & Baumert, 2006).

2 Method

2.1 *Participants*

PISA adopts a two-stage stratified sampling strategy. First, schools are randomly sampled from a list of schools in each participating country. Second, around 30 students are sampled randomly from a list of 15-year old students enrolled in each school. For Indonesia in 2015, this resulted in a sample of 6,513 students (51.3% female) from 236 schools (see Table 2.1). Data were obtained from the PISA database website.[1] The average sample size in each school was 27.60 students.

TABLE 2.1 Number of participants

School type		Students	School
Level	Junior secondary (SMP)	3,116	118
	Senior secondary (SMA)	3,397	116
Status	Public	4,032	131
	Private	2,481	105
	TOTAL	6,513	236

2.2 *Learning Outcome Variables*

2.2.1 Science Literacy

Science literacy is the ability to use science concepts to explain natural phenomena, to design and evaluate scientific inquiry, and to interpret data in a scientific method (OECD, 2016a). Combining multiple-choice and open-ended questions, the PISA science literacy test contains items referring to problems related to health, natural resources, environmental quality, hazards, and frontiers in science and technology. The test (as well as all background questionnaires) was translated into Bahasa Indonesia. Item-response theory scoring procedures were applied by the OECD to yield 10 plausible values representing each student's science literacy (OECD, 2016b). The scores were scaled to have a mean value of 500 (across the OECD countries) and a standard deviation of 100. Values below 500 indicate literacy levels below that of the average student in OECD countries.

2.3 *Predictor Variables*

2.3.1 Classroom Management

Classroom management refers to the extent to which the classroom environment is orderly enabling students to concentrate on learning activities. It is measured using 5 items with response options from 1 = "Every lesson" to 4 = "Never or hardly ever".

Example item: "There are noise and disorder". Reliability (alpha) was 0.77.

2.3.2 Emotional Support

Emotional support reflects the extent to which students feel emotionally supported by the teacher to succeed in their learning. It is measured using 5 items with response options from 1 = "Hardly ever" to 4 = "In all lessons".

Example items: "The teacher shows interest in every student's learning" and "Teacher allows expressing opinions". Reliability (alpha) was 0.69.

2.3.3 Teacher-Directed Instruction

Teacher-directed instruction reflects a form of lecturing in which the teacher provides explanations and discusses students' questions. It is measured using 4 items with response options from 1 = "Never or almost never" to 4 = "Every lesson or almost every lesson". The items were:
- The teacher explains scientific ideas.
- The teacher demonstrates an idea.
- The teacher discusses our questions.
- A whole-class discussion takes place with the teacher.

Reliability (alpha) was 0.70.

2.3.4 Interactive Instruction

Interactive instruction refers to an interactive form of concept-focused instruction that combines teacher explanations (about how science ideas are relevant and can be applied) with student explanations and argumentation. While indicators of Teacher-directed Instruction are activities which are controlled or led by the teacher, indicators of Interactive Instruction include student-centred activities. Interactive Instruction was measured using 4 items with response options from 1 = "Never" to 4 = "In all lessons". The items were:
- The teacher explains how <school science> idea can be applied.
- Students are given opportunities to explain their ideas.
- The teachers clearly explain the relevance of science concepts to our lives.
- Students are required to argue about science questions.

Reliability (alpha) was 0.68.

2.3.5 Inquiry-Based Instruction

Inquiry-based instruction illustrates the implementation of inquiry activities (conducting and debating experiments/investigations) performed independently by students, without a teachers' guidance. It is measured using 5 items also with response options from 1 = "Never" to 4 = "In all lessons". An example item is "Students are allowed to design their experiments". Reliability (alpha) was 0.70.

2.3.6 Teacher Feedback

Teacher feedback describes the feedback students received from their science teacher regarding performance, areas of strength, areas of improvement, and how to progress. It is measured by 4 items with response options from 1 = "Never or almost never" to 4 = " Every lesson or almost every lesson". An example item is "The teacher tells me how I can improve my performance". Reliability (alpha) was 0.79.

2.3.7 Socio-Economic Status (SES)

Socio-economic status reflects parents' highest level of education, occupational prestige, cultural possessions at home, and overall family wealth. Scores were IRT-scaled by the OECD. A value of zero represents the average SES of students from OECD countries.

2.4 *Control Variables*

2.4.1 Motivation

Instrumental motivation refers to students' perceptions regarding the utility of learning science. It is measured using four items with response options from 1 = "Strongly agree" to 4 = "Strongly disagree". Scores were reversed so that higher scores reflect stronger motivation. An example item is "Many things I learn in my <school science> subject(s) will help me to get a job". Internal reliability (alpha) was 0.98.

2.4.2 Grade Repetition

Grade repetition measures whether a student has repeated a grade (0 = "No", 1 = "Yes"). Grade repetition, in most cases, indicates the failure to perform at the required level at a certain grade.

2.4.3 School Level

School level differentiates between junior secondary (SMP) and senior secondary schooling (SMA). Senior-secondary students in the sample, on average, have one-year additional schooling compared to junior-secondary students.

2.4.4 School Status

School status differentiates between private and public (government-owned) schools.

2.5 *Analysis*

Multilevel modelling (hierarchical linear regression) was employed to account for the clustered nature of the data (Hox, 2010). SES, teaching variables, and science literacy were treated at both the student (L1) and second levels (L2) of analyses. At L1, scores represent individual differences between students in the same school. Thus, L1 instructional practices reflect differences in how often students (from the same school) experienced each form of instruction (e.g. inquiry-based instruction). Individual differences in the experience of instruction are possible because students in one school come from different classes and may be taught by different science teachers. L1 classroom discipline and emotional climate represent individual differences in perceptions of the classroom environment. Such variation is possible because each student may have different perceptions about the quality of discipline and support a teacher/classroom provides. At L2, variance in these variables represent differences between schools in average levels of each variable.

Multilevel modelling was implemented using the CLUSTER and TYPE = TWOLEVEL options in Mplus v.8 (Muthén & Muthén, 2017). The final student weight provided by the OECD was incorporated to account for sampling bias due to stratification. All analyses to predict science literacy were performed 10 times (each of the 10 plausible values) and integrated through Mplus' TYPE = IMPUTATION data command. To help control for individual differences which may influence students' science literacy, motivation and grade repetition were included as covariates at L1. In addition, school level (junior vs. senior secondary) and type (public vs. private) were used as control variables at L2.

In summary, the following models were analysed. The first research question is addressed by Model 3, while the second question by Models 4a–f.

- Null model (no predictors)
- Model 1: motivation, grade repetition, senior secondary school, and private school
- Model 2: all predictors in Model 1 + SES
- Model 3: all predictors in Model 1 + SES + teaching variables
- Model 4a–f: all predictors in Model 1 + SES + teaching variables + interaction term

To facilitate interpretation, interactions between SES and teaching were tested separately for each teaching dimension (thus the six sub-models in Model 4). SES and teaching dimensions examined for their interaction were centred at the grand mean.

3 Findings

Descriptive statistics for SES, teaching variables and covariates are displayed in Table 2.2. The low SES scores indicate the sample's position compared to the average student from OECD countries.

TABLE 2.2 Descriptive statistics

Variable	Minimum	Maximum	Mean	Std. Dev.
Main predictors				
SES	−5.5762	1.8734	−1.79	1.11
Interactive instruction	1	4	2.86	0.65
Inquiry-based instruction	1	4	2.03	0.60
Teacher-directed instruction	1	4	2.42	0.65
Teacher feedback	1	4	2.27	0.67
Emotional support	1	4	3.11	0.59
Classroom management	1	4	3.08	0.60
Covariates				
Motivation	1	4	1.69	0.56
Grade repetition	0	1	0.14	0.35

Zero-order correlations between predictors are displayed in Table 2.3. The correlation strengths are mostly weak to moderate. The strongest correlation is between interactive instruction and inquiry-based instruction, most likely because both constructs reflect instruction which involves student-centred activities. Nonetheless, the size of the correlation (0.495) suggests that they can be differentiated and should not pose multicollinearity problems for the regression models.

3.1 *Multilevel Modelling*

Based on the null model, the student level variance was estimated at 2749.617, while the school level variance was 1946.842. This resulted in an Intraclass Correlation (ICC) of 0.422, indicating that a substantial portion (42.2%) of the variation in science literacy existed at the school level. Meanwhile, the intercept, reflecting the average science literacy score—was estimated at 405.747.

Standardised coefficients, standard errors, and p values from subsequent models are displayed in Table 2.4. Models 1 and 2 show the effects of the

TABLE 2.3 Inter-correlations between predictor variables

Variable	SES	Interact.	Inquiry	T. dir.	T. feed.	Em. sup	Class. M	Motiv.
SES								
Interact. inst.	0.065**							
Inquiry. inst.	0.061**	0.495**						
Teach-dir. inst.	0.066**	0.286**	0.278**					
Teacher feed.	−0.052**	0.250**	0.266**	0.395**				
Emot. support	0.038**	0.494**	0.347**	0.280**	0.278**			
Class. manag.	−0.012	−0.023	−0.087**	0.078**	0.053**	0.029*		
Motivation	−0.022	−.138**	−0.089**	−0.091**	−0.088**	−0.147**	−0.037**	
Grade rep.	−0.174**	0.009	0.061**	0.014	0.050**	−0.023	−0.075**	0.002

** $p < 0.01$; * $p < 0.05$

covariates and SES on a students' science literacy. As predicted, SES is associated with better performance at the student and school levels. Students who repeated grades tended to perform worse, while those who report stronger motivation tended to perform better. Senior secondary schools exhibited higher scores compared to junior secondary schools. Private schools on average had lower scores than public ones.

3.1.1 Main Effects of Teaching Practices (Research Question 1)

The effects of teaching practices are revealed in Model 3. Two practices were associated with higher science literacy at the individual and school levels: classroom management and interactive instruction. Inquiry-based instruction was associated with lower literacy also at both levels of analysis. Teacher-directed instruction and feedback were both negatively associated with literacy at the individual level. Emotional support was also negatively associated with literacy but at the school level.

3.1.2 Interaction between Teaching and SES (Research Question 2)

The interaction terms from Models 4a-f are displayed in Table 2.5. Only the interaction between interactive instruction and SES was found to be significant at the school level (Model 4a, complete results from this model is shown in Table 2.4). The positive value of the interaction indicates that the association between interactive instruction and science literacy becomes

TABLE 2.4 Results of the multilevel models predicting students' science literacy; number represent standardised coefficients, standard errors, and p values (1-tailed)

Predictors	Model 1			Model 2			Model 3			Model 4a: Interactive X SES		
	Estimate	s.e.	p	Estimate	s.e.	p	Estimate	s.e.	p	Estimate	s.e.	p
L1: Student level												
Grade repetition	**−0.151**	0.018	0.000	**−0.146**	0.018	0.000	**−0.122**	0.018	0.000	**−0.121**	0.018	0.000
Motivation	**0.053**	0.015	0.000	**0.052**	0.015	0.000	**0.054**	0.016	0.001	**0.054**	0.016	0.000
SES	–	–	–	**0.068**	0.015	0.000	**0.078**	0.016	0.000	**0.078**	0.016	0.000
Interactive instruction	–	–	–	–	–	–	**0.118**	0.018	0.000	**0.118**	0.018	0.000
Inquiry-based instruction	–	–	–	–	–	–	**−0.166**	0.021	0.000	**−0.167**	0.021	0.000
Teacher-directed instruction	–	–	–	–	–	–	**−0.031**	0.019	0.048	**−0.031**	0.019	0.050
Teacher feedback	–	–	–	–	–	–	**−0.084**	0.016	0.000	**−0.083**	0.016	0.000
Classroom management	–	–	–	–	–	–	**0.092**	0.019	0.000	**0.092**	0.019	0.000
Emotional support	–	–	–	–	–	–	0.008	0.020	0.349	0.008	0.020	0.342
Interaction term	–	–	–	–	–	–	–	–	–	−0.009	0.016	0.295
L2: School level												
Senior secondary	**0.381**	0.058	0.000	**0.100**	0.053	0.029	**0.092**	0.053	0.044	**0.157**	0.065	0.008

(cont.)

TABLE 2.4 Results of the multilevel models predicting students' science literacy; number represent standardised coefficients, standard errors, and p values (1-tailed) (*Cont.*)

Predictors	Model 1			Model 2			Model 3			Model 4a: Interactive X SES		
	Estimate	s.e.	p	Estimate	s.e.	p	Estimate	s.e.	p	Estimate	s.e.	p
Private school	**−0.218**	0.064	0.000	**−0.180**	0.050	0.000	**−0.207**	0.053	0.000	**−0.220**	0.055	0.000
SES	–	–	–	**0.682**	0.047	0.000	**0.580**	0.076	0.000	**0.568**	0.076	0.000
Interactive instruction	–	–	–	–	–	–	**0.313**	0.16	0.028	**0.449**	0.189	0.009
Inquiry-based instruction	–	–	–	–	–	–	**−0.365**	0.112	0.001	**−0.478**	0.129	0.000
Teacher-directed instruction	–	–	–	–	–	–	−0.108	0.122	0.187	0.188	0.224	0.200
Teacher feedback	–	–	–	–	–	–	−27.15	30.60	0.190	−0.113	0.124	0.183
Classroom management	–	–	–	–	–	–	**0.200**	0.058	0.001	**0.159**	0.063	0.006
Emotional support	–	–	–	–	–	–	**−0.214**	0.097	0.014	**−0.184**	0.100	0.033
Interaction term												
Explained variance	–	–	–	–	–	–	–	–	–	**0.231**	0.139	0.043
L1 (student level)	2.6%			3.0%			7.2%			7.2%		
L2 (school level)	18.0%			56.6%			75.4%			79.1%		

Note: Values in bold indicate statistically significant estimates ($p < 0.05$)

TABLE 2.5 Interaction between teaching and SES (Models 4a–f)

Interaction term	Estimate	s.e.	p
L1 (*Student level*)			
a. Interactive inst. X SES	−0.009	0.016	0.295
b. Inq.based inst. X SES	0.000	0.017	0.493
c. Teacher-dir. inst. X SES	−0.013	0.015	0.184
d. Teacher feedback X SES	−0.023	0.016	0.174
e. Classroom manag. X SES	−0.014	0.014	0.167
f. Emotional support X SES	−0.019	0.015	0.104
L2 (*School level*)			
a. Interactive inst. X SES	**0.231**	0.139	0.043
b. Inq.based inst. X SES	0.050	0.062	0.210
c. Teacher-dir. inst. X SES	0.164	0.109	0.065
d. Teacher feedback X SES	−0.047	0.089	0.299
e. Classroom manag. X SES	0.025	0.079	0.375
f. Emotional support X SES	0.013	0.073	0.429

Note: Values in bold indicate statistically significant estimates ($p < 0.05$)

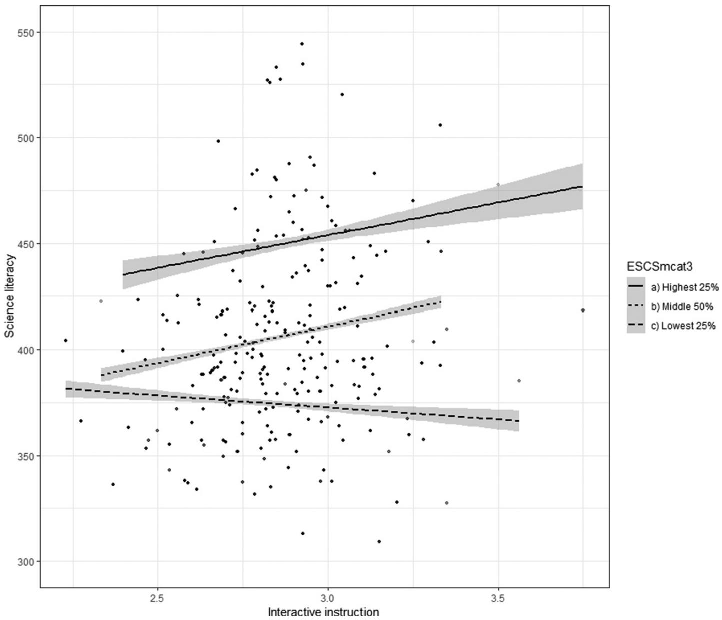

FIGURE 2.1 Regression lines for schools at the highest 25%, middle 50%, and the lowest 25% SES quartile, with 95% confidence intervals

stronger as school SES increases. Put differently, interactive instruction is more effective among higher SES schools than lower SES ones, as illustrated in Figure 2.1.

4 Discussion

This study seeks to generate evidence-based insights regarding good science teaching practices in Indonesian secondary schools. More specifically, two questions were addressed, the first regarding associations between teaching and learning outcomes generally, and the second regarding whether teaching interacts with students' family background (SES).

4.1 Associations between Teaching Practices and Learning Outcome

Controlling for individual differences in the family background (SES), motivation, and grade repetition, two teaching practices were found to be associated with higher learning outcomes at both the student and school levels: classroom management and interactive instruction. Thus, within the same school, students who reported that their science lessons were orderly also tended to perform better at PISA's science literacy test. Schools where students reported experiencing more orderly science lessons also showed higher than average performance compared to other schools. Similarly, within the same school, students who reported to have experienced more interactive science instruction tended to obtain better science literacy scores. Schools where students reported higher frequencies of interactive science instruction also performed better than other schools in PISA's science literacy test. These findings are consistent with prior research as well as with contemporary theories of learning.

Conversely, inquiry-based instruction was found to be negatively associated with science literacy at both the student and school levels. This finding is consistent with previous studies based on large-scale assessments of learning such as PISA and TIMSS. Given the strong emphasis on the use of inquiry in contemporary science education reforms, this may seem disconcerting (Sjøberg, 2018). However, it is useful to note that inquiry-based instruction in this study refers to unstructured or unguided inquiry activities; that the five items forming the inquiry-based instruction variable in this study referred to student-led activities without reference to any teacher or expert guidance. From a cognitive theory perspective, unstructured inquiry posed a heavy cognitive load, much of which may not be relevant for learning about the intended content (Kirschner et al., 2006; Mayer, 2004). Thus, the negative association between unguided inquiry activities and science literacy is to be expected. It does not mean that inquiry-based science instruction should be abandoned. Indeed, there is strong evidence to suggest that guided inquiry approaches are effective to foster science learning (Furtak et al., 2016; Lazonder & Harmsen, 2016).

Teacher-directed instruction, teacher feedback, and emotional support were also associated with lower science literacy at either the student or school level. Teacher-directed instruction refers to a teacher-centred, content-focused approach. It was found to be associated with lower science literacy only at the student level, and only affected a small percentage of students. That is to say, within the same school, students who reported experiencing more teacher-directed instruction also tended to obtain slightly lower scores on PISA's science literacy test. From a constructivist perspective, this negative association is unsurprising: learning occurs when learners are prompted/facilitated to actively process new information (Bransford et al., 2000; Derry, 1996). Thus, instruction which emphasises the delivery of content from teacher to student is unlikely to be effective.

The other negative associations between teaching practices and learning outcomes observed in this study are unexpected and more difficult to explain theoretically. Teacher feedback during instruction was found to be associated with lower science literacy at the individual level. Thus, within the same school, students who often received feedback regarding their performance and areas of improvement also tended to obtain lower science literacy scores. Given the strong body of research showing that feedback facilitates learning, it seems imprudent to conclude that the provision of feedback by Indonesian science teachers is detrimental. Another possibility for this negative association is that teachers tended to provide more individual feedback for students with lower science abilities. In other words, it is a students' prior abilities which prompted teachers to provide more frequent feedback. Further research, preferably utilising longitudinal or experimental designs, would need to be conducted to examine this possibility.

Emotional support was also found to be related to lower science literacy but at the school level. Schools with more positive emotional climate tended to perform poorly in PISA's science literacy test compared to other schools. Again, it would be hasty to conclude that Indonesian science teachers should refrain from creating a positive emotional climate in their classrooms (Becker & Luthar, 2002; Good, Wiley, & Florez, 2009). A closer examination of PISA's emotional support items ("the teacher gives extra help" or "the teacher continues teaching until students understand") suggest that this variable may reflect teachers' perception of students' learning needs. Similar to the provision of individual feedback, teachers may feel a stronger need to provide emotional support when teaching students with lower abilities; longitudinal and/or experimental research is needed to be conducted to test this conjecture.

4.2 *Teaching and Educational Equity*

Good teaching should be effective for all students, regardless of their family background. In technical terms, this condition would be reflected in a non-significant interaction between teaching practice and a students' SES. Of the two teaching practices found to associate positively with science literacy, only classroom management met this criterion. Findings in the same school showed that students who reported experiencing an orderly "better managed" science lesson (regardless of their SES background) tended to perform better than their peers. This was also true at the school level: classroom management is positively associated with school performance, regardless of the school's SES composition.

As illustrated in Figure 2.1, an increased frequency of interactive instruction is directly linked to better performance in schools catering to students from the mid to high SES backgrounds. However, this is not so with students from low SES backgrounds; the study shows that interactive instruction did not seem to add to an improved learning outcome. One can safely assume that unlike their peers in higher SES schools, students attending low SES schools fail to benefit from interactive science instruction.

While unfortunate, this finding is to be expected; social stratification theories have long suggested that schools play an important role in reproducing inequalities between socio-economic classes (Collins, 2009). One proposed mechanism involves discussing how instruction is experienced by students from different social classes (Sadovnik, 1991). The academic culture that is dominant in many schools is often incongruent with the dispositions and identities of students from disadvantaged families. Compared to peers from more advantaged backgrounds, these students are often less interested in academic subjects, less confident in their academic ability, have poorer study skills, and possess incongruent beliefs about the kinds of expected behaviour in class. In addition, they may also perceive that educational institutions favour their wealthier peers and hence tend to adopt lower academic aspirations (e.g. obtaining vocational as opposed to academic degrees). Due to these reasons, students from lower SES families may be less prepared and less willing to take initiative and participate actively in the context of interactive instruction, which requires students to express their ideas and engage in argumentation about science questions.

5 Implications for Practice and Future Research

This study highlights the importance of classroom management to create an orderly climate for learning to occur. How can teachers create orderly classrooms? Emmer and Stough (2001, p. 105) identified two principles which underlie good classroom management. First, classroom management should be preventive rather than reactive. Desirable and undesirable behaviours need to be made clear to students at the start of a school year. In other words, classroom rules need to be established at the outset, and not made up on the fly in response to specific events. Second, desirable behaviours need to be explicitly taught: students need help to understand, adhere to, and enact classroom rules. This can also involve careful monitoring so that problematic behaviours can be detected and addressed before they become entrenched (Emmer & Stough, 2001).

It needs to be noted that classroom management should not be equated with a controlling style of teaching. The notion of classroom management has evolved from an authoritarian view which emphasises teacher control over student behaviour, to more egalitarian views which emphasise student involvement in co-constructing a climate conducive for learning (Egeberg, Mcconney, & Price, 2016). In this more contemporary perspective, classroom management is implemented in a participatory manner (e.g. by involving students in formulating classroom rules and help monitor their implementation). Orderly behaviour is considered to be a by-product of an underlying positive emotional climate and intellectually stimulating instruction. To generate appropriate guidelines and professional development related to effective classroom management, more in-depth research in the Indonesian context is needed.

With regards to instruction, on the one hand, the current findings should caution against using unstructured or unguided inquiry activities. Asking students to independently perform science experiments or investigations may seem like a good, student-centred teaching practice. However, student-centred teaching should not be translated as simply allowing students to perform complex activities without scaffolding. Without proper structure and guidance, students will tend to enact inquiry in a hands-on manner, without processing the underlying science concepts. This is not to say that a more traditional style of instruction is the antidote. Instruction which emphasises content delivery through teacher-centred lectures was found to be ineffective (and even slightly negatively associated with poorer learning).

What should be promoted as good teaching is what I refer to as "interactive instruction", a style of instruction which combines teacher explanations with student-centred discussions and argumentation. More specifically, rather than focus on abstract definitions (declarative knowledge per se), the teacher explanations in interactive instruction focus on how science concepts relate to everyday life, on how they can be applied to understand familiar phenomena and solve important problems. Furthermore, interactive instruction involves allowing students to explain their ideas about science, and to argue about science questions. Thus, to implement interactive instruction, teachers need to value students' ideas, to be skilled at eliciting and productively responding to those ideas. Teachers also need to value and understand science argumentation as a learning method. These needs should be prime targets for professional development programs intended for the science teacher.

This study also indicates that while interactive instruction seems to be effective for middle and high SES schools, it is less so for students in low SES schools. In other words, the implementation of interactive instruction does little to rectify the achievement gap between rich and poor secondary school students in Indonesia. Social stratification theories propose that students often lack the dispositions required to benefit from instruction that demands active participation and initiative. Further research should investigate this issue to examine the interaction between family SES, student dispositions, and experiences of instruction in the Indonesian context. A deeper understanding of the underlying mechanism would be useful for teachers, school managers, and policymakers who wish to address the issue of educational inequity.

6 Limitations and Conclusions

As a secondary analysis, the current study is constrained by the characteristics of the primary study. In this case, the cross-sectional nature of PISA data prevents causal inferences to be made regarding the effects of teaching. Even so, the current analysis yielded some findings which are theoretically and practically meaningful. In particular, classroom management and interactive instruction emerged as practices which were associated with higher science literacy, both at the individual/student and collective/school levels. Furthermore, the findings also highlight the challenge of addressing educational inequality by showing that students from disadvantaged families may need additional support to benefit from science instruction at school. On the flip side, instructional practices which seem to be effective in general (i.e. interactive instruction) need to be adjusted to make it beneficial for all students regardless of their socioeconomic background.

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Note

1 See http://www.oecd.org/pisa/data/2015database/

References

Aditomo, A. (2009). Cognitive load theory and mathematics learning: A systematic review. *Indonesian Psychological Journal, 24*(3), 207–217.

Aditomo, A., & Hasugian, E. J. (2018). Indonesian adolescents' EFL reading comprehension: Gender differences and the influence of parental background. *Indonesian Journal of Applied Linguistics, 8*(2), 325–335. https://doi.org/10.17509/ijal.v8i2.13279

Agirdag, O. (2018). The impact of school SES composition on science achievement and achievement growth: Mediating role of teachers' teachability culture. *Educational Research and Evaluation, 24*(3–5), 264–276. https://doi.org/10.1080/13803611.2018.1550838

Agirdag, O., Van Houtte, M., & Van Avermaet, P. (2012). Why does the ethnic and socio-economic composition of schools influence math achievement? The role of sense of futility and futility culture. *European Sociological Review, 28*(3), 366–378. https://doi.org/10.1093/esr/jcq070

Andersen, I. G., & Andersen, S. C. (2017). Student-centered instruction and academic achievement: Linking mechanisms of educational inequality to schools' instructional strategy. *British Journal of Sociology of Education, 38*(4), 533–550. https://doi.org/10.1080/01425692.2015.1093409

Armor, D. J., Marks, G. N., & Malatinszky, A. (2018). The impact of school SES on student achievement: evidence from U.S. statewide achievement data. *Educational Evaluation and Policy Analysis, 40*(4), https://doi.org/10.3102/0162373718787917

Becker, B. E., & Luthar, S. S. (2002). Social-emotional factors affecting academic outcomes among disadvantaged students: Closing the achievement gap. *Educational Psychologist, 27*(4), 197–214. https://doi.org/10.1207/S15326985EP3704

Bee, H. L., Van Egeren, L. F., Pytkowicz Streissguth, A., Nyman, B. A., & Leckie, M. S. (1969). Social class differences in maternal teaching strategies and speech patterns. *Developmental Psychology, 1*(6), 726–734. https://doi.org/10.1037/h0028257

Berkowitz, R., Moore, H., Astor, R. A., & Benbenishty, R. (2017). A research synthesis of the associations between socioeconomic background, inequality, school climate, and academic achievement. *Review of Educational Research, 87*(2), 425–469. https://doi.org/10.3102/0034654316669821

Bodovski, K., & Farkas, G. (2007). Do instructional practices contribute to inequality in achievement? The case of mathematics instruction in kindergarten. *Journal of Early Childhood Research, 5*(3), 301–322. https://doi.org/10.1177/1476718X07080476

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school*. National Academies Press.

Brophy, J. E. (1983). Classroom organisation and management. *The Elementary School Journal, 83*(4), 265–285. https://doi.org/10.1086/461318

Chinn, C. A., & Malhotra, B. A. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education, 86*, 175–218. https://doi.org/10.1002/sce.10001

Collins, J. (2009). Social reproduction in classrooms and schools. *Annual Review of Anthropology, 38*, 33–48. https://doi.org/10.1146/annurev.anthro.37.081407.085242

Deci, E. L., Ryan, R. M., Vallerand, R. J., & Pelletier, L. G. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist, 26*(3–4), 325–346. https://doi.org/10.1080/00461520.1991.9653137

De Graaf, N. D., De Graaf, P. M., & Kraaykamp, G. (2000). Parental cultural capital and educational attainment in the Netherlands: A refinement of the cultural capital perspective. *Sociology of Education, 73*, 92–111.

Derry, S. J. (1996). Cognitive schema theory in the constructivist debate. *Educational Psychologist, 31*(3–4), 163–174. https://doi.org/10.1080/00461520.1996.9653264

Dumay, X., & Dupriez, V. (2007). Accounting for class effect using the TIMSS 2003 eighth-grade database: Net effect of group composition, net effect of class process, and joint effect. *School Effectiveness and School Improvement, 18*(4), 383–408. https://doi.org/10.1080/09243450601146371

Dumay, X., & Dupriez, V. (2008). Does the school composition effect matter? Evidence from Belgian data. *British Journal of Educational Studies, 56*(4), 440–477. https://doi.org/10.1111/j.1467–8527.2008.00418.x

Edgerton, J. D., & Roberts, L. W. (2014). Cultural capital or habitus? Bourdieu and beyond in the explanation of enduring educational inequality. *Theory and Research in Education, 12*(2), 193–220. https://doi.org/10.1177/1477878514530231

Egeberg, H. M., Mcconney, A., & Price, A. (2016). Classroom management and national professional standards for teachers: A review of the literature on theory and practice. *Australian Journal of Teacher Education, 41*(7), 1–18.

Emmer, E. T., & Stough, L. M. (2001). Classroom management: A critical part of educational psychology, with implications for teacher education. *Educational Psychologist, 36*(2), 103–112. https://doi.org/10.1207/S15326985EP3602

Entwisle, D. R., Alexander, K. L., & Olson, L. S. (2010). Socioeconomic status: Its broad sweep and long reach in education. In J. L. Meece & J. S. Eccles (Eds.), *Handbook of research on schools, schooling, and human development* (pp. 237–255). Routledge.

Esmonde, I. (2009). Ideas and identities: Supporting equity in cooperative mathematics learning. *Review of Educational Research, 79*(2), 1008–1043. https://doi.org/10.3102/0034654309332562

Fauth, B., Decristan, J., Rieser, S., Klieme, E., & Büttner, G. (2014). Student ratings of teaching quality in primary school: Dimensions and prediction of student outcomes. *Learning and Instruction, 29*, 1–9. https://doi.org/10.1016/j.learninstruc.2013.07.001

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2016). Experimental and quasi-experimental studies of inquiry-based science teaching: A meta-analysis. *Review of Educational Research, 82*(3), 300–329. https://doi.org/10.3102/0034654312457206

Good, T. L., Wiley, C. R. H., & Florez, I. R. (2009). Effective teaching: An emerging synthesis. In G. Dworkin (Ed.), *International handbook of research on teachers and teaching* (pp. 803–816). https://doi.org/10.1007/978-0-387-73317-3_51

Hess, R. D., & Shipman, V. C. (1965). Early experience and the socialisation of cognitive modes in children. *Child Development, 36*(4), 869–886.

Hmelo-silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99–107.

Hox, J. J. (2010). *Multilevel analysis: Techniques and applications*. Routledge.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75–86. https://doi.org/10.1207/s15326985ep4102

Klieme, E., Pauli, C., & Reusser, K. (2009). *The pythagoras study: Investigating effects of teaching and learning in Swiss and German mathematics classrooms* (pp. 137–160). Munster: Waxmann Verlag.

Lazonder, A. W., & Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of Educational Research, 86*(3), 681–718. https://doi.org/10.3102/0034654315627366

Liu, H., Van Damme, J., Gielen, S., & Van Den Noortgate, W. (2015). School processes mediate school compositional effects: Model specification and estimation. *British Educational Research Journal, 41*(3), 423–447. https://doi.org/10.1002/berj.3147

Lüdtke, O., Trautwein, U., Kunter, M., & Baumert, J. (2006). Reliability and agreement of student ratings of the classroom environment: A reanalysis of TIMSS data. *Learning Environments Research, 9*(3), 215–230. https://doi.org/10.1007/s10984-006-9014-8

Mayer, R. E. (2004). Should there be a three-strikes rule against pure the case for guided methods of instruction. *American Psychologist, 59*(1), 14–19. https://doi.org/10.1037/0003-066X.59.1.14

Muijs, D., Kyriakides, L., van der Werf, G., Creemers, B., Timperley, H., & Earl, L. (2014). State of the art-teacher effectiveness and professional learning. *School Effectiveness and School Improvement, 25*(2), 231–256. https://doi.org/10.1080/09243453.2014.885451

Muthén, L. K., & Muthén, B. O. (2017). *Mplus user's guide* (8th ed.). Muthén & Muthén.

Neumann, K., Kauertz, A., & Fischer, H. E. (2012). Quality of instruction in science education. In B. J. Fraser, K. Tobin, & C. J. McRobbie (Eds.), *Second international handbook of science education* (pp. 247–258). Springer.

OECD. (2016a). *PISA 2015 assessment and analytical framework: Science, reading, mathematic and financial literacy*. OECD Publishing. https://doi.org/10.1787/9789264255425-en

OECD. (2016b). *PISA 2015 results: Excellence and equity in education* (Vol. I). OECD Publishing.

Rjosk, C., Richter, D., Hochweber, J., Lüdtke, O., Klieme, E., & Stanat, P. (2014). Socioeconomic and language minority classroom composition and individual reading achievement: The mediating role of instructional quality. *Learning and Instruction, 32*, 63–72. https://doi.org/10.1016/j.learninstruc.2014.01.007

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. https://doi.org/10.1037/0003–066X.55.1.68

Sadovnik, A. R. (1991). Basil Bernstein's theory of pedagogic practice: A structuralist approach. *Sociology of Education, 64*(1), 48. https://doi.org/10.2307/2112891

Scheerens, J. (2001). Monitoring school effectiveness in developing countries. *School Effectiveness and School Improvement: An International Journal of Research, 12*(4), 359–384. https://doi.org/10.1076/sesi.12.4.359.3447

Sfard, A. (1998, March). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, 4–13.

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*(3), 417–453.

Sirin, S. R., Diemer, M. A., Jackson, L. R., & Howell, A. (2004). Future aspirations of urban adolescents: A person-in-context model. *International Journal of Qualitative Studies in Education, 17*(3), 437–459. https://doi.org/10.1080/0951839042000204607

Sjøberg, S. (2018). The power and paradoxes of PISA: Should inquiry-based science education be sacrificed to climb on the rankings? *Nordic Studies in Science, 14*(2), 186–202. https://doi.org/10.5617/nordina.6185 van Ewijk, R., & Sleegers, P. (2010). The effect of peer socioeconomic status on student achievement: A meta-analysis. *Educational Research Review, 5*(2), 134–150. https://doi.org/10.1016/j.edurev.2010.02.001

Windschitl, M., Thompson, J., & Braaten, M. (2008). Beyond the scientific method: Model-based inquiry as a new paradigm of preference for school science investigations. *Science Education*, 1–27. https://doi.org/10.1002/sce