Inquiry-based leading and learning

Inquiry-based working by school boards, school leaders and teachers and students' inquiry habit of mind

Luijk, E.

Publication date
2017

Document Version
Other version

License
Other

CHAPTER 4

Teachers' role in stimulating students' inquiry habit of mind in primary schools[3]

Abstract

Curiosity and critical thinking skills are essential for life in the twenty-first century. This mixed-method study examined the relationship between teachers' inquiry-based work and students' inquiry habit of mind. Teachers who work in an inquiry-based manner create a culture of inquiry in the classroom and contribute to a culture of inquiry at the school level. Students with an inquiry habit of mind are curious and have critical thinking habits. This study consisted of a survey, followed by a case study. Questionnaire data were collected from 1,104 students and 249 teachers at 31 primary schools. The case study was conducted in two primary schools. The survey data revealed a relationship between teachers' inquiry-based work and students' curiosity. However, no relationship was found between teachers' inquiry-based approach and students' critical thinking habits. The case study results illustrate how teachers' inquiry-based working can be related to students' curiosity and critical thinking habits.

[3] This chapter is based on Uiterwijk-Luijk, L., Krüger, M., Zijlstra, B., & Volman, M. (submitted). Teachers' role in stimulating students' inquiry habit of mind in primary schools.

Introduction

Nowadays, complex thinking and communication skills are in greater demand than more basic skills (Levy & Murnane, 2005; Saavedra & Opfer, 2012). This economic and social necessity encourages a greater appreciation of abilities such as creativity, problem solving, and collaboration. At the same time, children are exposed to an enormous amount of information from many sources, and not all of this information is always accurate (Mills, 2012). As early as 1999, Wells pointed out that young people need to develop an understanding and attitude that will help them become informed, critical, and responsible members of a changing world (Wells, 1999). To better reflect developments in today's society, he advocated for explorative and collaborative learning in schools. In that approach, classes and schools become communities of inquiry, in which real understanding is achieved via a collaborative problem-solving process. Today, twenty-first century skills are in demand worldwide. Learning through inquiry is becoming an increasingly essential aspect of educational practices. Effective communication, curiosity, and critical thinking skills are essential competencies and habits of mind for life in today's world (e.g., Wagner, 2014).

Teachers play a crucial role in developing students' critical inquiry skills (Dobber & Van Oers, 2015). Creating a culture of inquiry in the classroom means creating an environment in which students are driven by curiosity, ask questions, make discoveries, and test their findings in a search for new understandings (Al-Sabbagh, 2009; Chin, 2002). Creating a culture of inquiry in the classroom requires changes in teachers' knowledge, skills, and attitudes. Researchers have suggested that engaging teachers themselves in a culture of inquiry can bring about these changes (Dobber & Van Oers, 2015; Wells, 2011). In such a culture, teachers systematically and intentionally investigate their own teaching as a means of quality improvement. Then, teachers can use the results of such research to enhance their teaching and learning (Ellis & Castle, 2010; Gallimore, Ermeling, Saunders, Goldenberg, 2009; Van der Linden, Bakx, Ros, Beijaard, & Vermeulen 2012). The research base on promoting students' inquiry-habit of mind is expanding. Previous meta-analyses have indicated a connection between inquiry-based teaching and improved student learning (Furtak, Seidel, Iverson, & Briggs, 2012). To add to the knowledge in this area, this study investigated the relationship between teachers' inquiry-based work and students' inquiry habit of mind.

Theoretical framework

All over the world, twenty-first century skills have become a key topic on the agendas of educational policymakers (e.g., Binkley et al., 2012; Niemi & Multisilta, 2016). Although the literature has defined the term "twenty-first century skills" in a variety of ways, some commonalities exist. Most definitions focus on complex thinking, learning, and communication skills (Saavedra & Opfer, 2012) and also emphasize students' capacity to learn throughout their lives (Niemi & Multisilta, 2016). Inquiry and knowledge-creation skills are the most crucial, and these are linked to analytical skills, critical thinking skills, and creativity (Niemi & Multisilta, 2016). A growing body of research has indicated that providing students with opportunities to explore authentic problems can substantially enhance their understanding (Levy, Thomas, Drago, & Rex, 2013). In this approach, students' inquiries focus on finding answers and creating artifacts that are significant in their own lives (Dobber & Van Oers, 2015).

Students' inquiry habit of mind

The concept "inquiry habit of mind" is strongly related to concepts such as "researcherly disposition" (Tack & Vanderlinde, 2014), "inquiry as stance" (Cochran-Smith, 2003), and "scientific research dispositions" (Van der Rijst, 2009). In their study on teacher educators, Tack and Vanderlinde (2014) defined a researcherly disposition as a triad of an inclination towards research (affective aspect), an ability to conduct research (cognitive aspect), and a sensitivity to research opportunities (behavioral aspect). Cochran-Smith (2003) who also focused on teacher educators, described "inquiry as stance" as a critical habit of mind; an intellectual perspective; and a way of questioning, understanding, and connecting one's day-to-day work to other's activities and larger contexts. It is "a process of continual and systematic inquiry wherein participants question their own and others' assumptions and construct local as well as public knowledge appropriate to the changing contexts in which they work" (Cochran-Smith, 2003, p. 25). In his study of scientific inquiry among university students, Van der Rijst (2009) found six different scientific research dispositions. These are the inclination to: (1) know, (2) understand, (3) be critical, (4) achieve, (5) share, and (6) be innovative. Earl and Katz (2006) have referred to school leaders' inquiry habit of mind as an ongoing process of seeking out and using evidence to make decisions. In other words, it refers to a habit of using inquiry and reflection to think about one's current position, as well as the destination and the means of reaching it. An inquiry habit of mind also means rethinking and evaluating this process, making

adjustments as necessary (Earl & Katz, 2006). Moreover, Wells (1999) explained that an inquiry habit of mind entails being open to wondering and puzzlement, trying to construct and test explanations, and mastering information.

There does not appear to be a consistent definition of students' inquiry habit of mind. All studies agree, however, that an inquiry habit of mind involves being both curious and critical. Both of these aspects are important components of a student's inquiry habit of mind, and this study investigates them.

Students' curiosity

Curiosity can be defined as a desire to know, see, or experience that motivates exploratory behavior directed towards the acquisition of new information (Litman, 2005). Curiosity can be aroused by what Jirout and Klahr (2012) called "uncertainty in the environment" on the basis of their review of children's scientific curiosity, such as a sense of uncertainty regarding the existence of an item in a particular location.

Zion and Sadeh (2007) found that curious high-school students seek challenges and enjoy modifying their inquiries as they move through the inquiry process. Students' curiosity increased when they obtained unexpected results. Furthermore, unanticipated outcomes can fuel student's inquisitive passion. The notion of a logical structure, with the inquiry questions at the core and the inquiry plan surrounding it, emphasizes the importance of questioning, logical thinking, and appreciating curiosity as triggers for formulating questions (Zion & Sadeh, 2007). Scardamalia and Bereiter (2010) pointed out that curiosity alone is not sufficient to motivate sustained inquiry. Long-term goals are also necessary to guarantee intentional learning and, ultimately, the building of knowledge (Scardamalia & Bereiter, 2010). Despite the emphasis on stimulating students' curiosity, Wagner (2014) demonstrated that the longer students are in school, the less curious they become. Wagner assumed that the main reason for this outcome is that teachers have not received training on teaching students how to think. Furthermore, textbooks and tests are often not designed to teach and assess students' ability to reason or analyze.

Students' critical thinking habits

Research has indicated that even young children can engage in critical thinking and that school environments can promote the growth of these critical capacities through discursive interactions

and formal interventions (Murphy, Rowe, Ramani, & Silverman, 2014). Critical thinking has a diversity of definitions (Mulnix, 2012; Petress, 2004). For example, according to Scriven and Paul (2008), critical thinking refers to an intellectually disciplined process of conceptualizing, applying, analyzing, synthesizing, and/or evaluating information to guide beliefs and actions. According to their definition, critical thinking is both a skill and a habit of mind. This means critical thinking is not only a set of processing skills but also a habit of using those skills to guide behavior. In other words, as Mulnix (2012) explained:

> This highlights the contrast between merely constructing a logical argument, which can be done in a mechanical way, and thinking critically, which requires careful application of the skills of sound reasoning to patterns of belief and a commitment to accept the results of that reasoning. (p.465)

This study did not focus on critical thinking as a skill. Rather, it emphasizes its role as a habit of mind, which we call *critical thinking habits*. This means that we do not interpret being critical as the practice of processing several scientific skills. Instead, we understand it as the attitude necessary for performing these skills. This attitude is based on universal intellectual values that transcend subject matter divisions, such as: clarity, accuracy, precision, consistency and relevance (Scriven & Paul, 2008). This conceptualization is in line with Van der Rijst (2009), whose research has demonstrated that critical thinking habits include having a critical attitude towards others (e.g., articles or colleagues) but also towards experimental observations. A self-critical attitude, or being critical of one's own ideas and work, also fits within this category. Generally speaking, a critical thinking habit boils down to harboring sophisticated doubts, consistently double-checking results, and considering issues of accuracy. These kinds of reservations can initiate critical questions on all manner of topics.

Teachers creating a culture of inquiry in the classroom

According to Lipman (2003), a culture of inquiry in the classroom (what he referred to as a "classroom community of inquiry") means that students are investigating problems and engaged in inquiry. Students collaborate together, build on ideas of others, challenge one another to supply reasons for opinions and assumptions, and draw conclusions as a group (Lipman, 2003). The concept of learning through inquiry can be applied across a diverse range of school subjects (Dobber & Van Oers, 2015; Levy et al., 2013; Wells, 1999). The purpose of inquiry is to guide students in constructing their own knowledge by helping to develop their curiosity (Zion & Sadeh, 2007).

A culture of inquiry in the classroom implies inquiry-based learning. Many studies have focused on the teacher's role in inquiry-based learning. These studies have revealed that student-centered approaches are limited in their ability to boost student achievement. In contrast, combined student-centered and teacher-centered approaches can provide structured support (Baeten, Dochy, & Struyven, 2012; Brown & Campione, 1994; Furtak et al., 2012).

Jones and Eick (2007) described three forms of inquiry-based science teaching. The first one is open-ended. With that approach, teachers put aside planned instruction to explore students' questions. The second form of inquiry-based teaching is project-based inquiry, in which teachers design projects for students on the basis of the questions driving classroom discussions. The third form is guided inquiry. This teacher-centered approach utilizes a curriculum revolving around fixed scientific concepts and lessons (Jones & Eick, 2007). These three forms create a continuum from open-ended inquiry to guided inquiry, and learners' responsibilities vary along this scale. According to Olson and Loucks-Horsley (2000), students should have opportunities to participate in all types of inquiries. They pointed out that guided inquiry is the best fit for developing science concepts, while more open-ended approaches afford more appropriate opportunities for cognitive development and scientific reasoning. Brown and Campione (1995) highlighted that it is not easy for teachers to know when to intervene and when to leave students alone. To be successful, teachers must be sensitive and continually diagnose student understanding (Brown and Campione, 1995). This is a difficult task for teachers, as it is nearly impossible to follow a single, standardized protocol for all students. This impediment constitutes one of the key reasons that teachers face difficulties worldwide in implementing inquiry-based learning (Abrahams & Reiss, 2012; Flick, 2000; Osborne & Dillon, 2008).

Lazonder and Harmsen's (2016) meta-analysis of 72 studies found that teacher guidance has a significant positive effect on: (a) performance success, or the quality of the products students create during inquiry; (b) learning activities, or the embedded assessment of students' actions during inquiry; and (c) learning outcomes, which are assessed after the task by means of domain knowledge posttests. Regarding *performance success,* their overall conclusion was "that learners perform better during an inquiry (i.e., create better products to exhibit their domain knowledge) when supported by more specific forms of guidance" (Lazonder & Harmsen, 2016, p. 704). Their results suggested that less specific forms of guidance (like process constraints or status overviews) are useful for young learners with lower inquiry skills, while older, more experienced learners benefit from specific types of guidance, like scaffolds

or explanations. Regarding *learning activities* and *learning outcomes,* less specific forms of guidance lead to comparable results as more specific forms (Lazonder & Harmsen, 2016).

Davis, Janssen, and Van Driel's (2016) study on elementary and secondary teachers and science curriculum materials demonstrated that the extent to which lessons are inquiry-oriented is heavily influenced by how inquiry-oriented the curriculum materials are. In line with Earl and Katz (2006), this study understood creating a culture of inquiry in the classroom to mean stimulating students' inquiry habit of mind, as well as their data literacy. Teachers' level of guidance in stimulating students' inquiry habit and students' data literacy can vary from student-centered to teacher-centered approaches.

Inquiry-based working by teachers at the school level

Creating a culture of inquiry in the classroom is one thing, but contributing to an inquiry-driven school culture is a different matter. Teachers' inquiry-based working involves both aspects. In an inquiry-driven school, teachers collaboratively and systematically investigate their own teaching and use internal data and external research results to improve their teaching and learning (Ellis & Castle, 2010; Gallimore et al., 2009; Krüger, 2010b; Van der Linden et al., 2012). To truly build knowledge in this type of culture, deep inquiry questions (i.e., *how* and *why*) are necessary, while shallower questions (i.e., *what* and *when*) are less important (Scardamalia and Bereiter, 2006). According to Earl and Katz (2006), school leaders must have an inquiry habit of mind, be data-literate, and create a culture of inquiry. Translating this to teachers and considering that they work at both the classroom level and the school level means that teachers working in an inquiry-based manner must: (1) have an inquiry habit of mind, (2) be data-literate, (3) contribute to a culture of inquiry at the school level, and (4) create a culture of inquiry at the classroom level.

A teacher's inquiry habit of mind has similarities with a student's inquiry habit of mind. In their study on teachers' inquiry habit of mind (or inquiry-based attitude, as they called it), Meijer, Geijsel, Kuijpers, Boei, and Vrieling (2016) found an internal reflective dimension and an external knowledge-sourcing dimension. This means teachers with an inquiry habit of mind critically reflect on their teaching and are curious about the evidence on which they base their decisions. In addition, Earl and Katz (2006) underscored that an inquiry habit of mind involves valuing deep understanding, reserving judgment, obtaining a range of perspectives, and systematically posing increasingly focused questions.

For teachers, data literacy refers to knowledge regarding measurement and statistical concepts. Data-literate teachers think about purposes, recognize different types and quality of data, prioritize the interpretation of data, and report to others (Earl & Katz, 2006). They can transform data into information, information into knowledge, and knowledge into action (Marsh & Farrell, 2014). Data is often narrowly defined as quantitative, standardized assessment data. Data literacy, however, also requires knowledge about other data, such as data about perceptions, motivations, processes, and behaviors (Mandinach & Gummer, 2013).

Contributing to a culture of inquiry at the school level means that teachers must collaborate in making sense of all sorts of data, engage in joint action planning, and share instructional strategies (Datnow, Park, & Kennedy-Lewis, 2013). Wanting to share is what Van der Rijst et al. (2008) called "an inclination to share." This means being open to others, wanting to interact, and desiring to work cooperatively. While collaborating, teachers are influenced through their interactions and negotiations with others (Coburn & Turner, 2011). These others are not necessarily only colleagues, the term can also refer to external researchers (Van der Linden et al., 2012; Schenke, Van Driel, Geijsel, & Volman, 2016) or trained peer facilitators (Gallimore et al., 2009). This cooperative use of internal and external data is a type of professional learning that enhances new understandings. These new interpretations can stimulate improved practices, which can, in turn, influence student learning (Katz & Dack, 2014). In addition, they can change teachers' attributions from external causes to their own teaching (Gallimore, 2009).

Psychological factors related to inquiry-based working

Earlier research has revealed that teachers' inquiry-based working is strongly related to psychological factors, such as: (1) teachers' attitude towards inquiry-based working, (2) teachers' experienced social pressure to work in an inquiry-based manner, (3) teachers' self-efficacy regarding inquiry-based working, and (4) teachers' collective efficacy regarding inquiry-based working (Uiterwijk-Luijk, Krüger, Zijlstra, & Volman, 2017; Geijsel, Sleegers, Stoel, & Krüger, 2009). A teacher's attitude towards inquiry-based working can be defined as his or her tendency to respond with some degree of (dis)favor towards inquiry-based working (based on Fishbein & Ajzen, 2010). Experienced social pressure to work in an inquiry-based manner refers to the belief that others want us to work in this specific manner and are already doing so themselves (based on Fishbein & Ajzen, 2010). Self-efficacy regarding inquiry-based working refers to believing that one is capable of successfully working in an inquiry-based

manner (based on Bandura, 1997). Finally, collective efficacy regarding inquiry-based working involves a teacher's beliefs about the ability of his or her team to take an inquiry-based approach to working. Uiterwijk-Luijk et al. (2017) found that teachers' sense of self-efficacy regarding inquiry-based working is related to all aspects of that approach, namely, working with an inquiry habit of mind, being data literate, creating a culture of inquiry in the classroom, and contributing to a culture of inquiry at the school level. In addition, teachers with a high sense of collective efficacy tend to engage in a culture of inquiry, at both the classroom level and the school level. Finally, a positive attitude towards inquiry-based working and a strong sense of social pressure to work in such a way appear to be valuable for teachers working with an inquiry habit of mind. Therefore, when studying teachers' inquiry-based work, investigating these related psychological factors is also important.

The present study

Previous meta-analyses have indicated a connection between inquiry-based teaching and improved student learning (Furtak et al., 2012). However, little is known yet about whether teachers' inquiry-based working also leads to an inquiry habit of mind in children. The present study is part of a larger study on school boards, school leaders, teachers, and students' inquiry-based working (see also Uiterwijk-Luijk et al., 2017; Uiterwijk-Luijk, Krüger, Zijlstra, & Volman, accepted). In the present study, a survey investigated how teachers' inquiry-based working is related to students' inquiry habit of mind. In this study, students' inquiry habit of mind includes curiosity (wanting to seek out new knowledge) and critical thinking habits (being critical of one's self and others). Inquiry-based working by teachers includes: (1) working with an inquiry habit of mind, (2) being data-literate, (3) contributing to a culture of inquiry at the school level, and (4) creating a culture of inquiry at the classroom level by stimulating students' inquiry habit of mind and data literacy. As research has demonstrated that teachers' attitude towards inquiry-based working, experienced social pressure to work in an inquiry-based manner, self-efficacy regarding inquiry-based working, and collective efficacy regarding inquiry-based working are all related to their actual inquiry-based work (Uiterwijk-Luijk et al., 2017), we also included these variables in the current study.

Since the role of the teacher appears to play a crucial role in helping students develop critical inquiry skills (Dobber & Van Oers, 2015), we hypothesized that the more teachers work in an inquiry-based manner, the stronger their students' inquiry habit of mind would be. In addition, we hypothesized that a positive attitude towards inquiry-based working, a strong sense

of experienced social pressure regarding that approach, and a high degree of both self-efficacy and collective efficacy concerning inquiry-based working would correlate with high scores on students' inquiry habit of mind. To provide a more in-depth understanding of teachers' experiences with inquiry-based working and students' perceptions of their inquiry habit of mind, a case study was conducted in two different schools.

The Dutch education system

The Dutch education system consists of 8 years of primary education, which is intended for children between the ages of 4 and 12 years old. In primary education, a large segment of schools are government-funded private institutions, most of which are based on religious principles (Scheerens, 2016). The Netherlands does not have a national curriculum. This means that curricula are shaped in a variety of ways, which can influence the extent to which teachers work in an inquiry-based manner. Nevertheless, at the central level, quality standards apply to all schools. These list the subjects to be studied, attainment targets, the number of teaching hours per year, teacher qualifications requirements, etc. However, these standards leave schools with a significant amount of freedom in terms of how to apply them. The national inspectorate is tasked with maintaining educational quality.

Method

Participants and procedures

An explanatory sequential mixed methods approach (Creswell, 2014) was used, involving a two phase project. The first phase, which utilized a survey, gathered and analyzed quantitative data. The survey's purpose was to investigate the relationship between the different aspects of teachers' inquiry-based working and students' inquiry habit of mind. The case study's objective was to help explain the survey responses, explore and understand teachers' perceptions, and provide a more complete picture of students' inquiry habit of mind.

We invited all 1,046 primary school boards in the Netherlands to participate with their schools in the first phase of the study. Invitations were sent by mail, social media was used to draw attention to this study, and we used our networks to extend more personal invitations to school boards. In total, 33 school boards (3.2%) responded positively. This low response rate was expected due to research fatigue in Dutch schools. After the school boards granted their permission, we sent a web-based survey to the school boards, school leaders, teachers, and

students. For this part of the study, we received responses from 1,104 students (at 31 schools) and 249 teachers from grade 5 through grade 8 (at 61 schools).

The 1,104 students were spread quite evenly across grade 5 (24%), grade 6 (25%), grade 7 (30%), and grade 8 (22%), with slightly more students in grade 7. Of student respondents, 50.5% were male, and 49.5% were female. The teachers often indicated that they worked with more than one grade. In particular, 29% reported teaching in grade 5, while 30% taught in grade 6, 35% taught in grade 7, and 35% taught in grade 8. Of the responding teachers, 70% were female, thus slightly diverging from national figures. In the Netherlands, 78% of teachers are female (Ministry of Education, 2013).

In phase two, the case study, we selected two schools: one with relatively high scores on inquiry-based working and one with average scores in that area. In order to gain a deeper understanding of teachers' perceptions regarding inquiry-based working and students' inquiry habit of mind, we collected data on different manifestations of inquiry-based working in everyday school practice. To select the schools for the case study, we examined teachers and school leaders' scores on inquiry-based working and then contacted the selected schools by phone. If a school did not want to be involved in the study, we contacted another school with approximately equal scores. The case study was conducted in the following schools: Queen Beatrix Primary School and Mosaic Primary School. To maintain anonymity, all names used in this study are pseudonyms.

To explore teachers' perceptions and provide a more complete picture of students' inquiry habit of mind, we conducted individual interviews with four teachers at each school (one teacher from each grade; four interviews per school; total N=8 teachers). We also held four group interviews at each school, each with four or five students (one group of students from each grade; four group interviews per school; total N=34 students). In addition, classroom observations were conducted. At Queen Beatrix Primary School students from grades 5 and 6 work together in one unit, and students from grade 7 and 8 work together in one unit. Two classroom observations were conducted at this school , one in each unit. At Mosaic Primary School, grade 5, 6, 7 and 8 were observed (total N=6 classroom observations). Teachers were asked to act as normally as possible so that we could view regular classroom activities. Individual interviews were approximately 45 to 60 minutes in length, while the group interviews with students were approximately 15 to 25 minutes long. Classroom observations took between 30 and 45 minutes and were videotaped.

Queen Beatrix Primary School is located in a small town in the Netherlands. Instead of working in grades, students and teachers work in units. Each unit has a large educational area with theme corners, quiet areas, and workplaces. Each unit contains a number of basic groups, composed of mixed grades and a classroom teacher. Teachers design the curriculum around certain themes, in which different subjects are explored. Students work with a development portfolio, in which they write down their targets, results, and reflections on each theme or subject. Mosaic Primary School is located in a large city in the Netherlands. It is situated in a so-called "impulse area," which means it is in a zone with low incomes and a high unemployment rate. Therefore, Mosaic receives additional funds to reduce students' educational disadvantages. The school uses regular year groupings from grade 1 through grade 8, and each class has its own teacher(s).

Instruments

Phase 1 Survey

Student questionnaire

We developed a questionnaire to investigate the degree to which students in grades 5 to 8 at Dutch primary schools (approximately 8 to 12 years old) have an inquiry habit of mind. Since there were no existing scales available for this measure, we designed all items specifically for this study.

The questionnaire contained 28 items divided across two instruments, one of which measured students' curiosity and the other of which measured their critical nature. We interpreted curiosity and critical thinking habits both as positive twenty-first century skills, as the below examples underscore. Both instruments contained 8 propositions and 6 vignettes. The propositions utilized a 4-point response scale: completely disagree, somewhat disagree, somewhat agree, and completely agree. Table 4.1 depicts a sample proposition for each instrument. For the vignettes, students were asked to pick the answer that best matched their opinion. Each vignette had four answers, two of which represented an inquiry habit of mind and two of which did not. An example vignette from the instrument measuring curiosity is: "During math, you learned new complex sums. These sums can be calculated in a number of ways. What do you do?" Answers: "a. I would want to hear all the different ways, so I could choose the best one; b. I would be glad if I could figure out one method, and that would be enough for me; c. I would rather find out on my own whether there are other ways of calculating

these complex sums; d. I would listen to other solutions but stick to my own method of calculating." In this example, answers a and c represent curiosity, whereas answers b and d do not. An example vignette from the instrument measuring critical thinking habits is: "You have to do a presentation about sharks. You found someone else's presentation about sharks on the Internet. What do you do?" Answers: "a. I would change a few words and use this presentation; b. I do not like that, and I would rather find things out by myself; c. I would look at other Internet sites to see if I come across something like it and then I would take the best things; d. I would copy this presentation and be glad that I finished it quickly." In this example, answers b and c represent critical thinking habits, whereas answers a and d do not.

Table 4.1 provides the number of items and the Cronbach's alpha for each scale. The reliability scores demonstrate that these scales could be trusted for use in further analyses.

Table 4.1. Reliability of the student questionnaire at the school level

Scale	Number of items	Cronbach's alpha
Curiosity	14	.71
I like reading books to learn about new things.		
Critical thinking habits	14	.66
I usually believe what I read on the Internet. (R)		

Notes: The text in italics is a sample proposition for each scale. "R" indicates that the item scores were reversed coded.

Teacher questionnaire

The questionnaire for teachers consisted of 49 items rated on a 4-point Likert scale: completely disagree, somewhat disagree, somewhat agree, and completely agree. The instruments for measuring whether teachers worked with an inquiry habit of mind, were data-literate, and contributed to a culture of inquiry at the school level were based on Krüger's (2010a) existing instruments. All scales were constructed by averaging the item scores (for the construction of the scales, see Uiterwijk-Luijk et al., 2017). As mentioned above, the present study used the mean scores per school. This means the study could draw conclusions about the schools but not about individual teachers. For this aggregate data, we deleted one item from the

scale measuring teachers' inquiry habit of mind ("I read literature to gain knowledge for my work") and one item of the scale measuring whether teachers stimulated the students' inquiry habit of mind ("I let students evaluate each other on the basis of assessment forms"), which resulted in higher Cronbach's alphas for the scales. Table 4.2 provides the number of items, the Cronbach's alpha, and a sample item for each scale. The preliminary analysis demonstrated that the reliability of the scales for working with an inquiry habit of mind and experienced social pressure were relatively low (Cronbach's alpha = .62 and .61). In contrast, the reliability of all other scales was higher.

Table 4.2. Reliability of the teacher questionnaire at the school level

Scale	Number of items	Cronbach's alpha
Working with an inquiry habit of mind	4	.62
In my work as a teacher, I value deep understanding.		
Being data-literate	6	.69
I am knowledgeable about statistical concepts.		
Contributing to a culture of inquiry at the school level	5	.88
My colleagues and I discuss new teaching methods based on the available research data.		
Creating a culture of inquiry at the classroom level		
- Stimulating students' inquiry habit of mind	5	.73
I encourage students to share knowledge with each other.		
- Stimulating students' data literacy	6	.74
In certain exercises, I let students keep a research log.		
Attitude towards inquiry-based working	5	.93
I enjoy inquiry-based working.		
Experienced social pressure regarding inquiry-based working	5	.61
Most people whose opinion I value think I should work in an inquiry-based manner.		
Self-efficacy regarding inquiry-based working	5	.93
I am confident that I have the skills to work in an inquiry-based manner.		
Collective efficacy regarding inquiry-based working	5	.93
I am confident that my team has the skills to work in an inquiry-based manner.		

Note. The text in italics is a sample item for each scale.

Phase 2 Case study

Semi-structured interview schedules were used for the individual and group interviews, and these were based on the questionnaire items. When the mean questionnaire score from a particular school indicated either partial or complete agreement with a certain item on inquiry-based working, participants from that school were asked to give examples of that item Students were observed in terms of their inquiry habit of mind, while the teacher observations focused on whether they created a culture of inquiry in the classroom.

Analysis

Theoretically, one would expect a mediation model with teachers' psychological factors as the independent variables, teachers' inquiry-based working as the mediator variable, and students' inquiry habit of mind as the dependent variable. However, after using Baron and Kenny's (1986) steps for mediation, it appeared that the statistical power was too low for this type of analysis.

We aggregated both the teacher data and the student data at the school level. As mentioned above, we used the mean scores. There was no straightforward link between teachers and students, because some teachers taught in more than one class, while some students had more than one teacher.

Next, we calculated the correlations between both the five aspects of teachers' inquiry-based working and teachers' psychological factors, and students' inquiry habit of mind. Pearson product-moment correlation coefficients were also computed. We deemed results to be statistically significant when their p-values were at or beneath .05.

One-sample t-tests were conducted to determine whether a statistically significant difference existed between the questionnaires' total mean scores and: (1) students' curiosity and critical thinking habits at the case study schools, (2) teachers' inquiry-based working and related psychological factors at the case study schools, and (3) school leaders' inquiry-based working at the case study schools.

We transcribed and coded all of the interview data according to a coding scheme using MAXQDA. To analyze the data from the 8 teacher interviews, we began by utilizing deductive coding, with a coding scheme based on the theoretical framework. However, we permitted other codes to emerge from the data (inductive coding). To create the coding scheme, two researchers independently created categories and codes based on a random set of 4 teacher interview

transcripts. Disagreements were settled through discussion, and the meanings of codes were carefully adjusted. Once the categories and codes had been clearly defined, both researchers then labeled the remaining 4 transcripts on their basis. Random sampling was used to check for similarities and differences, and discussions settled any inconsistencies. Following coding, 6 categories emerged, and these were subdivided into 29 codes on teachers' inquiry-based working. In the results section, Table 4.7 provides an overview of these categories and codes.

On the basis of the theory outlined above, the data gathered from the student interviews was coded into two categories: curiosity and critical thinking habits (both aspects of students' inquiry habit of mind). To analyze the interview data, two researchers used the same strategy to analyze the data from the teacher interviews.

Once the coding scheme had identified trends in teachers' creation of a culture of inquiry in the classroom and students' inquiry habit of mind, these guided the analysis of the data from the observations. Specifically, we evaluated whether the observations reinforced or contradicted these trends. The data from the observations indicated whether classroom practices supported our interview results. We used the coding scheme to find examples of students working (or not working) with an inquiry habit of mind and teachers creating (or not creating) a culture of inquiry in the classroom. Relevant quotations were selected and interwoven with the findings.

Results

Descriptive statistics

The instruments measuring students' curiosity and students' critical thinking habits both contained two types of questions. Specifically, each had 8 propositions and 6 vignettes. Each type of question had two different answer categories. Whereas the propositions utilized a 4-point Likert scale (1, 2, 3, and 4), the vignettes had 4 answers, two of which represented an inquiry habit of mind and two of which did not (0 or 1). Therefore, we used the mean of the sum scores in our descriptive results (see Table 4.3). As Table 4.3 demonstrates, the mean sum score of all schools on curiosity was 27.24, while the mean sum score of all schools on critical thinking habits was 24.77.

Table 4.4 provides descriptive statistics for the scales used to measure teachers and school leaders' opinions at the school level. Since the respondents filled out the questionnaire on their own, all scores reflect teachers and school leaders' perceptions, aggregated at the school

level. All scales were constructed by first averaging the item scores and then averaging these scores at the school level. The mean scores for the scales fell between 2.70 and 3.39, as the "total scores" column in Table 4.4 makes clear. Bearing in mind that the midpoint of each scale was 2.5, the results indicated that at the school level, teachers and school leaders had (moderately) positive scores on the scales measuring inquiry-based working.

Table 4.3. Descriptive results of used scales of students at the school level

Scale	**n**	**total mean sum**	**sd**	**Min**	**Max**	**mean sum Mosaic**	**mean sum Beatrix**
Being curious	31	27.19	1.73	23.99	33.00	26.17	27.39
Being critical	31	24.76	1.73	20.00	28.33	25.06	23.74

Notes. n = sample size, sd = standard deviation, Min = minimum score, Max = maximum score.

Table 4.4. Descriptive statistics at the school level of used scales of teachers from all schools and from the two schools selected for the case study

		Total scores (all schools)	Scores case study schools					
			Beatrix			Mosaic		
		m (sd)	t (df)	m	p	t (df)	m	p
School leaders (n=58 schools)	Inquiry habit of mind	3.39 (.34)	-.24 (54)	3.40	.81	4.15 (54)	3.20	**.00**
	Data literacy	3.36 (.39)	.55 (56)	3.33	.59	1.72 (56)	3.27	.09
	Creating a culture of inquiry by:							
	• Communicating a vision	3.18 (.49)	-5.00 (57)	3.50	**.00**	-2.36 (57)	3.33	**.02**
	• Stimulating teachers' inquiry habit of mind	3.33 (.41)	-.05 (55)	3.33	.96	.87 (55)	3.28	.39
	• Stimulating teachers' data literacy	3.10 (.55)	-9.60 (56)	3.80	**.00**	-.44 (56)	3.13	.66
Teachers (n=61 schools)	Inquiry habit of mind	3.16 (.29)	-9.14 (60)	3.50	**.00**	1.16 (60)	3.12	.25
	Data literacy	3.24 (.30)	-8.80 (60)	3.58	**.00**	-1.55 (60)	3.30	.13
	Contributing to a culture of inquiry by:							
	• Collaborating in a culture of inquiry	2.81 (.42)	-7.33 (60)	3.20	**.00**	2.44 (60)	2.68	**.02**
	• Stimulating students' inquiry habit of mind	3.06 (.30)	-15.85 (60)	3.67	**.00**	-1.76 (60)	3.13	.08
	• Stimulating students' data literacy	2.70 (.34)	-8.60 (60)	3.08	**.00**	3.96 (60)	2.53	**.00**

Notes. Answer categories: 1 = completely disagree; 2 = partly disagree; 3 = partly agree; 4 = fully agree. n = sample size, m = mean item scores, sd = standard deviation. Significant p-values (≤ .05) are reported in bold type.

Correlations

Table 4.5 provides the correlations (r) at the school level between elements of teachers' inquiry-based working and students' inquiry habit of mind, and it also contains the p-values (p).
As Table 4.5 demonstrates, there was a significant relationship at the school level between students' curiosity and both teachers working with an inquiry habit of mind and teachers stimulating students' data literacy. In terms of teachers' psychological factors, in line with our hypothesis, there appeared to be a strong significant relationship between several of teachers' psychological factors and students' curiosity. Teachers' attitude towards inquiry-based working, their self-efficacy regarding inquiry-based working, and their collective efficacy regarding inquiry-based working were all strongly related to students' curiosity. However, none of these teacher variables were significantly related to students' critical thinking habits.

Table 4.5. Correlations at the school level between teachers' aspects regarding inquiry-based working and students' inquiry habit of mind

	Students' inquiry habit of mind			
	Curiosity		Critical thinking habits	
Teachers' aspects regarding inquiry-based working	r	p	r	p
Working with an inquiry habit of mind	.38	**.04**	-.16	.41
Being data literate	.30	.10	-.03	.88
Stimulating students' inquiry-habit of mind	.34	.07	-.22	.25
Stimulating students' data literacy	.61	**.00**	-.29	.13
Contributing to a culture of inquiry at the school level	.35	.06	.08	.68
Attitude towards inquiry-based working	.46	**.01**	-.15	.42
Experienced social pressure regarding inquiry-based working	.07	.72	.14	.45
Self-efficacy regarding inquiry-based working	.52	**.00**	-.20	.30
Collective efficacy regarding inquiry-based working	.42	**.02**	-.09	.63

Notes: n=30 schools. Significant p-values (≤ .05) are reported in bold type.

Queen Beatrix Primary School and Mosaic Primary School

Students at Queen Beatrix Primary School and Mosaic Primary School

One-sample t-tests indicated that students at Queen Beatrix scored close to the mean sum score on curiosity (t (30) = -.67, m = 27.39, p = .51) and below the mean sum score on critical thinking habits (t (30) = 3.42, m = 23.74, p = .00). The scores for students at Mosaic demonstrated the opposite trend. Their scores on curiosity were below the mean sum score on that variable (t (30) = 3.43, m = 26.17, p = .00), while they were close to the mean sum score on critical thinking habits (t (30) = -1.01, m = 25.06, p =.32) (see Table 4.3).

In the case study, students were asked during the group interviews if they thought of themselves as curious and critical thinkers. When the students interpreted these traits as negative habits, we also utilized supplementary and more indirect questions. The answers indicated a difference between both schools regarding students' curiosity and critical thinking habits. Students at Queen Beatrix gave many examples of being curious and critical, while students at Mosaic provided few illustrations of either trait. Regarding curiosity, students from Queen Beatrix Primary School gave examples, such as the following:

> *I am curious whenever I see, do, or hear something. I always just want to know things.* (Nick, student at Queen Beatrix Primary School)
>
> *I always talk a lot with other people, because I am curious about their opinions.* (Ben, student at Queen Beatrix Primary School)
>
> *I am always curious about other countries and other cultures and that kind of stuff.* (Indy, student at Queen Beatrix Primary School)

One student at Mosaic mentioned his curiosity during history lessons about events that happened in the past. Three others mentioned looking up unknown words on the Internet or in a dictionary as an example of being curious.

Students from Queen Beatrix also offered many examples illustrating their critical thinking skills. These especially involved facts about which they had heard or read:

> *On Wikipedia, on the Internet, everybody can just write anything, so that's why I do not just believe anything that is on there.* (Stefanie, student at Queen Beatrix Primary School)
>
> *Yes, I am critical, because we are all human, and humans make mistakes, so… for example, books are also made by humans, and so, yes, I am always critical.* (Bart, student at Queen Beatrix Primary School)

Usually, I go to more than one website. When something is mentioned on two or three sites, then it is probably true. (Willemijn, student at Queen Beatrix Primary School)

Although the survey scores of students at Mosaic Primary School were close to the total mean in terms of critical thinking habits, the case study data highlighted the same pattern for this variable as for curiosity. In contrast to students from Queen Beatrix, students at Mosaic gave very few examples of critical thinking habits.

Teachers at Queen Beatrix Primary School and Mosaic Primary School

As Table 4.4 demonstrates, the results of a one-sample t-test revealed that teachers from Queen Beatrix Primary School scored significantly higher on all aspects of inquiry-based working than the total mean scores of teachers at other schools. Teachers from Mosaic Primary School scored around the total mean in terms of working with an inquiry habit of mind, data literacy and stimulating students' inquiry habit of mind. They scored above the mean on collaborating in a culture of inquiry. Finally, they scored below the mean on stimulating students' data literacy.

Table 4.6 contains the results of one-sample t-tests assessing differences between the total mean scores for teachers and the mean scores for teachers at Queen Beatrix and Mosaic on psychological factors related to inquiry-based working. As can be seen, teachers at both schools scored above the mean in terms of their attitude, and their collective efficacy regarding inquiry-based working. In addition teachers at both schools scored around mean on self-efficacy regarding inquiry-based working. However they differ on their experienced social pressure: teachers at Queen Beatrix score below the mean and teachers at Mosaic score above the mean. This indicates that teachers at Mosaic Primary School experience more social pressure than teachers at Queen Beatrix Primary School.

In the case study, the results from the teacher interviews illustrated several ways in which teachers at both schools express their commitment to inquiry-based working. Teachers at both schools mentioned most of the same aspects related to working with an inquiry habit of mind, being data-literate, and contributing to a culture of inquiry at the school level. Table 4.7, which provides an overview of all elements mentioned by the teachers, demonstrates these similarities. For example, Irene from Queen Beatrix cited wanting to thoroughly understand an issue as an aspect of working with an inquiry habit of mind:

Well, there is an on-going discussion about teaching and assessing math. How can we teach math? We are not quite satisfied with our course books. So, we are looking around to see what else is out there. You hear a lot in the media at the moment about it, and my

Table 4.6. Comparison of total mean scores and scores of the case study schools on teachers' psychological factors

		Total scores (all schools)	Scores case study schools					
			Beatrix			Mosaic		
		m (sd)	t (df)	m	p	t (df)	m	p
Teachers (n=61 schools)	Attitude	3.23 (.41)	-11.00 (60)	3.80	**.00**	-5.61 (60)	3.52	**.00**
	Experienced social pressure	3.01 (.36)	5.61 (60)	2.75	**.00**	-9.68 (60)	3.45	**.00**
	Self-efficacy	2.95 (.42)	-.99 (60)	3.00	.33	.49 (60)	2.92	.62
	Collective efficacy	2.69 (.42)	-9.49 (60)	3.20	**.00**	-2.73 (60)	2.84	**.01**

Notes. Answer categories: 1 = completely disagree; 2 = partly disagree; 3 = partly agree; 4 = fully agree. n = sample size, m = mean item scores, sd = standard deviation. Significant p-values (≤ .05) are reported in bold type.

colleague and I often look for articles or literature to read about it, to see what is considered a good way of teaching math and how we can look at it from different angles. (Irene, teacher at Queen Beatrix Primary School)

Angela from Mosaic Primary School gave the following example of wanting to thoroughly understand an issue:

When you look at the assessment data and see that the whole group had difficulties with one particular aspect, then you know either I have not done enough or I have done quite a lot, but it did not have the desired effect. Maybe I should do it in a different way to reach my goals. (Angela, teacher at Mosaic Primary School)

According to Table 4.7, the two schools differed in terms of how teachers create a culture of inquiry in the classroom. Teachers from Queen Beatrix mentioned a greater variety of aspects during the interviews than teachers from Mosaic. To stimulate students' inquiry habit of mind, teachers from both schools mentioned that they encourage students to be critical, do not immediate answer students' questions, and are open to students' ideas. In addition, teachers at Queen Beatrix mentioned that they encourage students to be curious, have high expectations for students, and work with so-called learning questions. Each student formulates a question involving what he or she wants to learn about a specific theme or subject.

We always start with the children's learning questions. What do you want to learn from this subject? Then, we look at how the student can formulate that question somewhat more broadly or more narrowly to make sure the core objectives are addressed. For example, a girl wanted to know about fashions during World War II. During interviews with elderly people, she found out that there was no fashion, and sometimes even no

Table 4.7. Teachers approaches to working in an inquiry-based manner

Aspects	Mosaic	Beatrix
Display an inquiry habit of mind		
• *Want to thoroughly understand issues*	X	X
• *Be critical*	X	X
• *Read literature*	X	X
• *Explore a range of perspectives*	X	X
• *Be ambitious*	X	
Be data-literate		
• *Collect data*	X	X
• *Analyze and interpret data*	X	X
• *Present research results to others*	X	X
• *Complete a course or a training that addresses research*	X	X
Create a culture of inquiry in the classroom by stimulating students' inquiry habit of mind		
• *Work with learning questions*		X
• *Stimulate students' curiosity*		X
• *Encourage students to be critical*	X	X
• *Avoid giving immediate answers to student questions*	X	X
• *Open to students' ideas*	X	X
• *Have high expectations for students*		X
Create a culture of inquiry in the classroom by stimulating students' data literacy		
• *Teach students how to write a research question*		
• *Teach students how to collect data*	X	X
• *Teach students how to present research results*	X	X
• *Encourage students to share knowledge*		X
• *Teach students how to evaluate/reflect*	X	X
		X
Create a culture of inquiry in the classroom by supporting inquiry		
• *Provide materials*		X
• *Have students working in learning corners*		X
• *Have students collaborate in groups*		X
• *Give students space and trust to conduct research*	X	X
Contribute to a culture of inquiry at the school level		
• *Conduct research with colleagues*		X
• *Discuss data together*	X	X
• *Share knowledge*	X	X
• *Be open*	X	X
• *Observe colleagues in other classrooms working with students*	X	X

> *clothes at all, during the war. She had a wonderful learning experience, because she had to let go of something in her head.* (Monica, teacher at Queen Beatrix Primary School)

To stimulate students' data literacy, teachers from both schools show students how to collect data, present results, and evaluate the research process. Teachers from Mosaic mentioned that this happens once a year when students must gather information on a self-chosen subject and present their findings to the class. Teachers from Queen Beatrix claimed that this approach is part of their daily teaching practice. Therefore, they teach students how to formulate research questions and encourage them to share knowledge in various ways.

To support inquiry, teachers from both schools give students adequate space and trust. In addition, teachers at Queen Beatrix provide various research materials (e.g., a telescope, an old typewriter for students to take apart, and bulbs to investigate and plant), and every afternoon students work in so-called learning corners in which they collaborate in small groups.

The observational data also presented two different pictures, with teachers performing in more inquiry-focused, student-centered roles at Queen Beatrix and adopting more traditional, teacher-centered roles at Mosaic. The lessons observations at Queen Beatrix revealed a large educational area in which small groups of students moved from corner to corner. In each corner (which was not a literal corner but more of a small workspace), the student groups read the assignment for that station and followed the instructions. For example, during a project on Leonardo da Vinci, Shirley and Jessica had to write like he did, with their left hands and mirrored. The teacher had placed mirrors, colored felt-tip pens, instructions, and practice sheets in this corner in advance. Moreover, one of the teachers had created the instructions and practice sheets. Shirley and Jessica discussed the problem, tried to mirror their writing with their right hands, made mistakes, looked in each other's mirrors, held the mirrors in different positions, asked the teacher for pointers, became frustrated, erased their mistakes in anger, started over, and were excited when they finally got it right. Meanwhile, Tom made a paper helicopter in the hallway and enthusiastically wanted to show his teacher how well it worked. After he let go of the helicopter at the top of the stairs, it dropped straight down and did not work properly. Tom was disappointed. After picking it up downstairs, Michael, a teacher, asked him what the problem was, following the question with, "*What have you found out so far?*" Tom started explaining what he had learned, tried again, and failed again. Michael mentioned the helicopter's relationship with leaves from some specific trees. At the same time as they were gathering in a very loose setting and running up and down the stairs, the students were discussing issues like weight and the ability to fly. Michael moved to another group and the

students kept trying to make the best helicopter. Later, Monica, another teacher, asked them: "*What have you found out, and what can you write about it in your research log?*" After discussing the important issues, the group of five students wrote these down in their research logbooks. Some lay the floor, while others were writing and walking at the same time. This approach is in line with Zion and Sadeh (2007), who pointed out that the purpose of inquiry is to lead students to construct their own knowledge, which involves developing a sense of curiosity. Most assignments and teacher instructions at Queen Beatrix seemed designed to encourage student inquiries. The friendly atmosphere left students free to express their opinions, and the teacher emphasized coaching rather than lecturing. Or, as Melanie said:

> *Children are curious by nature, and I think at school we really encourage that. We want children to have ownership, so that they receive education based on their needs. But, I also think it is very important that the children here at school can let their curiosity run free. That is why we sometimes have something like a demolition corner or a corner with microscopes.* (Melanie, teacher at Queen Beatrix Primary School)

At Queen Beatrix, all of the types of teacher guidance mentioned by Jones and Eick (2007) were observed: open-ended, project-based inquiry, and guided inquiry. The evidence suggests that the teachers at Queen Beatrix focus on inquiry, with teachers' guidance ranging from open-ended to guided inquiry and students' responsibility levels varying accordingly. Teachers did not follow curriculum books. Rather, continual learning lines spanned subjects, and teachers concentrated on inquiry. This is in line with the previously mentioned theories of Dobber and Van Oers (2015), Levy et al. (2013), and Wells (1999), who pointed out that learning through inquiry can be applied in and across all sorts of subjects at school.

All the lessons observations at Mosaic indicated that both teachers and students predominantly adhered to traditional roles during whole-class instruction. Most class time was devoted to transferring knowledge, with a one-way interaction from teacher to students. For example, Janet, a sixth-grade teacher, read a chapter from a book while all students read along in their own copies. Next, Janet pronounced the difficult words, with the students repeating after her in a group. Sandra, an eighth-grade teacher, explained math problems to the whole class, asking questions and writing down the answers on the smart board in front of the classroom. She immediately corrected incorrect answers and further explained the problems. Correct answers were mostly praised. After the instruction, all students quietly worked to finish the course book's math problems by themselves. In both cases, two or three students did not participate in the classroom instruction, because they had individual learning programs.

However, most observed class time at Mosaic was used for what Weimer (2002) identified as the most common teacher-centered methods: lecturing, explaining, demonstrating, questioning, and seat work. In all observed classes, students sat in rows facing the teacher in front. The teachers' equipment consisted of course books, task sheets, a smart board, and a traffic light. They used the smart board to illustrate, present, and explain new topics. Each classroom at Mosaic also had a traffic light. When the teacher turned on the red light, students were supposed to work silently. Usually, silent work immediately followed instruction. When the teacher turned on the yellow light, students were allowed to work together and ask each other for help. When the green light was turned on, students could ask the teacher questions. When teachers were asked how they stimulated students' inquiry habit of mind, they often mentioned the yellow traffic light, intended to encourage students to collaborate with each other:

> *Yes, students often work together, but I am realistic – it quickly becomes chatting with each other rather than actually helping each other. I definitely encourage students to not just give any answer but to also explain how they got to the answer.* (Sandra, teacher at Mosaic Primary School)

In addition, Sandra highlighted that she tries to avoid immediately answering students' questions. Instead, she encourages them to look up unknown words in a dictionary.

Discussion and conclusions

Since curiosity, critical thinking, and effective communication skills are essential competencies and habits of mind for life in the twenty-first century (Wagner, 2014), schools are increasingly implementing learning through inquiry. This study sought to investigate the relationship between teachers' inquiry-based working and students' inquiry habit of mind (curiosity and critical thinking habits). We hypothesized that the more teachers worked in an inquiry-based manner, the stronger the students' inquiry habit of mind would be. In addition, we hypothesized that high scores on teachers' attitude, experienced social pressure, self-efficacy, and collective efficacy regarding inquiry-based working would correlate with high scores on students' inquiry habit of mind. We begin by discussing the results on students' curiosity and then address students' critical thinking habits.

Looking at students' *curiosity*, the survey results partly supported our hypotheses. Indeed, the more teachers worked with an inquiry habit of mind, the more curious the students were. Moreover, in line with the results of Furtak et al.'s (2012) meta-analysis, the more teachers stimulated students' data literacy, the more curious the students appeared. Although

earlier research has suggested that teachers could more effectively create a culture of inquiry in the classroom by working in such a culture themselves (Dobber & Van Oers, 2015; Wells, 2011), collaborations with others during inquiry, but also teachers' data literacy, and efforts to stimulate students' inquiry habit of mind did not seem to influence student curiosity. The finding that teachers' data literacy or collaborative research efforts did not appear to enhance students' curiosity could be due to the fact that these elements of inquiry-based working usually take place outside the classroom. Thus, they might affect students' inquiry habit of mind to a lesser degree. However, an unexpected finding was that, when teachers see themselves as encouraging students' inquiry habit of mind, this is not necessarily reflected in students' curiosity scores.

In terms of teachers' psychological factors regarding inquiry-based working, the study revealed that three factors are very important for students' curiosity: (1) teachers' positive attitude towards inquiry-based working, (2) a strong sense of self-efficacy regarding inquiry-based working, and (3) collective efficacy regarding inquiry-based working. All of these variables play a key role in stimulating students' curiosity. Teachers at both case study schools had the same scores on these three factors. Their scores diverged on experienced social pressure regarding inquiry-based working (low at Queen Beatrix, high at Mosaic), but that variable did not influence student curiosity.

Regarding students' *critical thinking habits*, the survey results quite unexpectedly indicated that none of the aspects of teachers' inquiry-based working or related psychological factors appears to have any effect. Perhaps, stimulating students' inquiry-habit of mind for teachers means encouraging curiosity, with less emphasis on promoting critical thinking.

The results of the case study illustrated that the classroom culture at Queen Beatrix Primary School is in line with what Lipman (2003) described as a classroom community of inquiry. At that school, teachers work in an inquiry-based manner, view inquiry as an important aspect of all lessons, and encourage various forms of inquiry, from guided to open-ended. In line with our hypothesis, students have plenty of space to investigate, be curious, and be critical. At Queen Beatrix, students think of themselves as both curious and critical, and they could offer many examples to support their opinion. At Mosaic, where teaching is teacher-centered, students feel less encouraged to be either curious or critical. Students at that school could think of very few examples either of curiosity or critical thinking.

One would expect that Queen Beatrix, with its high scores on teachers' inquiry-based working within an inquiry-centered culture, would have also produced high scores on students' curiosity and critical thinking habits. However, these scores were close to the mean and below

the mean scores, respectively. This suggests that an inquiry-based classroom culture does not automatically imply that students are curious and critical thinkers.

The survey findings and the case study results seemed to diverge. The survey suggested that when teachers indicate that they strongly stimulate students' inquiry habit of mind, it does not affect students' critical thinking abilities. However, the case study illustrated that in a school in which teachers continuously focus on stimulating students' inquiry habit of mind students indeed were both more curious and more critical. The reason for this difference might be that the survey results measured the mean scores of all teachers at one school, while the case study revealed the actions of individual teachers.

Davis et al. (2016) found that the extent to which science lessons are inquiry-oriented is heavily influenced by how inquiry-oriented the curriculum materials are. In this study, the school at which teachers work in an inquiry-based manner does not rely on curriculum books, however. Rather, the teachers created their own materials and were led by learning lines and their focus on inquiry. This suggests that there are more ways of working in an inquiry-based manner than strictly following curriculum materials.

A limitation of the survey is that the teacher questionnaire relied on self-reports (see, for example, Schwarz, 1999). Thus, the results reflect teachers' own perceptions. The case study provides more insight into teachers' actual inquiry-based working, but a larger qualitative research study is necessary to overcome this limitation.

As mentioned above, we found a direct correlation between teachers' psychological factors related to inquiry-based working and students' inquiry habit of mind. It seems logical that the effect of these psychological traits would be indirect rather than direct. Unfortunately, mediation analysis was not possible with the available dataset, and it is up to future research to address this type of investigation.

The two case study schools were situated in quite dissimilar areas and served different populations. While Queen Beatrix is located in a smaller city in an area with mean incomes and an average unemployment rate, Mosaic primary is in a large city in an area with low incomes and a high unemployment rate. This dissimilarity could have affected teachers' approaches and students' inquiry habit of mind. It also means that the results on students' inquiry habit of mind could have been influenced by variables other than the teachers and the school culture, such as the style of upbringing by their parents.

Implications

The findings of the present study contribute to our understanding of teachers' inquiry-based working and students' inquiry habit of mind. As the results demonstrate, teachers' inquiry-based working and their related psychological factors influence students' curiosity. This implies that teacher educators and school leaders who want to create an inquiry-based culture in schools, and (indirectly) enhance students' curiosity, should encourage teachers' inquiry-based working. They can do this by prompting teachers to discuss results together, sharing knowledge, and modeling behavior. Moreover, they could encourage teachers to take a positive attitude towards inquiry-based working by, for example, pointing out the educational benefits of such an approach and being enthusiastic about it. Finally, they could add to each teacher's sense of self-efficacy and collective efficacy regarding inquiry-based working by enabling teachers to work in peer groups and creating a safe environment in which teachers feel free to investigate their own teaching practice.

To promote students' curiosity, teachers can create a culture of inquiry in the classroom. This means, for example, teaching students how to work with learning questions and research questions, being open to students' ideas and questions, and facilitating inquiry by providing research materials and having students work together in small groups.

This study has added to the literature on the relationship between teachers' inquiry-based working and students' curiosity. Future research could provide additional insights into how teachers can stimulate students to become critical thinkers.