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SCIENCE TEACHERS' BELIEFS ABOUT TEACHING AND LEARNING IMPLEMENTING INQUIERY-BASED LEARNING – A CASE IN QATAR GOVERNMENT PRIMARY SCHOOLS

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ABSTRACT

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Title: Science Teachers' Beliefs about Teaching and Learning Implementing Inquiry-based learning – a Case in Qatar Government Primary Schools

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The current study investigates the beliefs held by science teachers' on constructivism and a traditional approach in Qatar government primary schools. More specifically, it aims to investigate the challenges that science teachers experience during inquiry-based learning implementation. A web-based survey was conducted in order to collect data from Grades 4, 5, and 6 science teachers. The survey consisted of three sections: Demographic Data, Teachers Beliefs, and Challenges.

A total of 112 science teachers responded and completed the survey on a voluntary basis. The results indicate that science teachers hold a higher beliefs in constructivism than traditional approach. A T-test and ANOVA analysis have showed that there is no significant differences between the beliefs of science teachers' and their gender, level of education, and years of teaching experience. In addition, Science teachers faced challenges in lesson planning, assessment, and teacher support.

DEDICATION

To my haven (MOM), my father, and my family member: Fatima, Zakeia, Omar, Mohammed, Khaled, and my nephews: Abdullah, Saleh, Tamadur, and Ahmed.

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CHAPTER 1: INTRODUCTION

1.1 Background

Inquiry involves an assortment of ways in which students study nature through raising questions and suggesting an explanation based on the collected data and evidence from their investigation, and this process develops student information and understanding of scientific concepts (National Research Council, 2000). Referring to the theories of learning, the methodology of inquiry has derived from constructivist theory (BADA, 2015; McLeod, 2019), which emphasizes that learning occurs when students builds new knowledge through experience using the previous knowledge (BADA, 2015; Phillips, 1995).

Constructivist theory finds its historical roots from the work of Dewey, Bruner, Vygotsky, and Piaget (BADA, 2015; McLeod, 2019). Piaget's cognitive development theory states that children build their knowledge based on their experiences and interactions with their environment. Moreover, they connect their previous knowledge with what they have discovered (Huitt & Hummel, 2003). Piaget emphasizes that each child goes through the same four stages of cognitive development as follows: Sensorimotor, Preoperational, Concrete Operational, Formal Operational (Huitt & Hummel, 2003; McLeod, 2019). However, both Vygotsky and Bruner have stated that children's cognitive development is influenced by their social interactions, which guide their learning process and emphasize the role of the adult in assisting children’s learning (McLeod, 2019). On the contrary, Dewey rejects the idea that students are recipients, instead putting forth the idea that the teacher assures students engagement in the learning process in order to build their knowledge and demonstrate it through collaborative work, practical activities, and inquiry (Williams, 2017).

The inquiry approach received great interest in the last century because of its impact on the development of student skillsets. As a result, the science curriculum moved from mere understanding and preservation to application, analysis, and synthesis (Sanderson & Kratochvil, 1971). According to this idea, the National Research Council set US national standards for the science curriculum from Kindergarten to Grade 12 based on inquiry, where standards focused on two main axes: understanding inquiry in science and the necessary skills for its implementation (National Research Council, 2000). Several studies have examined the impact of implementing inquiry on students, and report that implementing inquiery-based learning (IBL) in sthe cience curriculum for the elementary stage increases student motivation toward learning as well as raises their levels of academic achievement (Borovay, Shore, Caccese, Yang, & Hua, 2019; Abdi, 2014; Kazempour & Amirshokoohi, 2013; Kanter & Konstantopoulos, 2010).

Qatar understands the importance of analytical and critical thinking developed through inquiry and its strong influence in the development of the individual, toward the preparation of employees in order to develop the state economy. Accordingly, the State of Qatar has developed its vision for 2030, and the first pillars in the vision is human development which occurs by building an educational system that engages with other countries, developing critical and analytical thinking among students and encouraging them to do scientific research (Qatar National Vision [QNV] 2030, 2008).

There is no doubt that the Ministry of Education and Higher Education (MOEHE) will keep up with this vision of Qatar and contribute to its realization. As a result, MOEHE has developed a strategic plan 2017 – 2020 to achieve the Qatar National Vision (QNV) 2030. One of the primary outcomes of the implementation of this strategy is to provide diverse learning opportunities through the development of the national curriculum of the state in order to raise student potential to meet the requirements of the 21st century (MOEHE Stratgic Plan 2017-2022, n.d.). The department of curriculum and Learning Resources in the Ministry of Education has developed the standards of the science curriculum, building them on several pillars the most important of which is inquiry (MOEHE, personal communication, September 1st, 2019). The scientific standards aim to provide the student with a sound and systematic knowledge of scientific facts, concepts, and principles in order to implement them in real life, further enabling a student to apply the skills of scientific research (MOEHE, personal communication, September 1, 2019).

Also, the Department of Curriculum and Learning Resources provided students with the opportunity to apply the inquiry skills and knowledge they gained during their educational trajectory, through preparing for a scientific research competition (Science Reserch, n.d.). The scientific research competition began its first session in 2009, involving 78 examples of student research; by 2017, the number had increased to 917 (Science Reserch, n.d.). This increase in the number of research projects can be attributed to several factors, including, the rise of student awareness about the importance of inquierys, the development of science curricula that have established the concept of research and investigation, and the ministry's motivation for students through the Award of Education Excellence, which promotes the concept of scientific research (Education Excellence Day, 2019).

Globally, the Ministry of Education and Higher Education will organize the Internationa Junior Science Olympiad [IJSO] (IJSO, 2019). The 16th edition of the IJSO will be held in collaboration with Qatar University in December. This competition provides an opportunity for students to develop their hypotheses, test them practically, and compete with students from different countries. This competition will increase students' motivation for learning, research, and inquiry (IJSO, 2019).

The 21st century skills targeted by QNV 2030 encourage the critical and analytical thinking of students from a basic level of education. According to QNV 2030, the Ministry of Education and Higher Education (MOEHE) set science curriculum standards whereby 30-40% focus on inquiry. Moreover, MOEHE set the national exam for Grade 6 based on the science curriculum standards. However, the last statistic that has been approved from MOEHE demonstrates that 67 % of male students and 54.5 % female students have failed the 2019-2018 exam (MOEHE, personal communication, October 16, 2019). Moreover, the passing percentage does not necessarily mean that the students fully mastered the standards of inquiry.

In addition, since 2011, Qatar has participated in the assessment of Trends in International Mathematics and Science Study (TIMSS). The TIMSS started in 1995 and are held every four years, to enablinges counteries around the world to measure the effectiveness of their science curricula for Grades 4 and 8 (Martin , Mullis, Foy, & Hooper, n.d.). The last international result for TIMSS illustrates that the fourth-grade Qatari student average is significantly lower than the the average Timss 4th grade scale of the TIMSS Grade 4 scale (Appendix 1) (Martin , Mullis, Foy, & Hooper, n.d.). Although there has been an improvement in Qatari student achievement in science assessment between 2011 and 2015 (Appendix 2), still they did not meet the international standards.

The above statistic indicates that elementary government schools face challenges in meeting the requirements of inquiry standards in science. There is therefore a need for more research to investigate the beliefs of teachers toward the inquiry standard, and for exploration of the challenges they have faced in the implantation process. This study aims to understand science teachers' beliefs, perceptions and experienced challenges in the beliefs, perception, and challenges experienced by Qatari primary science teachers in the implementation of inquiry-based learning.

1.2 Problem Statement:

The Ministry of Education in Qatar believes in the importance of the teacher’s role in achieving the goals of science standards, raising the achievement level of students, and establishing the concept of scientific research and investigation. Conequently, MOEHE places the development of the teacher and trainig among the main results of 2017-2022 strategic plan (MOEHE Stratgic Plan 2017-2022, n.d.). Accordingly, the Training and Educational Development Centre of the MOEHE has been established in order to provide professional development programmes for teachers to meet their needs (TEDC, n.d.).

Despites the Ministry's significant efforts to develop the standard of science teaching and the associated curriculum, there has still been a measurable decline in students academic achevimnet, as evidenced by ministry-issued statistics. Indeed, research has been conducted to invistegate the causes of low science achivement among students. For instance, Said (2016) atributes this low achivement to three factors: 1) low student motivation; 2) an overemphasis of the textbook; and 3) the underemphasis of inquiry-based and problem-based methods (p. 2253). Morover, Areepattamannil (2012) has studied the effect of impleminting inquiry-based science on student achievement.

However, the pedagogical and methodological choices of science teachers are also affected by their beliefs (Kaymakamoğlu, 2017; Irez, 2007). Their intentions and capability to teach scientific inquiry is affected by the their beliefs about the teaching of science (Grawford, 2007). For instance, Eltanahy and Forawi (2019) have found that the implementation of scientific inquiry is positively correlated with a science teacher's belief in constructivism. This is the theoretical base of scientific inquiry. Due to the importance of teacher beliefs in this regard, Tosun suggests that these beliefs should be takne into consideration before designing a teacher preparation program (Tosun, 2000).

Recently, the role of a teacher's beliefs in his or her teaching practice has received considerable attention by educational researchers. As a result, many studies have been issued in this field, such as the work of Ogunkola and Samuel (2013), and Kaymakamoğlu (2017). However, in the Gulf context, nd specifically in Qatar, there is a distinct lack of research regarding teacher beliefs in IBL, and how these beliefs in turn reflect upon their practices. Said (2016) emphasizes that there should be further reaserch in Qatar about science teachers' beliefs in order to understand the decline in students' scientific achievements.

1.3 Research Questions:

The purpose of this study is twofold: to investigate science teachers' beliefs regarding IBL, and to explore the challenges they face in the implementation process. The results of the study therefore address the following questions:

1 What are science teachers' beliefs regarding IBL across Qatar's government primary schools?

2 Do science teachers' beliefs about teaching and learning vary by gender, level of education, and years of teaching experience?

3 What challenges do science teachers face in their implementation of IBL?

3.4 Significance of the Study:

The outcome of this study aims to: 1) contribute to the field of IBL at the primary level with empirical data from Qatar government primary school teachers; 2) provide an understanding of teacher experiences and beliefs about IBL so as to benefit practitioners' practices in adjusting IBL in a Qatari context; 3) expose critical areas in the science curriculum field that many researchers have not been able to explore; and 4) potentially fill the gap in the surrounding literature regarding teachers’ perspectives of IBL in the Middle Eastern context.

3.5 Operational Definitions

Government school: Schools that operate under the umbrella of the government and follow the laws and policies of the Ministry of Education, and work to achieve the vision and mission of the Ministry. These schools receive financial support from the government.

Primary school science teacher: Teachers recruited by the Ministry of Education for the purposes of teaching science for Grades 4, 5, and 6 at Qatar Government Primary Schools.

1.6 Thesis Organization

This thesis encompasses five chapters. Following this introductory chapter is Chapter 2, which includes background information about inquiry-based learning concepts and teachers’ beliefs based on theories, articles, and previous studies. Chapter 3 describes the research context, design, instrument, procedures, and method of data analysis. Chapter 4 illustrates the results and findings of the study, using the SPSS program. Chapter 5 discusses the findings of the study, and offers a summary for the study, a conclusion, and future recommendations.

CHAPTER 2: LITERATURE REVIEW

This chapter discusses existing international studies and research conducted in the field of teacher beliefs and inquiry-based learning in local contexts. This chapter is divided into two sections: the first section focuses on inquiry-based learning definitions, its history and background, and previous studies about inquiry-based learning at different level of educational. The second section focuses on teacher beliefs, including how these beliefs have been defined, the history of beliefs in the field of education, and the relationship between teacher beliefs and practices.

2.1 Inquiry-based Learning

2.1.1 *Definition*

As reported by Hanauer, Hatfull, and Jacobs-Sera, inquiry in science has been defined in an assortment of ways (Hanauer, Hatfull, & Jacobs-Sera, 2009). Justice and others referred to inquiry as a process of discovery and its orderly progression from a certain level of understanding to another, higher level of understanding. In general, inquiry is understood as incorporating the practices of the researcher that work toward the production of knowledge (Justice , et al., 2007). In the field of education, Crawford (2000) has defined inquiry-based learning as a strategy that integrates two components: encouraging learners to investigate questions and employing data as a clue to subsequently answer these questions.

Other research goes further in defining inquiry, considering it as a pedagogical practice that students go through in order to find an answers for a question they have generated, and these practises lead students to develop their higher-order intellectual and academic skills (Hudspith & Jenkins, 2001; Lee, 2011). Aceytuno and Barroso add that sometimes a question may not be permitted to be generated by the student, and in some cases the teacher may set the question (Aceytuno & Barroso, 2015).

Furthermore, Areepattamannil has stated that “scientific inquiry covers a wide range of diverse activities to foster student interest in learning science and to enhance their scientific literacy” (Areepattamannil, 2012, p.135). In addition, Bybee has argued that science as an inquiry consists of three components, namely: skills of scientific inquiry, knowledge about scientific inquiry, and pedagogical approaches for teaching science (as cited in Cigdemoglu & Köseoğlu, 2019).

The current study adopts Llewellyn’s definition, which links inquiry with the investigation of the natural world, and he refers to inquiry as the entire process of learning that comprises student outcomes, such as knowledge, attitudes, and critical-thinking skills that students acquire during their investigation (Llewellyn, 2011).

2.1.2 *Theoretical Background For IBL*

Science reforms began in the middle of the eighteenth to early nineteenth century by academics such as Huxley and Dewey, who encouraged instructors to engage their students in the discovery of scientific knowledge rather than emphasize the memorization of facts (Haynes & Saskatchewan, 2012). At the end the eighteenth century, Thomas Henry Huxley supported science classes that allowed students to investigate and interact with nature in order to learn. For example, instead of teaching students about botany, a student should “handle the plants and dissect the flowers for himself” (as cited in DeBoer, 2006,

p. 22). Huxley's beliefs about how science should best be taught became the basis for the development of science laboratory instruction (DeBoer, 2006). Moreover, Herbert Spencer encouraged teachers to implement laboratory investigations during science teaching (as cited in DeBoer, 2006). Spencer emphasized that teachers should give students the opportunity to make their own investigations and let them lead the learning process. In this way, students would gain independence and retain the knowledge they gained for a longer period of time (as cited in DeBoer, 2006).

In 1910, John Dewey argued that there was excessive emphasis placed on scientific facts rather than on thinking skills in classroom teaching (Barrow, 2006). This investigation in the education field established the importance of developing students' critical thinking skills instead of rote memorization, in order to understand scientific concepts (Justice, Rice, Roy, Hudspith, & Jenkins, 2009). As a result, the idea of integrating inquiry in science curricula from K-12 has been based on Dewey's educational philosophy (Barrow, 2006; Burgh & Nichols, 2012).

Constructivism is a learning approach that holds that learning is constructed and that new knowledge gained in learning experiences is influenced by their pre-existing knowledge (Phillips, 1995). Constructivists hypothesize that knowledge illustrates "what we can do in our experiential world." (Glasersfeld, 1995, p.3). This approach has been established based on Piaget's cognitive development theory, which focuses on the learner's internal cognitive processes (Glasersfeld, 1995; Tiilikainen, Karjalainen, Toom, Lepola, & Husu, 2019). Piaget determined four stages in cognitive development: sensorimotor, preoperational, concrete operational, and formal operational (Huitt & Hummel, 2003).

Previous studies indicate that IBL is not only generated from scientific inquiry and

Dewey's theory of inquiry, but was also originally linked to constructivism theory (Chan, 2010). The current study considers this as a guiding framework. Eick and Reed (2002) highlight the constructivist theories of learning that in turn form the foundation of inquiry-based learning. Moreover, Exline (1995) has stated that inquiry-based leaning is strongly linked to constructivist philosophy (as cited in Chan, 2010).

In addition, IBL is a social constructivist approach, a result of cooperative work in which the learner collaborates with his or her partner in order to find resources, and uses these resources alongside tools gained through the process of inquiry (Vygotsky, 1978; Doise & Mugny, 1984).

2.1.3 *Roles of Teachers and Students in IBL*

Some resrachers distinguish between teacher and student roles when using an IBL methodology. They agree that the teacher's role involves guiding students toward reaching learning objectives through the creation of a supportive environment that encourages student to think critically, investigate, and learn. Moreover, teachers acting as a resource enriches the learning process and helps teachers serve as a reference for the student whenever they need support (Justice, Rice, Roy, Hudspith, & Jenkins, 2009; Lee, 2011). On the other hand, as students master the learning process in IBL methodology, they use critical thinking and investigation in order to solve a problem or find an answer to a question. Generally, students learn by themselves and they take responsibility for their own learning (Justice, Rice, Roy, Hudspith, & Jenkins, 2009; DiBiase, & McDonald, 201; Lee, 2011).

In order to implement IBL in an appropriate way, teachers should ensure that students have the necessary skills to do inquiry. These skills include developing questions, making observations, designing and implementing inquiry, utilizing suitable methods to collect and analyse data, using critical thinking skills, providing evidence for developing demonstration and predication, and distributing this information to others (National Research Council [NRC], 2000; Cigdemoglu & Köseoğlu, 2019; Gutwill & Allen, 2010,2012).

2.1.4 *Previous IBL Studies*

2.1.4.1 Literature Review

Inquiry is the focus of many researchers in the field of education at the university and school level in general, and several aspects have been researched. For administrators who have experience integrating inquiry into the curriculum, they agree that it offers many benefits for students (Justice, Rice, Roy, Hudspith, & Jenkins, 2009). For instance, inquiry develops student learning and performance in their courses, and helps instructors focus on their students and keep them engaged (Justice, Rice, Roy, Hudspith, & Jenkins, 2009). However, McMaster administrators found challenges during inquiry implementations, such as instructors' resistance to implementing and developing inquiry pedagogy, as well as having difficulty finding qualified instructors to effectively teach inquiry (Justice, Rice, Roy, Hudspith, & Jenkins, 2009). Justice et al. attributed instructor resistance to the concept of inquiry as being based on shifting the role between the student and instructor, in the sense that students become self-directed learners and the instructors become facilitators of student exploration (Justice, Rice, Roy, Hudspith, & Jenkins, 2009). If the instructors accept and implement the idea of the role shifting between the students and themselves through the pedagogy of inquiry, then learning can be expected to occur in the classroom (Sharpe, 2008).

From the student perspective, Aceytuno and Barroso found that at Huelva University in Spain, students in a Spanish Economics course were pleased with the implementation of the IBL methodology. Furthermore, the students reported feeling that the IBL methodology was more beneficial and motivating than traditional methodology (Aceytuno & Barroso, 2015). Indeed, in when comparing inquiry and a more traditional curriculum in the sciences, inquiry-based learning has been found to increase the development of student literacy and research skills (Gormally, Brickman, Hallar, & Armstrong, 2009). Moreover, students who are exposed to an inquiry curriculum have been found to have more self-confidence in their scientific abilities, while traditional curricula tend to promote over-confidence in one's abilities (Gormally, Brickman, Hallar, & Armstrong, 2009).

A considerable number of studies have established that implementing and involving students in investigations and hands-on scientific activities enhances their attitudes and motivation toward science (Abd-El-Khalick, et al., 2004; Hofstein & Mamlok-Naaman, 2007). In addition, investigations and hands-on activities develop higher-order learning skills, such as metacognition and argumentation (Dori & Sasson, 2008; Kaberman & Dori, 2009; Kipnis & Hofstein, 2008). As a result, students have been found to engage in the classroom discussions more effectively when their instructor teaches them how to interact critically and constructively with the ideas of their peers. Furthermore, students have been found to engage more effectively in classroom debates when they are explicitly taught how to engage critically and constructively with one another's ideas, their challenges, and offer ideas for how to confront them (Gillies & Boyle, 2008; Rojas-Drummond & Mercer, 2003).

On the academic achievement side, learners who are educated in student-centred and constructivist learning environments were found to excel academically (Ozkal, Tekkaya, Cakiroglu, & Sungur, 2009). Moreover, the frequency of implanting hands-on activities has been correlated with student scores in science: the greater the frequency that students were exposed to hands-on activities, the higher their scores tended to be in science (Jaakkola & Nurmi, 2008; Klahr, Triona, & Williams, 2007).

2.1.4.2 Primary Schools

Gillies et al. argue for the importance of teaching student to ask and answer critical question in inquiry-based science. In their study, they found that a teacher's ability to ask metacognitive questions positively affects their students' discussion, reasoning, and problem-solving skills (Gillies, Nichols, Burgh, & Haynes, 2014). For instance, students who had a trained teacher in metacognitive questioning asked more thoughtful questions and interacted in classroom discussions by utilizing analogies to verbally illustrate the concepts they were attempting to express (Gillies, Nichols, Burgh, & Haynes, 2014).

A study that was carried out on 272 Grade 5-9 students in Canada concluded that students who participate in inquiry-based activities in inquiry-based learning environment have high intrinsic motivation, flow, and mastery of learning objectives (Borovay, Shore, Caccese, Yang, & Hua, 2018). Lecturers have emphasized that knowledge is promoted when students are actively involved in the learning process, and when this is combined with directives from the instructor, students are capable of acquiring a better understanding of scientific concepts (Correiro, Griffin, & Hart, 2008; Martin-Hansen, 2005; Lindquist, 2001). Moreover, Şimşek and Kabapınar's study concludes that IBL enhances students' conceptual understanding in science (Şimşek & Kabapınar, 2010).

When implementing an inquiry, students are expected to use scientific skills such as generating questions, setting a hypothesis, and testing this hypothesis (National Research Council [NRC], 2000; Cigdemoglu & Köseoğlu, 2019; Gutwill & Allen, 2010,2012; Şimşek & Kabapınar, 2010). Therefore, exposing students to inquiry-based learning is expected to develop their scientific process skills (Şimşek & Kabapınar, 2010; Stout, 2001; Wu & Hsieh, 2006; Sullivan, 2008).

Previous studies on the effectiveness of inquiry-based teaching on student learning remain inconclusive. Yurumezoglu and Oguz-Unver reported that students became more creative, positive, and independent during IBL implemnetation and found that science students became more active during the IBL exercises, even those who had different acdemic performance levels (Yurumezoglu & Oguz-Unver, 2014). On the other hand, however, a few studies have found that inquiry-based teaching did not influence student attitudes toward science (Lindquist, 200; Şimşek & Kabapınar, 2010).

2.2 Teacher Beliefs

2.2.1 *Definition*

The term "belief" has been defined in various ways. Pajares (1992) refers to belief as an "individual's judgment of the truth or falsity of a proposition, a judgment that can only be inferred from a collective understanding of what human beings say, intend, and do" (p. 316). Furthermore, Philipp (2007) defined beliefs as "psychologically held understandings, premises or propositions about the world that are thought to be true" (p.

259). In the educational context, Kagan (1992) defined teacher beliefs as "implicit assumptions about students, learning, classroom, and the subject matter to be taught" (p. 66).

The current study adopt Irez definition, which considers beliefs to be "psychological constructs that (a) include understandings, assumptions, images or propositions considered to be true, (b) drive a person's actions and support decisions and judgments, (c) have highly variable and uncertain linkages to personal, episodic and emotional experiences, (d) although undeniably related to knowledge, differs from knowledge in that beliefs do not require a condition of truth." (Irez, 2007, p.17).

2.2.2 *Theoretical Background*

According to Richardson (1996) educational research surrounding teaching and teachers has focused on teacher behaviour and cognition since the mid-1980s, followed by an emphasis on beliefs and attitudes that were considered to be significant concepts in comprehending teacher practices. Dewey was the first to recognize the significance of beliefs in the educational context, and he defined belief as "something beyond itself by which its value is tested; it makes an assertion about some matter of fact or some principle of law" (as cited in Irez, 2007, p. 17). After the emergence of Dewey's theory, the educator accepted that investigation of teachers' beliefs can indicate their educational practice (Pajares, 1992). This idea is based on the supposition that teachers' beliefs influence their delineation, decision-making, and classroom behaviours (Irez, 2007). As a result, the current study has been established.

In 1997 Rosenthal established the affect-effort theory, which suggests that changes in teachers' expectations and beliefs about their student performance will lead to 1) a change in the influence shown by instructors toward their students, and 2) a change in the teacher effort in teaching students (Rosenthal, 1997). For instance, if the teacher has positive expectations for student performances, consequently there will be an increased exertion shown by the student during the learning process (Rosenthal, 1997).

2.2.3 *Beliefs and Practices of Science Teachers*

Several studies have suggested that teacher beliefs are the best indicators in determining the decisions they will make about selecting curricula and instructional design (Pajares, 1992; Tsai, 2002; Mansour, 2009). Thus, many studies have been implemented in order to measure the impact of science teacher beliefs on their implementation of IBL.

In 2002, Tsai classified the teaching and learning beliefs of science teachers into three categories: traditional, process-oriented, and constructivist (Tsai, 2002). This study was carried out among 37 Taiwanese science teachers, and Tsai found that the majority believed in a traditional method for teaching and learning science (Tsai, 2002). On the other hand, Aldrich and Thomas (2002) conducted a study on 74 student teachers in order to assess their beliefs about constructivist learning after completing an education program. They found that the majority of the science teachers have postive beliefs about constructivism.

Other studies have found that teacher beliefs regarding a traditional approach and constructivism is linked to their specialization (Koballa , Graber, Coleman, & Kemp, 2000; Markic & Eilks, 2012). Markic and Eilks have found that junior chemistry and physics student teachers held traditional beliefs about teaching and learning science, while biology and primary school student teachers believed in constructivist theory (Markic & Eilks, 2012). Science teachers' beliefs in traditional approaches are rooted in their own school experiences of classes, laboratory practices, and related activities (Tsai, 2002; Mansour, 2009). Moreover, science teachers often fail to gain a positive opinion of a constructivist approach to teaching and learning because they had a successful experience in a traditional education environment (Trumbull & Slack, 1991). As a result, teachers may not gain an accurate understanding of the benefits and advantages of constructivist theory (Mansour, 2009).

The literature in this field indicates that teachers are more willing to implement inquiry-based learning when they believe in constructivism for learning because IBL is "theoretically derived from the constructivist philosophy of teaching and learning" (Eltanahy & Forawi, 2019. P.15). Woolley, Benjamin, and Woolley (2004) stated that it is important to measure teacher beliefs about constructivism because it has a direct on their classroom practices. Moreover, measuring teacher beliefs gives teachers a "theoretical basis of their teaching philosophy" (p. 328), which can in turn provide useful information about how their chosen teaching approach will influence the teaching and learning practices in their classroom.

According to Crawford (2014), the beliefs of science teachers play a significant role in whether they propose and/or indeed implemente science as inquiry (as cited in Ramnarain & Hlatswayo, 2018). In alignment with Crawford, some researchers emphasize that one of the essential barriers to implementing science as inquiry involves teachers' beliefs in teaching, learning, and classroom management (Saad & BouJaoude, 2012; Haney, Czerniak, C, & Lumpe, 1996). Teachers' beliefs in inquiry can lead them to implement IBL activites in their classrooms, which in turn creates a prosperous science learning environment — specifically in conceptual understanding (Wallace & Kang, 2004).

Previous studies have also identified challenges and factors constraining teachers from implementing IBL, revealing that there are factors other than beliefs that prevent teachers from impleminting IBL in their science classes. These include inconsistancies between teachers' beliefs and practices (Ramnarain & Hlatswayo, 2018). Ramnarain and Hlatswayo (2018) found that Grade 10 Physical Science teachers in South Africa held positive beliefs about inquiry, and they reported a positive impact of IBL on student motivation and understandings of scientific concepts. However, other factors such as the lack of laboratory facilities, equipment, large class sizes, and restricted time to complete the required curriculum, may also prevent teachers from integrating IBL in their classrooms (Ramnarain & Hlatswayo, 2018). Aceytuno and Barroso found that the successful implementation of IBL also depends on the capabilty of the teacher to encourage their students to attend class (Aceytuno & Barroso, 2015).

According to DiBiase and McDonald (2015), the majority of middle and secondary science teachers in North Carolina believe that inquiry is an effective way to teach science. However, the teachers have a critical issue that prevents them from implementing inquiry-based learning in their classrooms. Science teachers feel that they are not well enough trained to implement IBL and do not possess the necessary skills to help them manage inquiry activities. Moreover, they are not sure that IBL will prepare students for their summative assessments. In addition, it is time-consuming to effectively prepare and implement an inquiry-based lesson, often preventing teachers from covering the entire curriculum. Furthermore, teachers are often anxious that students will not be capable of managing their time or working effectively in the collaborative activities of an inquiry lesson. As a result, the students will not be able to master the basic scientific skills and understanding of the scientific concepts (DiBiase & McDonald, 2015).

At the primary level, Chan investigated teachers' beliefs about IBL in primary schools in Hong Kong (Chan, 2010). A qualitative study was carried out on eight teachers from two different schools, with the aim of investigating the impacts of the teachers' beliefs on their implementation of inquiry-based learning in the new Primary General Studies (PGS) curriculum. Chan uncovered that:

- Teachers hold different core beliefs about IBL principles. For example, some teachers believe that their role in IBL should be as facilitators, while others believe that they are knowledge transmitters.
- Although the teachers said they believed in IBL, they rarely implemented it in their classrooms, indicating the level of these beliefs.
- Teachers who had positive beliefs about IBL prepared better quality inquiry lessons better than others did. For example, teachers who believed in IBL prepared lessons with more challenging questions and more opportunities for student inquiry.
- Factors other than teacher beliefs influenced assessment strategies, such as school administration and parents.

In Lebanon, Saad and BouJaoude (2012) carried out a study on 34 science teachers from different grades and in different schools, in order to determine the relationship between teacher attitudes and beliefs about inquiry and their teaching practices. They found that 85% of their teacher sample held positive attitudes and beliefs toward scientific inquiry; however, this was not necessarily reflected in their teaching practices.

In the local context, a study was conducted on 17 math teachers from three primary government schools. Part of the research aimed to explore teacher beliefs about their role in problem-based learning (PBL) after three years of implementation (Al Said, Du, ALKhatib, Romanowski, & Barham, 2019). The results show that the teachers' beliefs have changed. Before PBL implementation, for instance, math teachers considered themselves to be machines: they always worked, planned for lessons, and provided students with the required knowledge, and in turn, students were recipients of knowledge. After three years of PBL implementation, teachers described their role in class as facilitators who put the student at the centre of the learning process, guiding them to learn and understand mathematics and discover new concepts. Thus, they affirmed a constructivist theory of teaching and learning.

Collectively, previous studies have agreed that if teachers want to successfully implement student-centred learning strategies in their classrooms, they should have a clear understanding of what it requires, and in turn believe in its efficacy (Harlow, 2010; Windschiti, Thompson, & Braaten, 2008). It is therefore necessary to prepare teachers to implement strategies and approaches "that challenge children's cognitive and metacognitive thinking and promote learning" (Gillies & Khan, 2008, p. 338). In this way, it is essential to understand the beliefs held by teachers and explore how they are related to new learning strategies, such as IBL.

2.3 Implementing IBL in a Qatari Context

In Qatar, IBL has been encouraged since 2004 for the purposes of "preparing students to be engaged and productive citizens. Critical thinking, enquiry and reasoning are emphasized in all grades to ensure that students develop the ability to work creatively, think analytically and solve problems" (MOEHE, 2004). Recently, several studies have been conducted in order to investigate the success of IBL implementation across Qatar. This is due to the state's strategy to implement scientific inquiry and the emphasis on its importance and inclusion in the Qatar science curriculum. Said (2016) discussed the performance of Qatari students on international science exams, such as TIMSS and the Programme for International Student Assessment (PISA), exploring the views of Qatari science teachers and coordinators about the factors that limit student achievement. The study's outcomes illustrate that although student performance has been improved on the exams (TIMSS and PISA) when compared with their previous performance, they are still below the international average. The science teachers and coordinators attribute the low performance of their students to insufficiencies in their motivations for learning, practical teacher activities, and teacher training in inquiry (Said, 2016).

In another study that was conducted in a Qatari context, a survey was distributed to 1,978 Arabic-speaking students from Grades 3 through 12 across 194 different schools (independent, semi-independent, private Arabic, international, and community schools) in order to measure the attitudes of Arabic-speaking students about science (Said, Summers, Abd-El-Khalick, & Wang, 2016). The survey was designed and named by the researchers, and in addition a five-factor model was demonstrated after analysing the data. The five factors are as follows: “attitudes toward science and science learning, unfavourable outlook toward science, control beliefs, behavioural beliefs about the benefits of science, and intentions” (p. 627). The study’s findings indicated that student age and attitude toward science is negatively correlated, meaning that as a student’s age increases, their attitude toward science decreases. Moreover, student attitudes were found to be influenced by their learning environments. Student gender, however, had no significant impact on any of the five factors (Said, Summers, Abd-El-Khalick, & Wang, 2016).

In a study conducted with 5,120 students from Grades 7 to 12 in 85 Qatari schools (Areepattamannil, 2012), the author investigated the effects of inquiry-based science instruction on scientific literacy and interest in science in adolescent students. The results of the study indicated that inquiry-based science instruction had an effect on scientific achievement as well as on student interest in science (Areepattamannil, 2012).

These studies provide an initial overview of IBL implementation in Qatar and also identify a list of challenges, such as student performance on international exams, student motivation for learning, and teacher practices. Nevertheless, little is known about the perspectives of teachers on IBL. In order to further implement IBL successfully in Qatar, it is necessary to explore teacher perspectives. In particular, what are their beliefs about teaching and learning, and how are their beliefs aligned with IBL? A better understanding of the beliefs of teachers will help us to understand their practices, and indicate ways in which teachers can be provided with the appropriate skills to practice IBL (Haney, Czerniak, C, & Lumpe, 1996; Cronin-Jones, 1991; Pajares, 1992).

CHAPTER 3: RESEARCH METHODOLOGY

This chapter introduces the research method that was applied to explore and identify the beliefs of science teachers toward teaching and learning, while implementing inquiry-based learning in Qatari governmental primary schools. The research sample and method are presented in this chapter, in addition to the data analysis and ethical considerations.

3.1 Research Context and Participants

3.1.1 *Population*

This study focuses on science teachers in Qatari governmental primary schools, specifically those who teach Grades 4-6. The reason for choosing this sample population is the lack of studies on inquiry-based learning in Qatar government primary schools, even though they represent approximately 35% of government schools across the country (Appendix 3) (MDPS, 2018). Moreover, according to MOEHE, the science curriculum standards indicate a gradation of content, with inquiry being simply implemented in early childhood (Grades 1-2), whereby student work is restricted to research using sources without conducting scientific experiments (MOEHE, personal communication, August 25, 2019). However, in the upper stages of primary school (Grades 4-6) the scientific curriculum allows for inquiry to be conducted with greater depth. In these grades, the science curriculum includes many different activities in which scientific inquiry skills are applied (MOEHE, personal communication, August 25, 2019). In addition, laboratories are only available in government schools at this stage, allowing students to conduct experiments and test the hypotheses they have formulated, helping them to employ the scientific method more deeply (MOEHE, personal communication, August 25, 2019).

This age group was also chosen based on Piaget's theory of cognitive development, which indicates that each child goes through four stages of cognitive growth and that there is a direct relationship between the cognitive development of an individual and their age (Huitt & Hummel, 2003). If we consider the ages of students in the three upper grades (Grades 4-6) in government schools, we find that they range from 9 to 11 years old, which means that students are in the third and fourth stages of cognitive development (concrete and formal operational stages) (Huitt & Hummel, 2003). At this age, students have the ability to employ higher thinking skills, such as classifying, reasoning and making a hypothesis—skills that enhance the application of IBL.

In 2019, the total number of science teachers in Grades 4-6 in Qatari governmental primary schools was 238 (MOEHE, personal communication, September 16, 2019), which represents 3.5% of the total number of primary school teachers (MDPS, 2018). Furthermore, 82% of these science teachers are female, while the remaining 18% are male (MOEHE, personal communication, September 16, 2019).

3.1.2 *Sampling Strategy*

A random approach was employed for the sampling strategy because it allows the researcher to better generalize the results. In addition, a random sample has less risk of bias than a non-random sample, since it better represents the wider population of science teachers in Qatar government primary schools (Cohen, Manion, & Morrison, 2011).

3.1.3 *Participants*

A web-based survey was sent via email by MOEHE's Department of Educational Supervision to all science teachers working in Qatari governmental primary schools. The survey was open from May 30 – September 26, 2019, and the researcher received 112 responses from science teachers teaching Grades 4-6 in Qatari governmental primary schools, representing approximately half (47%) of all science teachers in these schools, providing greater reliability for the study. Based on Cohen, Manion, and Morrison (2011), the larger the sample size (based on the population), the greater reliability and more sophisticated statistics (p. 144).

- *Gender*

The majority of the respondents were female teachers (81%), while approximately one fifth were male teachers (19%) (see Table 1). Similar to the unequal distribution of science teachers in Qatari governmental primary schools, the sample's gender distribution was also unequal.

- *Teaching Experience*

Regarding years of educational experience, around 40% of the participants were highly experienced with more than 11 years of experience. Approximately 30% of the participants had 7 to 10 years of experience. The remaining 30% of the participants had between 0 and 6 years of teaching experience (see Table 1).

- *Educational Level*

According to the data in Table 1, the majority of the sample held a bachelor's degree (90%) while the remaining 10% held a master's degree, a PhD, or other kind of educational certificate.

Table 1. *Demographic descriptive statistics*

Demographics		Frequency	Percentage
Gender	Male	21	18.8
	Female	91	81.3
Teaching Experience	Less than 4 years	16	14.3
	4-6 years	15	13.4
	7-10 years	33	29.5
	11 and more	48	42.9
Educational Level	Bachelor	101	90.2
	Master or PhD	11	9.8

3.2 Data Collection Method

3.2.1 *Choice of Method*

This study embraced a quantitative approach for several reasons. The most important of these is the research purpose, which involves measuring teacher beliefs. According to Cohen, Manion, and Morrison (2011), a quantitative approach is suitable for research that aims to conduct measurements (Cohen, Manion, & Morrison, 2011).

Another reason is that the previous studies discussed in the literature review of Chapter 2 used a quantitative approach to measure subjects related to IBL, including McDonald and DiBlase in their study the attitudes of science teachers toward IBL (DiBiase, & McDonald, 2015) and Aceytuno and Barroso's study about the development of IBL methodology (Aceytuno & de la O Barroso, 2015).

3.2.2 *Instrument*

A web-based survey was employed for data generation. The survey consisted of three sections (see Appendix 4):

- Section 1 included demographic data, including gender, years of experience, and level of education.
- Section 2 included 21 items related to how the teacher would set up their own future classroom, as developed by Woolley, Benjamin, and Woolley (2004) in their Teacher Beliefs Survey (TBS). The teacher decided the extent to which he/she agreed or disagreed with a set of statements on a scale ranging from 1 (strongly disagree) to 6 (strongly agree). There were several reasons for choosing these 21 items:

1- The items were designed by three experts in the education field from Mansfield and Harvard universities. Woolley, Benjamin, and Woolley designed the TBS based on seven themes they found emerged from interviews with 14 in-service elementary teachers on their beliefs about teaching, as well as a review of the literature on constructivist and traditional approaches. Initially, the TBS included 32 items; after they conducted a survey on a pilot study and validation study sample and did further analysis they eliminated some items, ending up with 21 items and 3 factors, namely Traditional Management (TM), Traditional Teaching (TT), and Constructivist Teaching (CT).

2- The researchers designed the TBS to measure teacher beliefs related to constructivist and traditional approaches, beliefs that are in line with the purpose of this study.

3- The reliability of the items on teacher beliefs in section two was assessed using SPSS software for the 112 participants in this study. Table 2 demonstrates that the 21 items on teacher beliefs have a high reliability, as Cronbach's alpha is 0.919 for the items.

4- Validity: to ensure the Constructive Validity of section 2 (21 items), a confirmatory factor analysis was conducted on the items using AMOS Program 24. According to the results reported in Figure 3.1, the factor loadings for all items were significant and exceeded the suggested cut-off level of 0.5 (Chin, Gopal, & Salisbury, 1997). The results showed a somewhat better fit of the model with the original study results (df = 188, $\chi 2$ = 417.622, RMSEA=.050, NFI=.668, NNFI=.598, CFI=.781, GFI=.705, AGFI=.636).

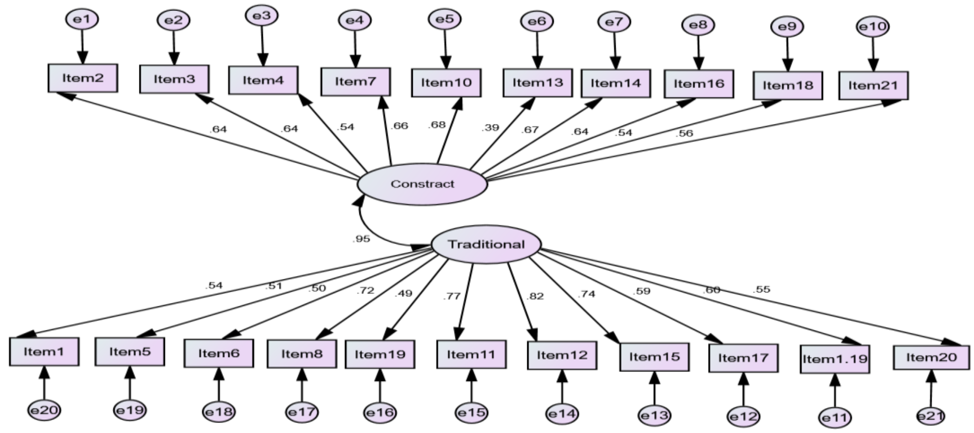

Figure 1. *The results of factor analysis using AMOS program for Section 2 Items*

5- Reliability: Based on Cronbach's alpha coefficients, presented in Table 2, the Instrument has excellent reliability.

Table 2. *Cronbach's alpha reliability for the dimensions (Sample=112)*

Dimensions	N of Items	Cronbach's alpha (α)
Section 2: Teacher belief	21	0.919

- Section 3 included 10 items related to the challenges that teachers face in classrooms that prevent the effective implementation of scientific inquiry. The teachers decide how much they agree or disagree with the statements on a scale of

1 (strongly disagree) to 6 (strongly agree). The 10 items were developed by researchers at the MOEHE in Qatar, and were validated by three experts from the College of Education at Qatar University and two other MOEHE specialists. According to the results in Table 2 above, the 10 items are highly reliable with a Cronbach's alpha of 0.834.

Since the participants in the study were Arabic speakers, the survey was translated from English to Arabic using back translation by an expert. For instance, the survey was written in English then translated to Arabic and back to English, in order to compare the new version to the original and ensure that the essential ideas did not change. Moreover, two science teachers from different grades in different schools reviewed the survey before it was used, in order to provide the researcher with comments on the clarity of the content and the survey layout. The survey content was very clear for both teachers; however, they suggested a change to the layout of the dropdown list to make it easier for the participants to make their selection.

The web-based survey was then constructed using Microsoft Forms, which allows researchers to create surveys in an easy and simple manner. It also directly analyses the data using Excel, and calculates the average time taken for each teacher to complete the survey. Moreover, the researcher used a feature in Microsoft Forms to restrict the survey to a specific group, i.e., it was accessible only to MOEHE teachers and would not open until they had entered their MOEHE email and password. The reason of choosing a web-based survey instead of using a paper-based survey was that it allowed a large number of participants to be reached while being easy to conduct and both time- and cost-efficient

(Wyatt, 2000).

3.2.3 *Procedure*

The study was implemented at government primary schools in Qatar from the second semester of the 2018/2019 academic year to the first semester of the 2019/2020 academic year. Before carrying out the study, the researcher received MOEHE approval and then requested an ethical research approval from the Qatar University Review Board (QU-IRB) department by submitting, via email, all the requirements; namely, the MOEHE approval letter and IRB supervisor letter, the QU-IRB application form and checklist, and the survey and consent form in both Arabic and English (Appendix 5). The researcher then received ethical approval after the QU-IRB department reviewed the application and requested some modifications by the researcher.

Subsequently, the web-based survey was created and carried out using the Microsoft Forms website. The researcher prepared an invitation email, which included the title of the study, some brief information, the target sample, the approval forms from the MOEHE and QU-IRB, the online survey link, and information on how to use it. The researcher sent the email to the Department of Educational Supervision and the head of the MOEHE science curriculum team, who then forwarded the email to all government primary schools in Qatar. A total of 112 science teachers responded to the survey on a voluntary basis, and there were no missing answers in their surveys.

3.3 Data Analysis

A descriptive analysis was used to describe the demographic and general information data in Section 1, and the potential challenges described in Section 3, by calculating the frequency and percentage of the items in Section 1 and the mean and standard deviation for the items in Section 3.

In addition, a confirmatory factor analysis was used to analyse the data in Section 2 by using the AMOS program. The researcher chose to use a confirmatory factor analysis because it allowed variables that had something in common to be grouped (Cohen, Manion, & Morrison, 2011). Moreover, this allowed the researcher to check the validity of the items in Section 2 by comparing them with the results in the original study (Woolley, Benjamin & Woolley, 2004).

A t-test was employed to analyse any significant differences among the participants' gender and educational level, with teacher beliefs (constructivist and traditional) as the dependent variable. A one-way analysis of variance (ANOVA) was conducted in order to uncover any significant differences between years of experience and teacher beliefs.

In order to implement the descriptive t-test and one-way ANOVA, the researcher used the Statistical Package for the Social Sciences (SPSS) software. SPSS was chosen because it is popular in the academic field (Cohen, Manion, & Morrison, 2011) and also offers various kinds of analyses and data transformations (Arkkelin, 2014). Moreover, SPSS is frequently being updated and improved (Arkkelin, 2014).

3.4 Ethical Considerations

Since the study involved human subjects, the researcher took ethical considerations into account. As a result, this study received approval from MOEHE and QU-IRB before being carried out. Moreover, the introduction of the online survey contained a consent form that included the title of the study, its purpose, a privacy statement, the voluntary nature of participation, the right to discontinue participation at any point, and the researcher's and supervisor's contact information in case the participants had any questions. If the participants responded to the survey, it meant that they agreed to the consent form. All participants were assured that strict privacy would be maintained, their identities would be completely obscured, and no names or identifiable information would be collected. The researcher also advised that in the data analysis the researcher would code the participants numerically. Two reminders were sent to the participants to complete the survey, and a note of gratitude was sent to each participant upon completion.

CHAPTER 4: RESULTS

This chapter reports on the results of the analysis described above. It is divided into three sections that report on the findings of the following research questions: 1) What are science teachers' beliefs regarding IBL across Qatar's government primary schools? 2) Do science teachers' beliefs about teaching and learning vary by gender, level of education, or years of teaching experience? 3) What challenges do science teachers encounter in their implementation of IBL?

4.1 Beliefs of Science Teachers Regarding IBL

To answer the first research question, descriptive statistics and a t-test were conducted on Section 2 of the survey (21 items) to describe teachers' beliefs regarding constructivist and traditional approaches. The means (**M**) and standard deviations (**SD**) for the domains and their items are then presented. The means were interpreted based on the following scale:

Table 3. *Scale used to determine the means*

Scale	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
Range	1.00 - 1.83	1.83 - 2.66	2.66 - 3.50	3.50 - 4.33	4.33 - 5.16	5.16 - 600

The responses of the participants (n=112) in relation to the domain of teachers' constructivist beliefs in the implementation of IBL are displayed in Table 4. It was noted that the teachers reported positive beliefs (*agree* and *strongly agree*) toward most of the constructivist items (M=4.35-5.40, SD=1.20-1.58) (see Appendix 4 for the complete list of items). In addition, the teachers reported a slight agreement with item number 13 ("I make it a priority in my classroom to give students time to work together when I am not directing them") (M=3.88, SD=1.64). Generally, the science teacher participants in this study reported positive beliefs on constructivist items (M=4.66, SD=0.91).

Table 4. *Means and standard deviations of teachers' constructivist beliefs*

Items	M	SD
2.2 Student ideas in … curriculum	5.40	1.20
2.3 Prefer to cluster desks	5.09	1.26
2.4 Have students create bulletin boards	4.76	1.36
2.7 Supporting families is part of my role as a teacher	4.73	1.33
2.10 Involve students in evaluating	4.85	1.40
2.13 Have students work together	3.88	1.64
2.14 Make it easy for parents to contact me	4.71	1.46
2.16 Invite parents to volunteer/visit	4.42	1.48
2.18 Assess students informally	4.46	1.37
2.21 Have thematic units on … interests	4.35	1.58
Weighted average	4.664	0.908

Note. Strongly disagree = 1.00-1.83 Disagree = 1.83-2.66 Slightly disagree = 2.66-3.50 Slightly agree = 3.50-4.33 Agree = 4.33-5.16 Strongly agree = 5.16-600

Table 5 shows that the respondents (n=112) generally reported positive beliefs on the traditional items (M=4.39, SD=0.95). The teachers' responses to the traditional items are approximately equally divided between *agreeing* on items 1, 8, 11, 12 and 15 (M=4.79-5.14, SD=1.24-1.36) and *slightly agreeing* on items 5, 6, 17, 19 and 20 (M=3.77-4.30, SD=1.33-1.53) (see Appendix 4 for the complete list of items). In this construct, teachers also reported negative beliefs, like *slightly disagreeing* on item 9 ("I teach subjects separately, although I am aware of the overlap of content and skills") (M=3.28, SD=1.81).

Table 5. *Means and standard deviations of teacher traditional beliefs*

Items	**M**	**SD**
2.1 Establish control first	5.14	1.36
2.5 Responsible to make choices	3.88	1.53
2.6 Base grades on homework … tests	3.77	1.52
2.8 Follow a textbook or workbook	4.95	1.35
2.9 Teach subjects separately	3.28	1.81
2.11 Intervene in disputes	5.02	1.24
2.12 Learn best through a fixed schedule	4.79	1.35
2.15 Students can do independently	4.88	1.27
2.17 Teacher's guide … discussions	4.28	1.40
2.19 Use textbooks … for curriculum	4.30	1.33
2.20 Students needs to learn to obey rules	3.96	1.45
Weighted average	4.386	0.950

Note. Strongly disagree = 1.00-1.83 Disagree = 1.83-2.66 Slightly disagree = 2.66-3.50 Slightly agree = 3.50-4.33 Agree = 4.33-5.16 Strongly agree = 5.16-600

A t-test was conducted to compare the two constructs, in order to determine whether there were any significant differences among teacher beliefs regarding the constructivist and traditional approaches. Table 6 presents the t-test results, demonstrating that the teachers held higher beliefs toward a constructivist approach than toward a traditional approach (M_1=4.66, SD=0.92, M_2=4.39, SD=0.95, t=4.84, df=111, p=0.00<0.05); however, this difference has a small effect size (d=0.29).

Table 6. *T-test results of teachers' beliefs*

Domain	M	Std. Error Mean	t	df	Sig. (2-tailed)
Constructivism	4.664	0.086	4.838	111	0.000
Traditional	4.386	0.090			

4.2 Belief variation by gender, level of education, and years of teaching experience

The second research question aimed to determine whether there were any significant differences (*alpha* $\leq$ *0.05*) between teachers' beliefs and demographic variables (gender, level of education, and years of teaching experience). In order to explore significant differences between teachers' beliefs and the demographic variables, a t-test and a one-way ANOVA were used for the analysis. The approaches toward teacher beliefs were used as the dependent variables, and the demographic variables were used as the independent variables.

Table 7. *T-test result of teachers' beliefs by gender (paired samples test)*

Gender	Domain	Mean	N	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Male	Constructivist	4.714	21	0.962	0.210	2.231	20.000	0.037
	Traditional	4.372	21	1.016	0.222			
Female	Constructivist	4.653	91	0.899	0.094	4.272	90	0.000
	Traditional	4.389	91	0.940	0.096			

Table 7 presents the results of the t-test on teachers' beliefs by gender. A paired sample test was used to compare the results in both domains by gender, in order to determine any statistical significance. Male teachers reported higher beliefs in a constructivist approach (M=4.71, SD= 0.96) rather than the traditional approach (M=4.37, SD=1.02). The differences were significant (*t*=2.23, df=20.00, *p*=0.037<0.05). Similarly, female teachers also hold higher beliefs in a constructivist approach when compared to the traditional approach (M_1=4.65, SD=0.90, M_2=4.39, SD=0.94, *t*=4.27, df=90, *p*=0.00<0.05).

However, there are no significant differences between male and female teachers in relation to either the constructivist approach (*t*=0.28, df=110, *p*=0.78) or the traditional approach (*t*=-0.071, df=110, *p*=0.94) (see Table 8).

Table 8. *T-test result of teachers' beliefs by gender*

Educational Approach	Gender	N	Mean	Std. Deviation	Std. Error Mean	t	df	sig
Constructivism	Male	21	4.7143	0.96244	0.21002	0.279	110.000	0.781
	Female	91	4.6527	0.89856	0.09419			
Traditional	Male	21	4.3723	1.01554	0.22161	-0.071	110.000	0.944
	Female	91	4.3886	0.93989	0.09853			

Table 9 presents the results of the paired-samples t-test, which was implemented in order to compare teachers' beliefs by educational level. The education level of teachers was divided into two categories, namely a bachelor's degree and a master's degree or PhD. The results indicate that teachers holding a bachelor's degree reported higher beliefs in a constructivist approach (M=4.62, SD=0.92) than a traditional approach (M=4.33, SD=0.95). The difference was significant (t=4.57, df=100, *p*=0.00<0.05). Nevertheless, teachers with a master's degree or a PhD did not report any significant difference regarding their beliefs in the constructivist and traditional approaches (M_1=5.10, SD=0.70, M_2=4.87, SD=0.84, *t*=1.59, df=10, *p*=0.14).

Table 9. *T-test result of teachers' beliefs by educational level (paired samples test)*

Educational Level	Domain	Mean	N	Std. Deviation	Std. error mean	t	df	Sig. (2-tailed)
Bachelor's	Constructivist	4.6168	101	0.91685	0.09123	4.573	100	0.000
	Traditional	4.3330	101	0.95019	0.09455			
Master's or PhD.	Constructivist	5.1000	11	0.69857	0.21063	1.589	10	0.143
	Traditional	4.8678	11	0.83751	0.25252			

However, the result of the t-test in Table 10 reveals that no significant differences are evident between the different teachers' educational levels in relation to the constructivist domain (t=-1.69, df=110, *p*=0.093) and the traditional domain (t=-1.79, df=110, *p*=0.076).

Table 10. *T-test result of teachers' beliefs by educational level*

Educational Approach	Educational Level	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Constructivism	Bachelors	101	4.617	0.917	0.091	-1.692	110	0.093
	Master or Ph.D.	11	5.100	0.699	0.210			
Traditional	Bachelors	101	4.333	0.950	0.095	-1.791	110	0.076
	Master or Ph.D.	11	4.868	0.838	0.253			

Table 11 shows the results of the paired-samples t-test, which was conducted to compare teachers' beliefs in relation to years of experience. Years of teaching experience were divided into four levels: less than 4 years, 4-6 years, 7-10 years, and 11 and more years. The results in Table 11 indicated that there was no significant difference between three of the levels of teaching experience and beliefs in either the constructivist or traditional approach, namely less than 4 years (M_1=4.37, SD=1.23, M_2=4.23, SD=1.26, t=1.053, df=15, p=0.309), 4-6 years (M_1=4.97, SD=057, M_2=4.62, SD=0.82, t=2.031, df=14, p=0.062), and 7-10 years (M_1=4.67, SD=0.99, M_2=4.42, SD=1.00, t=1.96, df=32, p=0.059). Only one group, that of teachers with more than 11 years of experience in teaching, reported stronger beliefs in the constructivist approach (M=4.66, SD=0.79) than the traditional approach (M=4.34, SD=0.85), and the difference was significant (t=4.21, df=47, p=0.0001<0.05).

Table 11. *T-test result of teachers' beliefs by years of experience (paired samples test)*

Years of Experience	Domain	Mean	N	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
less than 4 year	Constructivist	4.3688	16	1.22894	0.30723	1.053	15	0.309
	Traditional	4.2330	16	1.26272	0.31568			
4-6 years	Constructivist	4.9733	15	0.57130	0.14751	2.031	14	0.062
	Traditional	4.6182	15	0.82193	0.21222			
7-10 years	Constructivist	4.66667	33	0.992682	0.17280	1.9557	32	0.0593
	Traditional	4.41873	33	0.997657	0.17367			
11 and more	Constructivist	4.66458	48	0.794526	0.11468	4.2089	47	0.0001
	Traditional	4.34091	48	0.845451	0.12203			

Table 12 presents the one-way ANOVA result, which was conducted to compare teachers' beliefs by years of experience. It demonstrates that no significant differences were evident between different teachers' years of experience in the constructivist domain (F (1, 111) = 1.15, p = 0.33) and the traditional domain (F (2, 111) = 0.48, p = 0.70) (see table 12).

Table 12. *One-way ANOVA of teacher beliefs and years of experience*

Educational Approach		Sum of Squares	df	Mean Square	F	Sig.
Constructivism	Between Groups	2.830	3	0.943	1.152	0.332
	Within Groups	88.427	108	0.819		
	Total	91.257	111			
Traditional_teaching	Between Groups	1.316	3	0.439	0.480	0.697
	Within Groups	98.820	108	0.915		
	Total	100.136	111			

4.3 Challenges faced by science teachers in IBL implementation

Table 13 demonstrates the descriptive statistics conducted in Section 3 of the survey (10 items) to describe challenges that science teachers faced during IBL implementation. Eight of the 10 listed items had means higher than 3.5, suggesting that the teachers had encountered these challenges. These challenges were related to topics in the following three clusters: lesson planning (items 3, 5, 8, and 10); assessment (items 4 and 9); and teacher support (items 2 and 7). The challenge science teachers were most likely to face during the implementation of scientific inquiry was "Don't know how to assess scientific inquiry" (M=4.74, SD=1.347). However, the participants reported that they did not encounter any serious challenges in two of the 10 listed items, which had means lower than 3.5; these were item 1, "Content cannot easily be taught in the time allotted," and item 6, "There is a variety of classroom measurement measures."

Table 13. *Descriptive statistics for challenges*

Items	Min.	Max.	Mean	SD	Decision
3.9 don’t know how to assess scientific inquiry	1	6	4.74	1.347	AG
3.5 Have limited technology access (e.g. computers, software, and internet)	1	6	4.42	1.563	AG
3.10 I worry about my students getting lost and frustrated in their learning.	1	6	4.38	1.495	AG
3.2 No promotion for inquiry-based learning that is more student-centered and less teacher-centered from administration	1	6	4.28	1.656	SLA
3.8 The curriculum does not encourage effective implementation	1	6	4.18	1.725	SLA
3.7 Obtain minimal support from principals, science supervisor, and guidance counselors	1	6	4.09	1.647	SLA
3.3 Can’t be implemented with a variety of instructional strategies	1	6	4.08	1.639	SLA
3.4 Can’t be easily assessed to show student’s true growth	1	6	4.07	1.469	SLA
3.1 Content cannot easily be taught in the time allotted	1	6	3.23	1.542	SLDA
3.6 Have a variety of classroom assessment measures	1	6	2.59	1.399	DA

Note. Strongly disagree (SDA)= 1.00-1.83 Disagree (DA)= 1.83-2.66 Slightly disagree (SLDA)= 2.66-3.50 Slightly agree (SLAG)= 3.50-4.33 Agree (AG)= 4.33-5.16 Strongly agree (SAG)= 5.16-600

CHAPTER 5: DISCUSSION AND CONCLUSION

The purpose of this study has been to investigate the beliefs of science teachers regarding constructivist and traditional approaches in the implementation of scientific inquiry-based learning. The study compares teachers' beliefs based on gender, level of education, and years of teaching experience. In addition, it explores the challenges science teachers face during the implementation of inquiry-based learning. In Chapter 1, three primary research questions were formulated; in the Chapter 2, a literature review was discussed; in Chapter 3, the research methodology was presented; and in Chapter 4, the results of the data were outlined. This chapter discusses the study's findings in relation to the literature review and the research questions. Limitations and recommendations will be presented at the end of this chapter, and are based on the discussion and conclusions.

5.1 What are science teachers' beliefs regarding IBL across Qatar government primary schools?

The results of this study indicate that primary school science teachers in Qatar government primary schools hold a higher level of belief in using a constructivist approach than a more traditional approach to teaching and learning, in the context of implementing inquiry-based learning. This result underscores suggestions from previous studies that teachers' practices in relation to student-centred learning can affect their beliefs (Mansour, 2009; Pajares, 1992; Poulson, Avramidis, Fox, Medwell, & Wray, 2001). In particular, Pajares (1992) has stated that changes in teacher behaviour may lead to changes in their beliefs. Previous studies in Qatar have documented the changes in teacher beliefs toward constructivism after having implemented PBL in mathematics and English classrooms (Du, Chaaban, & ALMabrd, 2019; Al Said, Du, ALKhatib, Romanowski, & Barham, 2019). Although this study did not investigate the effect of change using supporting data on teachers' beliefs surrounding inquiry-based learning implementation from 15 years ago, such a change may be assumed in the case of science teachers as constructivist theory-based approaches are still new in Qatar and thus most teachers have no prior experiences of them (Said Z. , 2016). Future studies may provide further evidence to support this assumption of science teachers' change in beliefs through qualitative and longitudinal studies.

The findings in this study are similar to previous studies conducted on student teachers in Nepal (Aldrich & Thoma, 2002) and Germany (Markic & Eilk, 2012). However, they are in conflict with Tsai's (2002) study, and that could be due to the different sample, where Tsai's study was conducted on secondary school science teachers in Taiwan and found that teachers have greater beliefs in traditional approaches than in constructivist approaches. Moreover, it is important to note that Tsai's study was based on the principle of constructivist theory in general, instead of specifically focusing on inquiry-based learning. Additionally, the findings also took into account teachers' past learning experiences during their own time as students.

In the current study, teachers' greater beliefs in constructivism could also be affected by the grades they taught. According to Vartuli (2005), teachers' beliefs are affected by the grade they teach due to changes in the cognitive skills of students. In the current study, the participant teachers teach Grades 4-6, meaning that the students are between the ages of 9 and 11. Based on Piaget's cognitive development theory, these students are in the concrete and formal operational stages of development, and as a result, teachers can more easily implement inquiry than in lower grades (Huitt & Hummel, 2003). Furthermore, previous studies have also demonstrated that the higher the belief science teachers have in constructivism can be affected by the particular science course they teach (Koballa, Graber, Coleman, & Kemp, 2000; Markic & Eilks, 2012). Markic and Eilks (2012) found that while chemistry and physics student teachers believed in traditional theory, biology and primary school student teachers tended to hold more constructivist beliefs.

Although the findings of this study reveal a significant difference between teachers' beliefs in constructivist and traditional approaches, the difference was found to have a small effect size. While teachers held constructivist beliefs, science teachers in Qatar also held positive beliefs in the traditional approach to teaching and learning. This study reported that teachers did not strongly believe in student self-direction during collaborative work. Participant teachers were found to slightly agree with item 13 "… give students time to work together <u>when I am not directing them</u>." This finding is similar to that of Aldrich and Thomas (2002), in that although teachers in their study had a positive perception of constructivism, they did not believe that students could direct the learning process (Aldrich & Thomas, 2002). Moreover, Justice et al. found that teachers resisted the concept of IBL because it is based on shifting the role between teacher and student (Justice, Rice, Roy, Hudspith, & Jenkins, 2009). Teachers tended not to accept this shift because they felt that their students did not have the required skills to lead the learning process. Moreover, they often felt that changing the role would cause them to lose their reputation and value as a professional (Justice, Rice, Roy, Hudspith, & Jenkins, 2009).

A factor that may have a significant effect on science teachers' beliefs in a traditional approach in Qatar can be found in their previous teaching experiences. Studies by several authors found that science teachers' belief in traditional theory was greatly influenced by the methods that their own teachers followed in the past, as well as the success and effectiveness of the traditional environment on them as students (Tsai, 2002; Mansour, 2009). This could also be the case in Qatar government primary schools. In terms of the development of education in Qatar, it can be seen that science education was based on memorization in the past (Brewer et al., 2007; Said, 2016). Although it now encourages the application of inquiry-based learning and the development of critical and analytical thinking among students, (MOEHE, 2018) the past model cannot be immediately changed.

Another factor influencing teacher beliefs in a traditional approach could be their expectations of student performance. Rosenthal (1997) found that how they expected their students to perform was positively correlated with the effort they put into teaching them. As a result, the science teachers' traditional beliefs examined in the current study may refer to their low expectations of their students' performance in science, which in turn could be due to the students' lower achievements in the Qatari national exam and TIMSS international exam (Said, 2016).

5.2 Do science teachers' beliefs about teaching and learning vary by gender, levels of education or years of teaching experience?

The findings of the current study reveal no significant differences between male and female teachers' beliefs regarding constructivist and traditional approaches. However, a previous study found that female teachers held more constructivist beliefs than male teachers (Beck, Czerniak, & Lumpe, 2000).

The findings in this study also illustrate that there is no significant relationship between a teacher's educational level and their beliefs regarding the constructivist and traditional approaches. Although prior literature does not discuss the differences in teacher beliefs based on their educational level, McMullen's (1997) study has illustrated how a college education can influence teachers' beliefs. McMullen found that teachers' beliefs towards developmentally appropriate practices (DAP) were affected by the knowledge and experience they gained during their university education. Moreover, McMullen stated that teachers' beliefs were positively correlated with their educational experience and practices.

The findings of this study have demonstrated that teachers with more than 11 years of experience tend to have greater beliefs in constructivist approaches than traditional approaches. Most of the studies in the above literature review did not consider gender as a factor that could influence teachers' beliefs, instead focusing on other factors, such as the subject being taught (Koballa , Graber, Coleman, & Kemp, 2000; Markic & Eilks, 2012) and experience level of the teachers (Pajares, 1992; Tsai, 2002; Mansour, 2009). The study results are similar to the findings by McMullen (1997) that more experienced teachers held a stronger belief in DAP (McMullen, 1997). This result can be attributed to the fact that teachers' beliefs are influenced by their experience (Pajares, 1992; Hancock & Gallard, 2004; Mansour, 2008). IBL has been integrated into the Qatari science curriculum since 2004 and, as a result, teachers with more than 11 years of experience implement IBL in their classrooms more often than other participants. Gaining exposure to IBL implementation over a long period of time could be the reason for their higher beliefs in constructivism. This assumption refers back to the study by Al Said et al., which reported that Qatari science teachers who had experienced PBL for three years changed their beliefs toward constructivism (Al Said, Du, ALKhatib, Romanowski, & Barham, 2019). In addition, Kagan (1992) found that an increase in teachers' experience in the classroom also informed their teaching beliefs (as cited in Mansour, 2008).

5.3 What challenges do science teachers face in their implementation of IBL?

The findings of this study indicate that science teachers in Qatar government primary schools encounter challenges during IBL implementation. Participating teachers reported a high level of challenges, with a mean higher than 3.5, across 8 of the 10 items. The challenges were found to primarily occur in three areas, namely assessment, teacher support, and academic content.

One of the most frequently reported challenges was that the teachers feel anxious about their students getting lost or frustrated in their learning. This finding is supported by DiBiase and McDonald (2015), who found that science teachers were concerned that their students would not have the required skills to work effectively in an inquiry lesson. This missed learning opportunity would prevent them from mastering the scientific concepts, and leave them unprepared for the summative exam. Previous studies have reported that implementing IBL develops the scientific skills of students, and enhances their understanding of scientific concepts (Areepattamannil, 2012; Correiro, Griffin, & Hart, 2008; Lindquist, 2001; Martin-Hansen, 2005; Şimşek & Kabapınar, 2010; Stout, 2001; Sullivan, 2008; Wu & Hsieh, 2006; Yurumezoglu & Oguz-Unver, 2014). Evidence from previous studies, along with their own experience, may help reduce teachers' concerns when they see the results of academic achievement on the Qatari national exam or an international exam such as TIMSS.

Another challenge reported on in this study is the lack of information that science teachers have on how to assess students in the context of IBL, and how to integrate technology and other instructional strategies into inquiry lessons. This challenge could be a result of insufficient professional development in scientific inquiry for science teachers. Said (2016) conducted a study on science teachers and coordinators across 24 government schools in Qatar, and found that teachers were not aware of how to use and employ the tools available in their schools when applying IBL. Moreover, there were deficiencies in teachers' practical activities, which was thought to be indicative of a lack of competences on the part of teachers in this field; thus, teachers needed to be better trained in conducting scientific inquiry. Another study in the United States has reported that science teachers do not consider themselves to be qualified in this area and do not have the required skills to implement and manage inquiry activities, due to deficiencies in the professional development of teachers (DiBiase & McDonald, 2015).

Previous studies have documented the challenges teachers often face in managing time during the implementation of inquiry-based learning. Nevertheless, in this study, science teachers did not consider the time allotted by the MOEHE to implement and cover the science curriculum to be a major challenge. This finding is in contrast to other studies, which have found that time was a major constraint in the implementation of inquiry in science classrooms (Aceytuno & Barroso, 2015; DiBiase & McDonald, 2015). Teachers must cover the entire curriculum within a limited period of time; therefore, they may be deterred from using apply inquiry in their class as it takes a long time to implement effectively (Aceytuno & Barroso, 2015; DiBiase & McDonald, 2015).

5.4 Limitations and future perspectives

This study has a few limitations. First, it only employed a quantitative approach in order to provide data on science teachers' beliefs in Qatar government primary schools. Further studies could be conducted to provide further qualitative data, such as interviews to offer insights into the reasons for teachers' beliefs, or observations to explore whether teachers' practices are influenced by their beliefs. Second, the current study was based on self-reported data, and the results could be further compared with other data, such as an exploration of teachers' practices of inquiry-based learning through classroom observation, for more reliable and accurate results. Third, the current study has mainly examined primary science teachers' beliefs, and thus future studies could compare the results with findings regarding teachers of other subjects and levels of education, such as secondary schools.

5.5 Recommendations

The results of the study at hand show that science teachers believe in constructivist and traditional theories, but their beliefs toward constructivism are higher. It was also reported that there are many challenges encountered by primary science teachers when implementing inquiry-based learning. Accordingly, we recommend that the MOEHE provide professional development on inquiry-based learning for science teachers and explore its relationship to constructivist theory. These workshops should be prepared by specialists in the field of scientific inquiry, whether from the Faculty of Education College at Qatar University, or from abroad. Moreover, the MOEHE could send experts into schools to observe science teachers during IBL implementation and provide advice and guidance on their skills, in order to enhance their practices.. In addition, school administration could motivate teachers to implement inquiry-based learning in the classroom, by allowing them to present their work to their colleagues or offering certificates of appreciation.

5.6 Conclusion

The current study has investigated science teachers' beliefs regarding constructivist and traditional approaches to teaching in Qatar government primary schools, exploring the challenges they face when implementing IBL. A web-based survey was utilised in order to collect the data, which consisted of three sections: demographic data, teacher beliefs (Woolley, Benjamin, & Woolley, 2004), and challenges. The results indicate that more science teachers in Qatar report believing in the constructivist approach more than the traditional approach. Moreover, there were no statistically significant differences between teachers' gender, educational level, and experience in relation to these beliefs. Science teachers in Qatar government primary schools also encountered many challenges during IBL implementation; however, they did not consider the time allotted for teaching science to be a challenge.

The results of this study will benefit teachers in particular, and the Ministry of Education and Higher Education in general, as it provides them with information and statistics regarding teachers' beliefs in the constructivist approach and the challenges they experience in its successful implementation. The results of this study open new horizons for research into the beliefs held by science teachers, and the ways in which these beliefs ultimately impact their practices.

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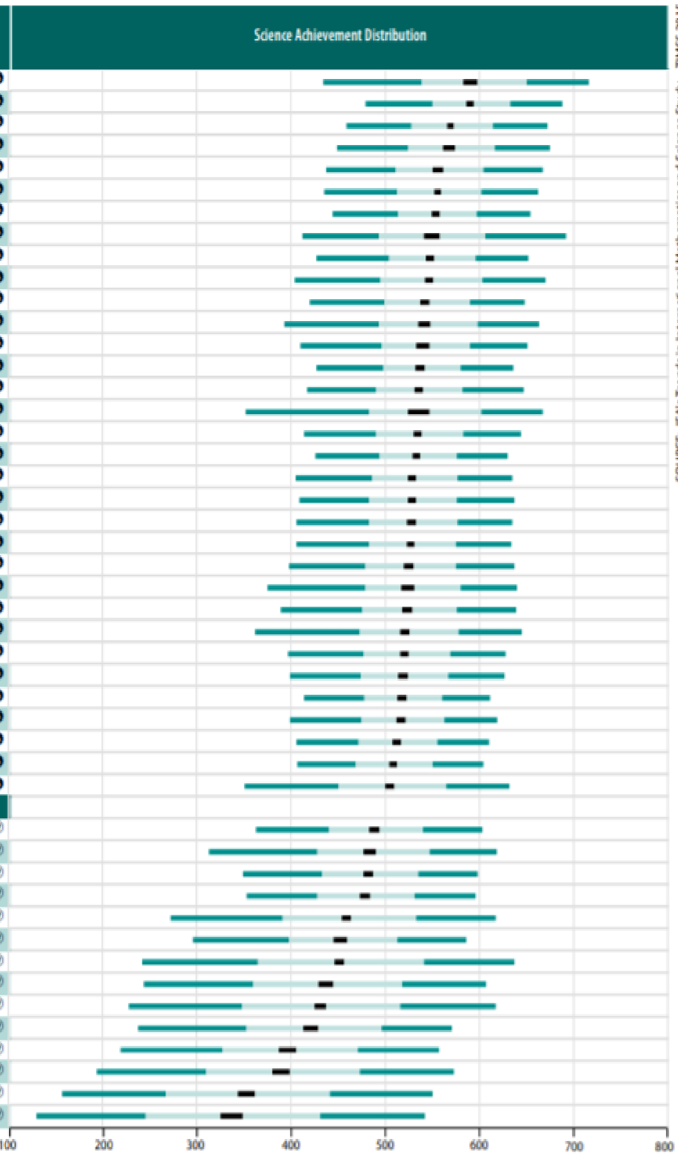
APPENDIX 1: TIMSS SCINCE RESULT FOR 4TH GRADE (2015)

TIMSS 2015 Science 4th Grade

Exhibit 1.1: Distribution of Science Achievement

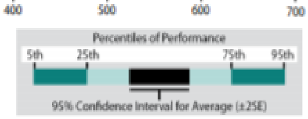
Country	Average Scale Score	
² Singapore	590 (3.7)	▲
Korea, Rep. of	589 (2.0)	▲
Japan	569 (1.8)	▲
Russian Federation	567 (3.2)	▲
† Hong Kong SAR	557 (2.9)	▲
Chinese Taipei	555 (1.8)	▲
Finland	554 (2.3)	▲
Kazakhstan	550 (4.4)	▲
Poland	547 (2.4)	▲
2 † United States	546 (2.2)	▲
Slovenia	543 (2.4)	▲
Hungary	542 (3.3)	▲
2 Sweden	540 (3.6)	▲
Norway (5)	538 (2.6)	▲
England	536 (2.4)	▲
Bulgaria	536 (5.9)	▲
Czech Republic	534 (2.4)	▲
Croatia	533 (2.1)	▲
Ireland	529 (2.4)	▲
Germany	528 (2.4)	▲
2 Lithuania	528 (2.5)	▲
2 † Denmark	527 (2.1)	▲
1 2 † Canada	525 (2.6)	▲
3 Serbia	525 (3.7)	▲
Australia	524 (2.9)	▲
Slovak Republic	520 (2.6)	▲
‡ Northern Ireland	520 (2.2)	▲
2 Spain	518 (2.6)	▲
† Netherlands	517 (2.7)	▲
2 Italy	516 (2.6)	▲
† Belgium (Flemish)	512 (2.3)	▲
2 Portugal	508 (2.2)	▲
New Zealand	506 (2.7)	▲
TIMSS Scale Centerpoint	500	
France	487 (2.7)	▼
Turkey	483 (3.3)	▼
Cyprus	481 (2.6)	▼
Chile	478 (2.7)	▼
2 Bahrain	459 (2.6)	▼
1 Georgia	451 (3.7)	▼
United Arab Emirates	451 (2.8)	▼
Qatar	436 (4.1)	▼
Oman	431 (3.1)	▼
Iran, Islamic Rep. of	421 (4.0)	▼
Indonesia	397 (4.8)	▼
Saudi Arabia	390 (4.9)	▼
ψ Morocco	352 (4.7)	▼
ψ Kuwait	337 (6.2)	▼



SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2015

▲ Country average significantly higher than the centerpoint of the TIMSS 4th grade scale

▼ Country average significantly lower than the centerpoint of the TIMSS 4th grade scale



The TIMSS achievement scale was established in 1995 based on the combined achievement distribution of all countries that participated in TIMSS 1995. To provide a point of reference for country comparisons, the scale centerpoint of 500 was located at the mean of the combined achievement distribution. The units of the scale were chosen so that 100 scale score points corresponded to the standard deviation of the distribution.

ψ Reservations about reliability because the percentage of students with achievement too low for estimation exceeds 15% but does not exceed 25%.

See Appendix C.1 for target population coverage notes 1, 2, and 3. See Appendix C.7 for sampling guidelines and sampling participation notes †, ‡, and ‖.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

APPENDIX 2: COMPARTION BETWEEM TIMSS SCINCE RESULT IN 2011 AND 2015 FOR 4TH AND 8TH GRADE

TIMSS 2015 Science 4th&8th Grade

Exhibit 1.9: Relative Achievement of 2011 Fourth Grade Cohort as Eighth Grade Students in 2015 – Countries Assessed Both Grades in Both Assessment Years

Follow the green arrow pointing diagonally downwards to compare relative performance among the TIMSS countries at the fourth grade in 2011 (upper-left panel) to relative performance at the eighth grade in 2015 (lower-right panel).

2011 - Fourth Grade

Country	Achievement Difference from TIMSS Scale Centerpoint (500)	
Korea, Rep. of	87 (2.1)	○
Singapore	83 (3.4)	○
Japan	59 (1.9)	○
Russian Federation	52 (3.4)	○
Chinese Taipei	52 (2.2)	○
United States	44 (2.1)	○
Hong Kong SAR	35 (3.7)	○
Hungary	34 (3.7)	○
Sweden	33 (2.8)	○
England	29 (3.0)	○
Italy	24 (2.7)	○
Slovenia	20 (2.6)	○
Australia	16 (2.9)	○
Lithuania	15 (2.4)	○
New Zealand	-3 (2.4)	
Kazakhstan	-5 (5.1)	
Norway (4)	-6 (2.5)	▼
Chile	-20 (2.5)	▼
Turkey	-37 (4.7)	▼
Georgia	-45 (3.9)	▼
Iran, Islamic Rep. of	-47 (3.8)	▼
Bahrain	-51 (3.5)	▼
Saudi Arabia	-71 (5.5)	▼
United Arab Emirates	-72 (2.5)	▼
Qatar	-106 (4.3)	▼
Oman	-123 (4.3)	▼
Morocco	-236 (4.4)	▼

2015 - Fourth Grade

Country	Achievement Difference from TIMSS Scale Centerpoint (500)	
Singapore	90 (3.7)	○
Korea, Rep. of	89 (2.0)	○
Japan	69 (1.8)	○
Russian Federation	67 (3.2)	○
Hong Kong SAR	57 (2.9)	○
Chinese Taipei	55 (1.8)	○
Kazakhstan	50 (4.4)	○
United States	46 (2.2)	○
Slovenia	43 (2.4)	○
Hungary	42 (3.3)	○
Sweden	40 (3.6)	○
England	36 (2.4)	○
Lithuania	30 (2.7)	○
Australia	24 (2.9)	○
Italy	16 (2.6)	○
New Zealand	6 (2.7)	○
Norway (4)	-7 (2.2)	▼
Turkey	-17 (3.3)	▼
Chile	-22 (2.7)	▼
Bahrain	-41 (2.6)	▼
Georgia	-49 (3.7)	▼
United Arab Emirates	-49 (2.8)	▼
Qatar	-64 (4.1)	▼
Oman	-69 (3.1)	▼
Iran, Islamic Rep. of	-79 (4.0)	▼
Saudi Arabia	-110 (4.9)	▼
Morocco	-148 (4.7)	▼

2011 - Eighth Grade

Country	Achievement Difference from TIMSS Scale Centerpoint (500)	
Singapore	90 (4.3)	○
Chinese Taipei	64 (2.3)	○
Korea, Rep. of	60 (2.0)	○
Japan	58 (2.4)	○
Slovenia	43 (2.6)	○
Russian Federation	42 (3.3)	○
Hong Kong SAR	35 (3.4)	○
England	33 (4.9)	○
United States	25 (2.4)	○
Hungary	22 (3.1)	○
Australia	19 (4.7)	○
Lithuania	14 (2.5)	○
New Zealand	12 (4.6)	○
Sweden	9 (2.6)	○
Italy	1 (2.4)	
Norway (8)	-6 (2.6)	▼
Kazakhstan	-10 (4.2)	▼
Turkey	-17 (3.4)	▼
Iran, Islamic Rep. of	-26 (4.0)	▼
United Arab Emirates	-35 (2.4)	▼
Chile	-39 (2.5)	▼
Bahrain	-48 (1.9)	▼
Saudi Arabia	-64 (3.8)	▼
Georgia	-80 (3.0)	▼
Oman	-80 (3.2)	▼
Qatar	-81 (3.2)	▼
Morocco	-124 (2.2)	▼

2015 - Eighth Grade

Country	Achievement Difference from TIMSS Scale Centerpoint (500)	
Singapore	97 (3.2)	○
Japan	71 (1.8)	○
Chinese Taipei	69 (2.1)	○
Korea, Rep. of	56 (2.2)	○
Slovenia	51 (2.4)	○
Hong Kong SAR	46 (3.9)	○
Russian Federation	44 (4.2)	○
England	37 (3.8)	○
Kazakhstan	33 (4.4)	○
United States	30 (2.8)	○
Hungary	27 (3.4)	○
Sweden	22 (3.4)	○
Lithuania	22 (3.0)	○
New Zealand	13 (3.1)	○
Australia	12 (2.7)	○
Italy	-1 (2.4)	
Turkey	-7 (4.0)	
Norway (8)	-11 (2.4)	▼
United Arab Emirates	-23 (2.3)	▼
Bahrain	-34 (2.2)	▼
Qatar	-43 (3.0)	▼
Iran, Islamic Rep. of	-44 (4.0)	▼
Oman	-45 (2.7)	▼
Chile	-46 (3.1)	▼
Georgia	-57 (3.1)	▼
Saudi Arabia	-104 (4.5)	▼
Morocco	-107 (2.5)	▼

○ Country average significantly higher than the centerpoint of the TIMSS scale

▼ Country average significantly lower than the centerpoint of the TIMSS scale

Trend results for Lithuania do not include students taught in Polish or in Russian.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2015

APPENDIX 3: EDUCATION STATISTIC CHAPTER 4 – 2018 FROM MDPS

الطلاب حسب المرحلة التعليمية والصف ونوع التعليم والجنسية والنوع

٢٠١٨/٢٠١٧

STUDENTS BY LEVEL OF EDUCATION, GRADE, TYPE OF EDUCATION, NATIONALITY AND GENDER

2017/2018

TABLE (65) جدول (٦٥)

Education Level	Grade	المجموع العام G.Total	المجموع Total إناث Females	المجموع Total ذكور Males	المدارس الخاصة(1) Private Schools(1) غير قطريين Non-Qataris إناث Females	المدارس الخاصة(1) Private Schools(1) غير قطريين Non-Qataris ذكور Males	المدارس الخاصة(1) Private Schools(1) قطريون Qataris إناث Females	المدارس الخاصة(1) Private Schools(1) قطريون Qataris ذكور Males	المدارس الحكومية Government Schools غير قطريين Non-Qataris إناث Females	المدارس الحكومية Government Schools غير قطريين Non-Qataris ذكور Males	المدارس الحكومية Government Schools قطريون Qataris إناث Females	المدارس الحكومية Government Schools قطريون Qataris ذكور Males	الصف	المرحلة التعليمية
Pre-primary(2)	Total	55,633	26,961	28,672	17,550	18,996	4,639	5,455	580	513	4,192	3,708	المجموع	رياض الأطفال(٢)
Primary	Grade I	28,367	13,965	14,402	7,819	8,369	1,401	1,697	2,398	2,246	2,347	2,090	الصف الأول	الابتدائية
	Grade II	27,618	13,486	14,132	7,235	7,977	1,397	1,726	2,350	2,298	2,504	2,131	الصف الثاني	
	Grade III	26,324	12,903	13,421	6,790	7,253	1,383	1,696	2,353	2,269	2,377	2,203	الصف الثالث	
	Grade IV	25,875	12,715	13,160	6,362	6,872	1,284	1,673	2,425	2,244	2,644	2,371	الصف الرابع	
	Grade V	23,566	11,201	12,365	5,585	6,238	1,087	1,586	2,044	2,137	2,485	2,404	الصف الخامس	
	Grade VI	21,798	10,653	11,145	4,945	5,445	1,002	1,524	2,106	1,942	2,600	2,234	الصف السادس	
	Total	153,548	74,923	78,625	38,736	42,154	7,554	9,902	13,676	13,136	14,957	13,433	المجموع	
Preparatory	Grade I	20,752	10,235	10,517	4,478	4,781	768	1,228	2,161	2,162	2,828	2,346	الصف الأول	الإعدادية
	Grade II	19,706	9,560	10,146	4,045	4,526	725	1,128	2,115	2,124	2,675	2,368	الصف الثاني	
	Grade III	18,296	8,920	9,376	3,702	4,107	577	1,015	2,139	2,024	2,502	2,230	الصف الثالث	
	Total	58,754	28,715	30,039	12,225	13,414	2,070	3,371	6,415	6,310	8,005	6,944	المجموع	
General Secondary	Grade I	17,489	8,511	8,978	3,260	3,484	521	927	2,168	2,247	2,562	2,320	الصف الأول	الثانوية العامة
	Grade II	14,992	7,449	7,543	2,776	3,051	449	845	1,988	1,913	2,236	1,734	الصف الثاني	
	Grade III	14,694	7,236	7,458	2,647	2,838	311	699	1,855	1,898	2,423	2,023	الصف الثالث	
	Total	47,175	23,196	23,979	8,683	9,373	1,281	2,471	6,011	6,058	7,221	6,077	المجموع	
Secondary Specialized	Grade I	298	37	261	0	0	0	0	3	13	34	248	الصف الأول	الثانوية التخصصية
	Grade II	182	31	151	0	0	0	0	1	8	30	143	الصف الثاني	
	Grade III	210	22	188	0	0	0	0	2	15	20	173	الصف الثالث	
	Total	690	90	600	0	0	0	0	6	36	84	564	المجموع	
Grand Total		315,800	153,885	161,915	77,194	83,937	15,544	21,199	26,688	26,053	34,459	30,726		المجموع العام

(1) Include Qatar Foundation schools. (١) تشمل مدارس مؤسسة قطر.

(2) Include nurseries. (٢) تشمل الحضانات.

APPENDIX 4: SURVEY

Instructions: Answer the following questions to the best of your ability:

Section (1): Demographic Data

1. Gender (Male / Female)

2. School type, where you are currently teaching (Tick the appropriate title)

   Boys ____ Girls ____

3. Position (Tick the appropriate title) ___Teacher ____ Coordinator

4. What grade(s) do you teach?

   ____ 4 ____5 _____6

5. How many years have you been teaching, including this year?

   ____0 ____ 1–3 ____4–6 ____ 7–10 ____11 and more

6. What is your highest educational degree?

   ___Bachelors ___ Masters ___Doctorate ___ Other

7. Are there any students for whom Arabic is not their first language?

   ____Yes ____No ____Don't knows Explain_______________________

Section (2):

Imagine how you will set up your own future classroom as you read each of the following survey statements. As you think about your classroom (not your current or cooperating teachers' classrooms), decide how much you disagree or agree with the statement on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*).

Aspect	**(1) Strongly Disagree**	**(2) Disagree**	**(3) Slightly Disagree**	**(3) Slightly Agree**	**(5) Agree**	**(6) Strongl y Agree**
1. It is important that I establish classroom control before I become too friendly with students.						
2. I believe that expanding on students' ideas is an effective way to build my curriculum.						
3. I prefer to cluster students' desks or use tables so they can work together.						
4. I invite students to create many of my bulletin boards.						
5. I like to make curriculum choices for students because they can't know what they need to learn.						
6. I base student grades primarily on homework, quizzes, and tests.						
7. An essential part of my teacher role is supporting a student's family when problems are interfering with their learning.						

8. To be sure that I teach students all the necessary content and skills, I follow a textbook or workbook.						
9. I teach subjects separately, although I am aware of the overlap of content and skills.						
10. I involve students in evaluating their own work and setting their own goals.						
11. When there is a dispute between students in my classroom, I try to intervene immediately to resolve the problem.						
12. I believe students learn best when there is a fixed schedule.						
13. I make it a priority in my classroom to give students time to work together when I am not directing them.						
14. I make it easy for parents to contact me at school or at home.						
15. For assessment purposes, I am interested in what students can do independently.						
16. I invite parents to volunteer in or visit my classroom at almost any time.						
17. I generally use the teacher’s guide to lead class discussions of a story or text.						
18. I prefer to assess students informally through observations and conferences.						
19. I find that textbooks and other published materials are the best sources for creating my curriculum.						
20. It is more important for students to learn to obey rules than to make their own decisions.						

21. I often create thematic units based on the students' interests and ideas.						

<u>Section (3): Classroom challenges that prevent the effective implementation of inquiry-based learning.</u>

Decide how much you disagree or agree with each statement on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*).

Aspect	**(1) Strongly Disagree**	**(2) Disagree**	**(3) Slightly Disagree**	**(3) Slightl y Agree**	**(5) Agree**	**(6) Strongly Agree**
1. Content cannot be easily taught in the time allotted						
2. There is no promotion of inquiry-based learning that is more student-centred and less teacher-centred from the administration						
3. Cannot be implemented with a variety of instructional strategies						
4. Cannot be easily assessed to show students' true growth						
5. There is limited technology access (e.g. computers, software, and internet)						
6. There are a variety of classroom assessment measures						
7. Minimal support is obtained from principals, science supervisor, and guidance counsellors						
8. The curriculum does not encourage effective implementation						

9. I don't know how to assess scientific inquiry						
10. I worry about my students getting lost and frustrated in their learning						

APPENDIX 5: CONSENT FORM

Information and Consent Form

Research Title:

"Science Teachers' Beliefs about Teaching and Learning Implementing Inquiry-based learning – a Case in Qatar Government Primary Schools"

You are invited to participate in a study investigating Science teacher beliefs toward the inquiry-based learning standard and exploring challenges they have encountered in the process of implementation in Qatar goverment primary schools.

You will take part in the study by responding to a questionnaire. Please make sure you respond to all the statements. There are no right or wrong answers on this questionnaire. Any information or personal details gathered in the course of the study are confidential. No individual will be identified in any publication of the results. The data collected will be destroyed after research is finished.

Participation in this study is entirely voluntary: you are not obliged to participate and if you decide to do so, you are free to withdraw at any time without having to give a reason and without consequences. The ethical aspects of this study have been approved by Qatar University's Ethics Committee.

The approval number of QU-IRB is 1071-E/19; If you have any question related to ethical compliance of the study you may contact this email at QU-IRB@qu.edu.qa .

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