Exploring teachers' perceptions towards using ICT and dialogic teaching in primary science classrooms in Saudi Arabia

by

Alruways Alharbi

A thesis submitted in partial fulfilment of the requirements for the degree of

Doctor of Education

University of Warwick, Centre for Education Studies

September 2021

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Acknowledgments

Always and forever, I praise and glorify God (Allah) who provided me with strength and ability to accomplish this thesis.

It is a genuine pleasure to express my deep sense of thanks and gratitude to my supervisor Sue Johnston-Wilder for her endless support, patience and guidance at all stages throughout my research journey and through my difficult personal circumstances and times of struggle. Without her sustained help and encouragement, I would have never finished this thesis and developed my academic skills. Also, I wish to extend my deep appreciation and thanks to my second supervisor Dr. Elisabeth Arweck for her valuable comments and feedback. In addition, I wish to express my warm thanks to all the members of the University of Warwick, and the staff of the Department of Education Studies for offering a supportive study environment.

I am extremely thankful to my sponsor the Ministry of Education in Saudi Arabia for the generous scholarship and the invaluable support. Moreover, I am greatly thankful to all primary science teachers involved in the process of this research. Also, I want to thank my friends and colleagues who offered helpful suggestions and comments, and I wish them all the best.

I would like to dedicate this thesis to my parents' souls. Also, I must express my very profound gratitude to my mother who raised me, Munira; nothing can describe your unlimited prayers and your countless support in all aspects of my life. I am also grateful to all my brothers and sisters and my parents-in-law who have always encouraged me during my study period.

I am hugely indebted to my oldest brother, Dr. Mohammed, who has always been a source of great inspiration, for his endless encouragement during my bachelor's, master's and doctoral journey; without your motivation and all kind of support, I would not have accomplished this dream. Also, I would like to give my sincere thanks and appreciation to Dr. Majed Alharbi, who has been a continuous source of motivation, and inspiration throughout my EdD journey. This journey owes you more than I can express, and I cannot thank you enough.

Last, but not least, my very special thanks and gratitude go to my dear wife, Amal, and my two children, Tariq and Tamim who have shown me enormous patience, and unwavering support, during the long time of my study at the University.

Declaration

I confirm that this thesis, submitted for the award of Doctor of Education, in the Department of Education Studies, University of Warwick, is entirely my own work, except where due acknowledgement has been made. In addition, I certify that, this thesis has not been previously submitted for the award of any degree at another university.

Alruways Alharbi

Abstract

This study investigated teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia. As a result, the research focused on three aspects: the implementation of dialogic teaching; the use of ICT in teaching practices; and the use of ICT to support dialogic teaching. Mixed-methods sequential research was conducted in Riyadh city in Saudi Arabia, using a questionnaire for the quantitative phase, which was completed by 305 teachers, followed by a semi-structured interview with 12 teachers for the qualitative phase, to achieve the study's main aim and objectives.

It was found that Saudi primary science teachers, in Riyadh, have positive attitudes towards dialogic teaching. Teachers appeared to be aware of the importance and the advantages of talking about and discussing ideas with their students and the role they play in facilitating students' learning. However, the results indicated that most teachers adopted a dominant role in classroom discussion activities in practice. Other issues that may affect the implementation of dialogic teaching were explored. These challenges may prompt teachers to resort to a traditional teaching style.

Regarding the use of ICT, Saudi primary science teachers seemed to be interested in and to enjoy using ICT, and generally believed that ICT tools are important in supporting students' learning and interaction. The results indicated that teachers use a variety of hardware and software depending on its availability in the schools. However, the findings revealed several external and internal challenges hindering the successful use of ICT in science classrooms. From the teachers' perceptions, one of the main findings of this study is that, by supporting dialogic teaching with ICT tools, there was a consequent increase in student engagement. Further, the findings indicated that the use of ICT tools can support the interactivity between teachers and students, and between students themselves. However, teachers' implementation of ICT to support dialogic teaching is negatively influenced by the unavailability of some vital ICT tools.

Abbreviations

ICT	Information and Communications Technology
MoE	Ministry of Education
IWB	Interactive Whiteboard
LRC	Learning Resources Centre
TAM	Technology Acceptance Model
UTAUT	Unified Theory of Acceptance and Use of Technology
TPACK	Technological Pedagogical and Content Knowledge

Chapter One: Introduction

1.1. Introduction

This thesis investigates teachers' perceptions of implementing the dialogic teaching approach and using Information and Communication Technology (ICT) in primary science classrooms in Saudi Arabia. Chapter One begins with a brief background to the study. Then, the rationale of the study is discussed, followed by a presentation of the aims of the study and the research questions. Finally, the structure of this thesis is outlined.

1.2. Background to the study

In many countries, the learning and teaching process has gradually moved away from traditional methods where education can be delivered through recitation and memorisation techniques, to a newer method where students can actively engage in meaning-making and co-construction of knowledge through interaction (Mortimer and Scott, 2003; Vlassi and Karaliota, 2013). This change encourages the teachers to shift their role away from transmitting knowledge to students and dominating classroom interaction to facilitating students' learning and engagement. Through the use of the dialogic teaching approach (Alexander, 2004), students can interact, participate, and exchange ideas in order to be actively engaged in the learning process within a positive and interactive learning environment. Several studies have been conducted in different contexts focusing on the implementation of the dialogic teaching approach in science classrooms (Scott et al., 2006; Scott and Ametller, 2007; Mercer et al., 2009; Gillies, 2020).

The use of ICT can play an important role in improving the teaching of science (Suduc et al., 2011). The dialogic teaching approach can be supported by using technology to provide more opportunities for students to interact with others, talk, and discuss others' ideas (Wegerif, 2007; Beauchamp and Kennewell, 2008). This study will consider teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia.

1.3. Rationale of the Study

Both my teaching experience in primary school education and my research journey have led me to the topic of this thesis. I taught science in three different primary schools in Saudi Arabia before beginning work on my EdD at the University of Warwick. During this period, the Ministry of Education (MoE) in Saudi Arabia launched an initiative to change the old science curriculum, which depends on teachers lecturing, to a new, spiral curriculum. The new curriculum is intended to promote students interacting with each other, sharing their own ideas, and conducting scientific experiments or activities both individually and in groups. This allows students to present, discuss, and compare results with others. As a science teacher, I also noted that the MoE initiative placed great value on science teaching and learning, particularly on training and guiding science teachers to teach effectively by using inquiry-based learning courses (Alghamdi and Alsalouli, 2013).

However, despite this effort from the MoE, the relevant academic literature has shown that some teachers are still using a traditional style of lecturing students and delivering the content without engaging students in the learning process (Alharbi, 2019; Alnosiaan, 2019). As a result, many students still participate as listeners and recipients of scientific content, rather than sharing information, expressing viewpoints, or interacting with others.

Additionally, based on my experience, I observed that, although the MoE spent a huge amount of money integrating technology into education, there was a clear lack of ICT tools in classrooms, a lack of ICT courses, and numerous under-equipped science labs. However, most schools in Saudi Arabia have been provided with a Learning Resources Centre (LRC), which is equipped with a variety of ICT tools (Albugami, 2016). I used to bring my students to the LRC to use the available ICT tools to teach some science lessons. When using these tools, my students were more active and attentive than when present in the normal, less equipped classroom. This may have been due to actualising some of the potential of ICT to increase general student interaction in the classroom.

Regarding my research journey, when I started studying for my EdD, I was required to study 6 modules in my first year and to write 6 essays, which prompted me to search for more information about communication, engagement and interaction in the classroom, and the role of ICT in supporting an effective teaching and learning process. An extensive literature

search led me to choose Alexander's (2004) framework of dialogic teaching because it matches my previous experience and interest. This approach has been applied in science education in various projects and studies across the world (Mercer et al., 2009; Lehesvuori et al., 2011; Kumpulainen and Rajala, 2017; Gillies, 2020). Additionally, several studies have indicated that the use of ICT can support interactivity in the classroom and provide opportunities for students' dialogue and meaning-making (Beauchamp and Kennewell, 2008; Hennessy, 2011; Major and Warwick, 2019; Mercer et al., 2019). However, even though there a wide literature regarding the use of ICT in education in Saudi Arabia (Almaghlouth, 2008; Alsulaimani, 2010; Bingimlas, 2013; Alenezi, 2015; Albugami, 2016; Alkahtani, 2017; Alharthi, 2018; Alharbi, 2019; Alnosiaan, 2019), there is a lack of studies investigating the effect of ICT in supporting interaction and engagement within the Saudi schools. Hence, this study investigates teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia.

To the best of my knowledge, there is no specified research related to using ICT to support dialogic teaching in primary science classrooms in the Saudi context. Thus, this study attempts to fill that gap and contribute to existing literature in the context of science education.

1.4. Research Aim and objectives

The major aim of this study is to investigate teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia. In this study, the following research objectives were formulated:

1. To identify the implementation of dialogic teaching in primary science classrooms.
2. To investigate the effect of dialogic teaching on primary students' learning and interaction.
3. To explore the challenges of implementing dialogic teaching in primary science classrooms.
4. To investigate the current use of ICT tools by primary science teachers.
5. To identify the effect of ICT tools on primary students' learning and interaction.
6. To explore the challenges of using ICT in primary science classrooms.
7. To investigate the current use of ICT to support dialogic teaching in primary science classrooms.

8. To explore the effect of using ICT to support dialogic teaching on primary students' learning and interaction.

1.5. Research questions

To address the main research aim and objectives listed above, this study aims to answer the following research questions:

1. To what extent do primary science teachers implement dialogic teaching, use of ICT, and, in turn, using ICT to support dialogic teaching in their classroom?
2. From primary science teachers' perspectives, what are the effects of dialogic teaching, the use of ICT, and using ICT to support dialogic teaching on their students' learning and interaction?
3. From primary science teachers' perspectives, what are the challenges of implementing dialogic teaching and using ICT in their classroom?

1.6. Organisation of the thesis

This thesis is presented in eight chapters, as described below:

Chapter One provides an overview of the research including a brief background to the study followed by the rational of the study**.** Details of the main aim and the objectives of the research, and the research questions, are provided. It closes with an organisation of the thesis.

Chapter Two presents the context of this study, including the background of Saudi Arabia and its education system. The educational reform and initiatives in Saudi Arabia are presented, followed by a brief description of the Saudi Vision 2030. Further, primary science education in Saudi Arabia and the dialogue in Saudi education are considered. This chapter also presents the use of ICT in education in Saudi Arabia.

Chapter Three reviews the relevant literature, including the theoretical framework used in this study. The implementation of dialogic teaching in the classroom and the role of teachers and students in the dialogue are considered. Further, the use of dialogic teaching in science

classrooms is discussed, and the framework of the communicative approaches in science classrooms is detailed. Finally, the challenges from the literature that affect teachers' implementation of dialogic teaching are outlined.

Chapter Four provides the methodology used in this study, including a presentation of the research paradigm. This chapter then gives a description of the sequential mixed methods used to collect data, including the quantitative and qualitative phases, which involved questionnaires and semi-structured interview research tools. The population of the study and sampling are presented, and the techniques of analysing quantitative and qualitative data are discussed. Chapter Four concludes with a discussion of the issues related to the trustworthiness, reliability and validity of the quantitative research and ethical considerations of this study.

Chapter Five presents the findings of the quantitative data, based on the knowledge gathered from questionnaires, including: the background information of the participants; the implementation and teachers' perceptions of dialogic teaching; the use of ICT tools; and the use of ICT to support dialogic teaching. This chapter also presents the inferential statistical analysis of the quantitative data.

Chapter Six explains the findings of the qualitative data which is based on findings drawn from semi-structured interviews. Three main themes are detailed: attitudes, implementation, and challenges.

Chapter Seven discusses the significance of the findings established by the quantitative and qualitative data analyses. In order to best address the research questions, this chapter is divided into three themes: attitudes, implementation, and challenges. Chapter Seven concludes with a discussion and comparison of findings, and a presentation of the links between this study and the existing literature.

Chapter Eight draws conclusions regarding the main findings and contributions of this thesis. It goes on to consider the implications and limitations of this study before providing suggestions for further research. Finally, Chapter Eight presents a personal reflection.

Chapter Two: Study Context

2.1. Introduction

The main aim of this study is to investigate teachers' perceptions of using ICT and dialogic teaching in primary school science classrooms in Saudi Arabia. To reinforce this aim, Chapter Two will begin by offering some background information regarding Saudi Arabia. This is followed by a description of the Saudi education system, including the various projects that have been implemented by the government. A review of education and the Saudi Arabia's Vision 2030 will then be presented. These wider contexts will provide a foundation for this study's transition to and focus on primary school science education in Saudi Arabia. This is followed by a description of the use of dialogue in the Saudi education system. Finally, a brief description of the current use of ICT in science education is presented before this chapter concludes with a summary of these sections.

2.2. Background of Saudi Arabia

The Kingdom of Saudi Arabia is a country in the Middle East, situated in the Arabian Peninsula, and was named and established in 1932 by King Abdul-Aziz Al Saud (Royal Embassy of Saudi Arabia, 2021). Saudi Arabia is divided into 13 regions; Riyadh is the capital city of Saudi Arabia, in the centre of the country. According to the General Authority of Statistics (2021), the population of Saudi Arabia is approximately 34.2 million, of which 12.5 million are non-citizens. The percentage of the population that is male is 57.48%, while the remaining 42.52% is female. Almost 40% of the total population is aged from 25 to 44 years old.

The main language of Saudi Arabia is Arabic, and the official state religion is Islam (Royal Embassy of Saudi Arabia, 2021). Saudi Arabia is often called the land of the two Holy Mosques in reference to the two Holy Mosques in Mecca and Medina (Aljabreen and Lash, 2016). The laws and principles of Saudi Arabia are based on Islam, on the Holy Quran, and on the Sunnah; the words and action of the prophet Mohammad 'peace be upon him' (Royal Embassy of Saudi Arabia, 2021). Additionally, Islamic religion and Arab culture play an important role in shaping the Saudi lifestyle, social life, traditions, and customs. Indeed, the Islam considers education to be one of the main duties for all Muslims throughout their lives. According to Alsalloom (1989, p.37):

> Islam dictates that learning is an obligation for every Muslim, man or woman. This obligation, which gives education the status of a religious duty, is the cornerstone of education in the Kingdom of Saudi Arabia. It is the foundation upon which the state builds its educational responsibilities, and in light of which, the citizen performs duties towards himself, his community, and his religion. The roots of education in Saudi Arabia therefore, go deep into the Islamic education which started in the mosque and led to the establishment of schools and universities around their pillars.

Thus, all aspects of the Saudi education system are heavily influenced by Islamic religious belief, giving education a very high status that often has a positive impact on Saudi citizens throughout their lives.

2.3. The education system in Saudi Arabia

The education system in Saudi Arabia is controlled by the Ministry of Education (MoE), which was established in 1954 with the responsibility for students' education, teacher training, and for providing all schools with educational resources (Royal Embassy of Saudi Arabia, 2021). The strategic goals of Saudi Arabia's Ministry of Education (MoE, 2021a) are as follows:

1. Promoting values and national belonging.
2. Improving learning outcomes and the global positioning of the educational system.
3. Developing the education system to meet the requirements of the labour market.
4. Developing the capabilities of the educational cadres.
5. Enhancing participation in teaching and learning.
6. Ensuring education for all and promoting lifelong learning opportunities.
7. Empowering the private and non-profit sectors and increasing their participation to improve the financial efficiency of education.
8. Raising the quality and effectiveness of scientific research and innovation.
9. Developing the university system and educational and training institutions.

The MoE authorises 42 educational departments throughout Saudi Arabia to link local schools with the Ministry, and to administer and operate education based on ministerial policies (Department of Education in Riyadh, 2021). The Department of Education in Riyadh is one such departments. The main aim of the Department of Education in Riyadh is to manage the

education process in all local regions, and to ensure the implementation of educational plans and programmes that are approved within the MoE's framework of educational goals, regulations, and policies (Department of Education in Riyadh, 2021). There are 13 educational offices linked to the Department of Education in Riyadh, which develop and evaluate the educational aims of schools (Department of Education in Riyadh, 2021). This oversight ensures the effectiveness of educational performance and assists departments in the region with the facilitation and implementation of programmes and plans.

The education system in Saudi Arabia consists of two phases: general education (government and private schools) and higher education (government and private universities and colleges) (MoE, 2021b). Government schools provide citizens and non-citizen students with free education at all levels for boys and girls in separate schools, while private schools must adhere to the MoE's policies but operate on a tuition-fee basis. The system of general education in Saudi Arabia divides the schools into four levels: children aged from 3 to 6 years can attend nursery school; from 6 years old, students begin studying at primary school for 6 grades; then three grades at intermediate school; and finally, three grades at secondary school (Alabdulaziz, 2019). Each student is required to pass examinations and assessments during the academic year that qualify them for the next grade. Failing these assessments means studying the same grade again until passing the relevant examinations.

According to the General Authority for Statistics (2021), the total number of government schools in Saudi Arabia in 2019 was 25,043, while the private schools numbered 4,331. In the same year, the number of students in general education was approximately 6.4 million. Students who study the same class do so according to the same curriculum for each subject and for every grade; this is done in congruence with textbooks in Arabic (except the subject English) which are provided by the MoE. The main aim of Saudi Arabia's national curriculum is to grasp Islam in an appropriate way; to provide students with Islamic values, expand their knowledge, and develop their skills (MoE, 2021b). According to Rugh (2002, p.43): "Islam is not only integral to Saudi education but also serves as the very essence of its Curricula". The national curricula include a variety of subjects, such as Arabic and Islam studies, history, science, mathematics, and English language. Often, each subject has its own teacher who has graduated from university to teach the subject that best suits his or her degree. For example,

a science teacher is assigned to teach a science subject in all grades; this teacher will not teach other subjects unless there is a shortage of teachers in other areas.

Students in Saudi Arabia study six lessons a day in primary school, and seven lessons a day for both intermediate and secondary school. The duration of each lesson at all levels is 45 minutes. The academic year for general education used to consisted of two semesters, with each semester consisting of 18 weeks. In 2021, the MoE changed the academic year to include three terms, with each term consisting of 13 weeks (MoE, 2021b). The educational system in Saudi Arabia is constantly changing and adapting to keep pace with national developments and technological and educational advancements around the world. The next section will discuss educational reform and initiatives in Saudi Arabia.

2.4. Educational reform in Saudi Arabia

In order to develop the education system and to address the problems and challenges that the education system may encounter, the government of Saudi Arabia started in the last two decades to reform education, implementing a number of initiatives and projects. The key projects are highlighted in the following sub-sections.

2.4.1. The King Abdullah bin Abdul-Aziz project for public education development

In 2007, the Saudi government launched a major initiative called the King Abdullah bin Abdul-Aziz public education development project (Tatweer), which cost $2.4 billion (Tayan, 2017). This project was established to implement four programmes in six years, all of which seek to develop the quality of public education:

1- Educational curriculum development programme: the aim of this programme was to provide a new national curriculum to improve students' learning, thinking skills, and independent learning.
2- Male and female teacher professional development programme: the main goal of this programme was to develop teachers' skills, enhance their teaching ability, and encourage schools to include teacher training.
3- Educational environment improvement programme: this programme aimed to provide ICT tools and materials to schools, and to support e-learning and digital models of curricula in the classroom, to increase effective teaching and learning.

4- Extracurricular activity programme: in order to benefit from students' time outside school, this programme focused on building a students' personality and improving their physical, intellectual, linguistic, and mental skills. Additionally, it involved building a spirit of positive competition in the fields of creativity and innovation (Alissa, 2009).

The expected impact of the Tatweer programmes was to improve the quality of education in Saudi Arabia, to improve teachers' and students' skills, and to prepare students for their future life. Accordingly, Quamar (2021, p.116) stated that:

> Tatweer was an ambitious project that had the potential to change the way teaching and learning activity were carried out in Saudi public schools. Its impact on the overall public education was felt significantly since the launch of the program.

However, the project faced several difficulties that negatively affected the implementation of the four programmes, such as a lack of human resources, a lack of motivation for teachers, insufficient technical resources, and the resistance of teachers to change due to their age and cultural values (Alyami, 2014). Furthermore, Quamar (2021, p.116) argued that:

> The project though had some limitations as well and fell short on many aspects for an overall improvement of the public-school education. Social sciences and languages subjects were largely ignored by the project, and no mention of the need to develop the curricula and teaching methodologies in these fields were found in the project's aims and objectives. It failed to recognize that these subjects were equally important for the overall development of students and for bringing the required change in the school environment.

Despite the difficulties and limitations of the programmes, the effect of the Tatweer project on the educational system, in general, has been positive. In the next section, the development of the mathematics and science curricula project is explored.

2.4.2. The development of the mathematics and science curricula project

To meet government aims and the objectives of the Tatweer project, the MoE launched the mathematics and science curricula project. In 2009, the Ministry implemented a new curriculum for primary, intermediate, and secondary schools (Aldahmash et al., 2019). The

project adapted a series of science and mathematics textbooks, which were produced by the American publishing company McGraw-Hill, and translated them into Arabic (Alghamdi and Alsalouli, 2013; Almazroa and Alshamrani, 2015).

The mathematics and science curricula project aimed to develop students' higher thinking skills such as inquiry-based learning, critical thinking, and problem solving and to create an environment for interaction and collaboration (Alghamdi and Alsalouli, 2013; Alkahtani, 2015). The project also employed technology to facilitate and enhance teaching and learning, aiming to improve the performance of students in science and mathematics (Alshaya and Abdulhameed, 2011; Alkahtani, 2015). In order to implement the new curriculum properly, a range of courses were provided for science and mathematics teachers, such as teaching methods, using technology, and inquiry-based learning. However, teachers tended to use traditional teaching methods to present the content (Almuntasheri, 2015). Furthermore, research has criticised the implementation of this project because of several challenges. For example: traditional teaching style remains a dominant method; there continues to be a lack of ICT tools; there is insufficient access to training courses for teachers; there are significant time constraints placed on teachers; and teachers often deal with large numbers of students in the classroom (Almazroa and Alshamrani, 2015; Albadi et al., 2019; Quamar, 2021). Curriculum development continues; the Minister of the MoE announced in May 2021 that the development of curricula for the next academic year is ongoing, in conjunction with the new three-term system as mentioned in Section 2.3. Recent developments and changes are mainly aimed at achieving the Saudi Vision 2030 for Education, which is presented in the next section.

2.5. Education and Saudi Arabia's Vision 2030

In April 2016, the Saudi government announced Saudi Arabia's Vision 2030 (Saudi Vision 2030, 2016). The main aims of the Saudi Vision 2030 are to reduce the government's dependence on oil, to create various opportunities to develop the country in all fields (Saudi Vision 2030, 2016), and "to introduce wholesome changes in the social domain" (Quamar, 2021, p.30). Education was given considerable attention as it is the main factor in developing the country "by building an education system aligned with market needs and creating economic opportunities" (Saudi Vision 2030, 2016, p.13).

Additionally, one of the main aims of developing the education system in the Vision 2030 is to develop students' characters by:

> [embedding] positive moral beliefs in our children's characters from an early age by reshaping our academic and educational system. Schools, working with families, will reinforce the fabric of society by providing students with the compassion, knowledge, and behaviours necessary for resilient and independent characters to emerge. The focus will be on the fundamental values of initiative, persistence and leadership, as well as social skills, cultural knowledge and self-awareness. We will also promote cultural, social, volunteering and athletic activities. (Saudi Vision 2030, 2016, p.28)

The Saudi Vision 2030 initiative promises to provide higher quality education for students, and to build "a centralized student database tracking students from early childhood through to K-12 and beyond into tertiary education (higher and vocational) in order to improve education planning, monitoring, evaluation, and outcomes" (Saudi Vision 2030, 2016, p.41). The Saudi Vision 2030 also intends to refine curricula and to train teachers to improve education outcomes.

To achieve the main objectives of the Saudi Vision 2030, the MoE began with the national transformation programme between 2016 and 2020 (MoE, 2021c). This programme aimed to provide education for all, to raise the quality of education outputs, to increase the effectiveness of scientific research, to encourage creativity and innovation, to develop community partnership, and to upgrade the skills and capabilities of education staff (MoE, 2021c). The programme included enhancing teachers' teaching methods, supporting the integration of technology in education, and developing the school environment for better teaching and learning.

2.6. Primary science education in Saudi Arabia

In the Saudi Arabian education system, students are required to study science subjects in all six primary grades (MoE, 2021d). At the beginning of each term, the MoE provides science textbooks for free to all students. In every grade, science textbooks are divided into units which contain biology, chemistry, physics, and geology. The new science curriculum follows a teaching approach based on the constructivist learning theory that supports a student-

centred learning approach and develop students' critical thinking and problem solving (Alghamdi and Alsalouli, 2013). The old science curriculum supported a teacher-centred approach and was considered to be "boring and monotonous, to lack information, and to focus on mathematics exercises that did not encourage student participation in experimental work" (Albadi et al., 2018, p.703).

The recent science curriculum is designed to support the Saudi Vision 2030 initiative by providing a positive social learning environment for students and by developing students' cultural and social dimensions (Alhomairi, 2018; Alghamdi, 2020). Primary science curriculum content consists of various activities designed to enable students to acquire a scientific approach in thinking, working, and developing mental and scientific skills, as well as linking knowledge with the real life of the student (Alhomairi, 2018; Alghamdi and Malekan, 2020). Accordingly, the science curriculum includes activities that support inquiry-based learning, critical thinking, reasoning, and problem solving. For instance, textbooks involve scientific activities that provide the students with opportunities to explore, compare, discuss, communicate, and explain. Therefore, it can be argued that the content of the recent curriculum requires science teachers to implement a dialogic teaching approach and expects them to move away from methods that focus on lecturing and memorisation. A description of the implementation of dialogic teaching in Saudi education is presented in the following section.

2.7. The use of dialogic teaching in Saudi education

The development of the new curricula and the improvement of teacher skills have helped to focus more attention on to the central role of the student in the learning process through joint thinking, co-construction of knowledge, and discussion. This is one of the most significant aspects of Saudi reforms to the education system. Bawazeer (2014, p.1449) argued that "the educational field could have an unrivalled position and play an essential role in increasing awareness amongst people, educating them and teaching them to be more capable in pursuing dialogue". Therefore, it is important for Saudi teachers to create an environment that supports a culture of dialogue in the classroom. As a result, the use of dialogue may support students' thinking, attract their attention, stimulate their prior knowledge, and help to consolidate new knowledge.

As described in Section 2.4.2, the primary school curriculum has changed since the MoE adapted the McGraw-Hill curriculum series in 2009, and now places greater focus on engaging students in an effective learning process. Consequently, it is hoped that students feel supported enough to listen, ask questions, discuss, and share their ideas to develop their dialogic skills. Moreover, the MoE provides courses for teachers to increase their awareness and understanding of the role of dialogue, discussion, and interaction in the classroom, such as inquiry-based learning, collaborative learning, and active learning courses (Almuntasheri, 2020; MoE, 2021d). Thus, teachers and students are encouraged to apply the dialogic teaching approach to achieve their full potential in the teaching and learning process.

However, Oyaid (2009, p.162) argued that "Saudi Arabia, like other Middle Eastern and oriental nations, gives teachers a special respectful status and the relationship between teachers and their students is a one-way relationship, in which students are lectured and instructed with little space for dialogue". According to Alfayez and Alshammari (2017, p.58), there is a "lack of educational dialogue practices, and thus a lack of opportunity for learners to express their opinions independently" in Saudi schools. Additionally, several studies have demonstrated that teachers in Saudi Arabia have failed to use dialogue in their classrooms and have, instead, adapted the traditional teaching method (Almuntasheri, 2015; Alanazi and Widin, 2018; Quamar, 2021). Research conducted in Saudi Arabia has identified several factors that hinder teachers from using dialogue in the classroom; for instance, the culture of Saudi schools which emphasizes strict respect for teachers, the limited time allotted for each lesson, the number of students in each class, and a lack of training for teachers in the use of the dialogic teaching approach (Oyaid, 2009; Almuntasheri et al., 2015; Alanazi, 2016; Alabdulkareem, 2017; Alanazi and Widin, 2018). Thus, in order to develop the culture of dialogue within Saudi schools, Alfayez and Alshammari (2017, pp.62-63) made the following recommendations:

> 1) training for teachers and school principals to strengthen their skills in creating positive dialogue in schools, 2) engage stakeholders in decision making including school principals, teachers, parents, and students, 3) sufficient budget for schools to hold dialogue activities, 4) supportive curriculum to implement educational dialogue activities, 5) sufficient school facilities including technologies that support the

dialogue activities, and 6) conduct future studies to evaluate the current state of the schools in term of using dialogue.

These recommendations are important at the present time as the MoE continues to develop the educational system and reform curricula to achieve Saudi Vision 2030 for Education. Having investigated the implementation of dialogic teaching in education in Saudi Arabia, in the following section, the use of ICT in education in Saudi Arabia is presented.

2.8. Using ICT in education in Saudi Arabia

The MoE in Saudi Arabia aims to increase the use of technology in all curricula to improve the teaching and learning process (Oyaid, 2009; Albugami, 2016; Alghamdi and Holland, 2020). To achieve this aim, a significant budget has been allocated for the provision of ICT tools and to train teachers to adopt technology-based teaching practices (Alenezi, 2019; Almarri et al., 2019). Based on this initiative, schools across the country have been provided with a variety of ICT tools, such as computers, data projectors, Interactive Whiteboards (IWB), internet access, and digital microscopes. The introduction of these technologies to Saudi schools has improved the quality of education. Furthermore, the use of ICT in classrooms has enabled teachers to improve their teaching methods and enhance students' learning. Further, the investment made to implement technology in education has encouraged students to be creative and innovative. This, in turn, develops the country as a whole in accordance with the Saudi Vision 2030.

Teachers and students can both benefit from ICT tools in classrooms, science labs, and LRCs. Saudi Arabian schools have been provided with LRCs that contain books and ICT tools for teaching and learning purposes. These centres are run by specialist staff members who help teachers and students to utilise resources and set a daily schedule for use of the centre (Alnosiaan, 2019). According to Alqahtani and Alqahtani (2020, p.150), the use of LRCs supports students' learning "through active participation, whether by speaking, listening or working in the fields that he wishes and according to his aptitude, and time [...]" and by "[providing] educational opportunities that cannot be provided by regular school environments, especially for students with special needs or advanced skills". Accordingly, teachers and students can use a variety of ICT tools, which are provided for schools in these LRCs, for different activities and purposes.

In recent years, the MoE has launched the virtual school to support the best possible use of new technology in the educational process (MoE, 2021e). The virtual school includes the iEN national education portal, iEN satellite TV channels, the iEN channel on YouTube, and Future Gate. The iEN portal offers free digital content to improve teaching and learning processes and provides reliable e-learning services to all teachers, students, principals, supervisors, and parents (iEN, 2021). The iEN portal enables users to benefit from iEN digital services, such as digital content, e-books, interactive games and activities, iEN bank tests, augmented reality, and iEN applications. Using the iEN portal, students can learn, communicate with teachers, and exchange knowledge and ideas with peers at any time. Furthermore, the iEN portal supports the teacher's creativity during lessons, acts as a channel to link students with what they have already learned, and measures and enhances their ongoing learning (iEN, 2021).

When the COVID-19 pandemic began to take hold, like all countries around the world, the Saudi government decided to set strict rules to protect citizens, which included closing schools in March 2020. This meant that face-to-face teaching and student learning in general were stopped. As a result of these restrictions, the MoE directed students to use the iEN portal and supplementary channels to support and ensure continued learning from home until the end of the academic year 2019/2020. During the school closure, the MoE created a new online virtual classroom called Madrasati, which means 'my school'. According to Alkinani and Alzahrani (2021, p.277), both teachers and students can use Madrasati "through Microsoft's Teams platform, in which the teacher interacts with his students, discusses them, answers their inquiries, assigns them the duties and electronic activities and motivates them to perform them". The Madrasati platform (2021) can be used along with the iEN portal and supplementary channels to ensure the continuation of the educational process during the pandemic.

However, even though the MoE has launched a number of programmes to facilitate the use of ICT in education, teachers still face a number of challenges that prevent them from using technology effectively. These challenges include a lack of access to ICT tools, a lack of skills or training in the use of ICT tools, and a lack of technical support (Albugami, 2016; Alkahtani, 2017; Alharthi, 2018; Alharbi, 2019). These issues must be addressed to support effective teaching and learning and to contribute to the success of the programmes launched by the MoE.

2.9. Summary

Chapter Two has provided an overview of the context of this study in terms of Saudi Arabia. The Saudi Arabian education system and Saudi educational reform projects were explained in detail, followed by a discussion of the Saudi Vision 2030. A consideration of primary school science education in Saudi Arabia and the new science curriculum was then presented. Next, Chapter Two detailed the use of dialogic teaching, including the barriers to implementation of the dialogic teaching approach and recommendations to improve the implementation of this vital approach. Finally, this chapter described the use of ICT in Saudi education, including technological initiatives such as the iEN portal and Madrasati platform. The next chapter presents a review of the literature underpinning this research.

Chapter Three: Literature Review

3.1. Introduction

Chapter Three reviews the literature related to dialogic teaching, the use of ICT and the use of ICT to support dialogic teaching in teaching and learning processes. This chapter is divided into three main sections. First, sections 3.2 to 3.7 present the theoretical framework of dialogic teaching, followed by the implementation of dialogic teaching, and the role of teachers and students in dialogic teaching, the use of dialogic teaching in science lessons, the framework of communicative approaches and the challenges of dialogic teaching. Second, sections 3.8 to 3.11 discuss the definitions of ICT, followed using ICT in teaching science and the challenges of using ICT, with a focus on Saudi Arabia, followed by the technology theories. Third, sections 3.12 to 3.13 consider the use of ICT to support dialogic teaching, followed by the literature regarding the use of ICT to support dialogic teaching in science lessons. These sections are then followed by a summary of Chapter Three in section 3.14.

3.2. The theoretical framework of dialogic teaching

The theoretical framework for dialogic teaching was initially introduced by Alexander (2004), who focused on the characteristics of the interaction between teachers and students within the context of dialogic teaching in the classroom. Alexander's (2004) framework of dialogic teaching is mostly influenced by works of Vygotsky (1962, 1978), Bakhtin (1981, 1986), and Bruner (1983, 1996). From the perspectives of Vygotsky, Bakhtin, and Bruner, language is viewed as an important cultural tool for mediating social interaction, thinking, and understanding. Furthermore, Alexander (2004, p.9) considered talk an essential tool of effective teaching and "arguably the true foundation of the learning". Therefore, the spoken language is a significant tool to promote the dialogic teaching approach within the classroom.

The term 'dialogic' has been linked with several approaches to classroom dialogue, including inquiry, exploratory talk, questioning and argumentation (Chin, 2006; Kerawalla, 2015; Lehesvuori et al., 2017; Gillies, 2020). Furthermore, Alexander (2020, p.37) stated that "as interactive form, with function implicit, dialogue may be defined as: conversation, discussion, deliberation [and] argumentation". Additionally, Lyle (2008) argued that dialogic teaching is the opposite of monologic talk, where the teacher acts as a transmitter and dominates the

classroom talk. Conversely, Alexander (2017, p.37) defined dialogic teaching as harnessing "the power of talk to engage children, stimulate and extend their thinking, and advance their learning and understanding". In this respect, the dialogic teaching approach involves students' interaction, participation, and exchange of ideas to engage in the learning process within a positive and interactive learning environment. Accordingly, Mercer et al. (2009, p.354) stated that dialogic teaching "involves raising pupils' awareness of the potential educational power of talk so that they develop a meta-awareness of the use of talk for learning". Furthermore, Scott et al. (2006) suggested that dialogic teaching can be implemented through collaboration, mutual support, and the interactions between teachers and students. It is, therefore, important to consider the quality of classroom talk when supporting students' learning and developing their understanding.

In this study, Alexander's theoretical framework of dialogic teaching was applied to explore teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia.

3.3. The implementation of dialogic teaching

The process of implementing dialogic teaching appears to be more complex than solely understanding its features (Bignell, 2012). Accordingly, Alexander (2017, p.38) reported five fundamental features of dialogic teaching:

- Collective: teachers and children address learning tasks together, whether as a group or as a class, rather than in isolation.
- Reciprocal: teachers and children listen to each other, share ideas, and consider alternative viewpoints.
- Supportive: children articulate their ideas freely, without fear of embarrassment over 'wrong' answers; and they help each other to reach common understanding.
- Cumulative: teachers and children build on their own and each other's ideas and chain them into coherent lines of thinking and enquiry.
- Purposeful: teachers plan and steer classroom talk with specific educational goals in view.

Adopting these five principles, Alexander claimed, will enable teachers to implement dialogic teaching effectively. In this respect, Alexander (2017, p.30) reported that, in order to implement dialogic teaching and meet its criteria, teachers are required to use two elements:

- Discussion: (teacher-class, teacher-group, or pupil-pupil): the exchange of ideas with a view to sharing information and solving problems.
- Dialogue (teacher-class, teacher-group, teacher-individual, or pupil- pupil): achieving common understanding through structured, cumulative questioning and discussion which guide and prompt, reduce choices, minimise risk and error, and expedite 'handover' of concepts and principles.

Furthermore, Alexander (2017) suggested five strategies to organise students' interactions within the classroom: whole class teaching; teacher-led group work; student-led group work; teacher-student interaction; and student-student interaction. These strategies may help teachers to plan the classroom dialogue and to form the interactive contexts.

The implementation of dialogic teaching within the classroom has multiple purposes for teachers and students. In this regard, Flitton and Warwick (2013, p.101) stated that "a dialogic stance aims to foster learner agency, whereby students collaborate with others in seeking understanding, building from their own ideas and allowing other ideas and opinions to mediate and modify their thinking". Furthermore, Scott et al. (2006) argued that the fundamental purpose of using dialogue is to promote meaningful learning among students. Accordingly, Mercer and Littleton (2007) claimed that teachers who use dialogue with their students regularly achieve the best learning outcomes; use of dialogue supports teachers to direct students' activities; control their engagement and develop their understandings.

Moreover, Alexander (2017) suggested that the process of shifting towards a dialogic teaching approach requires changing teachers' attitudes and understanding of social relations rather than simply changing their behaviour. Alexander (2004, p.88) assumed that teachers may not be expected to "change teaching without attending to the values underpinning the practice we seek to reform". Thus, teachers may need to both change their behaviour and the way in which they view relationships to implement dialogic teaching effectively within the classroom.

Alexander (2017) noted that the use of traditional teaching methods, through whole class teaching, is the most common teaching style around the world. In traditional teaching methods, the teacher tends to dominate the classroom and deliver instruction to students. Furthermore, the teacher may rely more on the use of traditional teaching resources, such as textbooks and white/blackboards, to help deliver the lesson to students. As a result, students may passively receive information and knowledge without being directly engaged in the learning process. To address this issue, teachers can provide opportunities to students to discuss and share ideas and thinking together, rather than dominating classroom teaching and controlling the learning process (Cornelius and Herrenkohl, 2004). Therefore, Alexander (2017, p.39) asserted that the use of dialogue "is needed in order that schools may meet the diverse objectives of a broad curriculum, and so that children may be empowered both in their learning now and later as adult member of society". Thus, it is important for teachers to consider the importance and purposes of dialogic teaching to achieve teaching and learning objectives. This can be also accomplished by recognising the teacher's and student's role in dialogic teaching; such role recognition is discussed in the following section.

3.4. The role of the teacher and students in the dialogue

Teachers and students play a critical role in promoting dialogue in the teaching and learning process (Kim and Wilkinson, 2019; Gillies, 2020). The main role of the teacher in dialogic teaching is to be a manager, a facilitator, and to provide opportunities for students to interact, engage, and contribute to the dialogue and discussion (Wells and Arauz, 2006; Sedova et al., 2016; Webb and Ing, 2019). The teacher creates a safe class environment for meaningful learning that encourages students' interaction and collaborative reasoning (Lehesvuori et al., 2018; Knight, 2020). Attracting students' attention is also considered one of the important roles of the teacher in educational dialogue (Muhonen et al., 2017). In this respect, Mercer and Littleton (2007, p.74) stated that the role of the teacher is:

> not simply as an 'instructor' or the 'facilitator' of the learning of [students], but rather as someone who can use dialogue to orchestrate and foster the development of a community of enquiry in a classroom in which individual students can take a shared, active and reflective role in building their own understanding.

Additionally, Alexander (2008, p.11) claimed that dialogic teaching requires teachers to support students' voices and develop a classroom culture of enquiry, because "pedagogy and culture are inextricably linked". Therefore, through dialogue, students are empowered to be an integral part of effective learning. Further, Lyle (2008) emphasized that "the role of dialogue in pupil learning is therefore about more than just promoting better thinking and raised standards. It has the potential to enable student voice to be accessed and legitimated". Therefore, the teacher's actions during dialogue and discussion can shape the quality of dialogic teaching. The success of the dialogue may depend on the teacher's role in encouraging students' voices and supporting each student's role in the classroom dialogue.

Students play a vital role in dialogic teaching because they are the focus of the educational process (Mercer and Littleton, 2007). According to Lyle (2008, p.229), the classroom dialogue enables students "to play an active role in developing a personally constructed understanding of the curriculum through dialogic interchange". Additionally, students help each other to learn, participate to reach common understanding, and then express thoughts freely without any fears (Alexander, 2017).

Moreover, students can challenge each other's ideas and collaborate with others to solve problems and co-create knowledge (Scott et al., 2006; Gillies, 2020). A major role can be played by students during dialogue; student discussion is the sharing of prior knowledge and experience (Mercer and Littleton, 2007). Furthermore, as argued by Alexander (2017), students are required to respect each other and listen carefully when they interact with their peers. It may be important for students to both ask questions and respond to the teacher's or peers' questions to allow the dialogue to continue (Mercer et al., 2009; Alexander, 2017).

Having discussed the definition of dialogic teaching, the implementation of dialogic teaching and the roles of the teacher and students during dialogue and discussion, in the following section the implementation of dialogic teaching in science classrooms is presented.

3.5. Dialogic teaching in science classrooms

The importance of using the dialogic teaching approach when teaching science as a social process has been widely acknowledged (Scott et al., 2006; Scott and Ametller, 2007; Mercer et al., 2009; Gillies, 2020). Using Alexander's theory of dialogic teaching and its principles,

research was conducted across different settings and contexts including science. Accordingly, it was established that meaningful learning in the science classroom involves teachers creating spaces for dialogic discussion during lessons (Scott and Ametller, 2007). Previous studies on the use of dialogue when teaching science indicated that, in general, teachers in developed nations have positive attitudes towards using dialogic teaching in science lessons (Mercer et al., 2009; Lehesvuori et al., 2011; Tytler and Aranda, 2015).

Prior studies have demonstrated several advantages to using dialogic teaching in science lessons. Scott et al. (2006), for instance, carried out a study in a Brazilian high school science classroom to investigate the movement between the different communicative approaches; a detailed examination of these approaches is presented in Section 3.6. Scott et al. found that using different types of the classroom talk in science lessons promotes a useful and complementary way of thinking which supports meaningful learning and promotes students' productive engagement.

Another study, conducted by Mercer et al. (2009) in England, aimed to describe the dialogue between teachers and students within primary school science classrooms using observations of two science teachers. They found that the use of dialogic teaching in science lessons enabled students to engage and interact with others to build scientific knowledge and develop their thinking skills. The results also emphasized the importance of science teachers not only to help students understand science, but also to ensure that they themselves know the dialogic processes that are applied in science teaching and learning practices.

A recent study conducted by Gillies (2020) investigated how primary teachers implemented inquiry-based science in the Australian curriculum using a case study. Their findings indicated that students engaged effectively with others, expressed their opinions, and justified their ideas. Moreover, the findings also showed that the use of dialogic teaching during co-operative, inquiry-based science attracted students' attention and challenged their thinking.

Furthermore, it has been determined that the use of dialogic teaching in science activities develops students' identities as learners of science and increases their confidence in participating and contributing during dialogue and discussion (Kerawalla, 2015; Gillies, 2016; Kumpulainen and Rajala, 2017; Lehesvuori et al., 2017). Additionally, the role of the science teacher in establishing a positive and respectful classroom environment is important because

it provides opportunities for students to build a knowledge of scientific concepts (Gillies, 2016; Kumpulainen and Rajala, 2017).

Bansal (2018) used observations and interviews to investigate the efforts of two Indian teachers to implement dialogic teaching in their secondary science classes. Bansal's study indicated that the teachers used a schema characterising dialogic discourse which included three components: foundation, initiation, and perpetuation. It was also determined that students did not engage in talk themselves during science lessons until their teachers provided opportunities to participate; this may be due to the culture of Indian classrooms. Bansal noted that the culture of talk in the classroom supports students' receptivity, reciprocity, openness, and respect for others. However, the researcher stated that just initiating talk is not enough to achieve the advantages of dialogic teaching; it is vital that efforts are made to sustain these interactions within the classroom.

However, research has been conducted to investigate the effect of dialogic teaching on the classroom in other subjects, such as mathematics (Bakker et al., 2015; Lugalia et al., 2015; Hofmann and Ruthven, 2018), English (Skuse, 2017; Alanazi and Widin, 2018), history (Deaney, et al., 2009), and learning the English language (Bahmani and Biria, 2016). These studies referred to the advantages of applying dialogic teaching to the classroom: when done well, it supports students' critical thinking and problem solving; it facilitates students' understanding of concepts; it enables teachers and students to co-construct meaning and build knowledge; and it assists in the development of social interaction in the classroom.

Even though all of these studies were conducted at different school levels and in different cultural contexts, it is clear that implementing dialogic teaching in science lessons would both support students' learning and facilitates the development of skills and characteristics to support students in the future. Additionally, there is a distinct lack of studies related to the implementation of dialogic teaching within the science classroom context of Saudi Arabia. Thus, one of the main objectives of this study is to explore the extent of implementation of dialogic teaching in primary science classrooms in Saudi Arabia.

3.6. A framework of the communicative approaches in science classrooms

To provide a method of effective classroom interaction, Mortimer and Scott (2003) developed an analytical framework describing the structure of interaction between teachers and students, and the way in which ideas are developed in science classrooms. Mortimer and Scott's (2003) framework is consistent with the theoretical approach to dialogic teaching developed by Alexander (2004). The communicative approach describes classroom discourse comprising four categories created from a combination of the following two dimensions: authoritative/dialogic and interactive/non-interactive. These categories have been outlined in Table 3.1. The categories were described by Mortimer and Scott (2003, p.39) as follows:

- Interactive/dialogic: the teacher and students explore ideas, generate new meanings, pose genuine questions, and offer, listen to, and work from different points of view.
- Non-interactive/dialogic: the teacher considers various points of view, thereby setting out, exploring, and working on the different perspectives.
- Interactive/authoritative: the teacher leads students through a sequence of questions and answers with the aim of reaching one specific point of view.
- Non-interactive/authoritative: the teacher presents one specific point of view.

Table 3. 1: Categories of communicative approach (Mortimer and Scott, 2003, p.35)

	Interactive	**Non-interactive**
Dialogic	**A** Interactive/dialogic	**B** Non-Interactive/dialogic
Authoritative	**C** Interactive/authoritative	**D** Non-interactive/ authoritative

Mortimer and Scott (2003) found that varying communicative approaches proved beneficial to support teachers' teaching practices in the classroom. Teachers were able to work with their students in various ways to develop ideas and support productive interaction in the science classroom. A firm understanding of the different categories of the communicative approach could, therefore, provide a vital contribution to science classroom interaction and improve the quality of the teaching and learning process overall. However, there are some

challenges that may influence the successful implementation of dialogic teaching in the classroom; these challenges are explored in the next section.

3.7. Challenges of dialogic teaching

Despite the advantages that dialogic teaching presents, the process of implementing a productive dialogic teaching approach is not an easy task; it requires more than simply understanding its benefits and how it should be applied. Indeed, the successful implementation of dialogic teaching may be inhibited due to several social, cultural, and pedagogical factors. This study will consider the major challenges related to the teacher, the students, the science curriculum, the lack of time, and the number of students.

The most significant potential challenges inhibiting the successful implementation of a dialogic teaching approach are the teacher's content knowledge and their understanding of how to implement dialogic teaching effectively (Lehesvuori et al., 2011; Alfayez and Alshammari, 2017; Ruthven et al., 2017; Hajar and Hendayana, 2019). Scott and Ametller (2007, p.6) stated that:

> One reason concerns the kind of knowledge that the teacher needs to engage in dialogic approaches with pupils. Here, it is not just a question of knowing and understanding some science, but the teacher also needs to have insights into the kinds of everyday ways of talking that pupils are likely to bring to their lesson and, crucially, to know how to respond to those everyday ideas.

Therefore, it is important for teachers to have effective techniques with which to engage students in classroom dialogue and interact with them individually. This may require significant skill to avoid a breakdown of the dialogue between teacher and student. Accordingly, Scott and Ametller (2007, p.6) argued that:

> the teacher may engage pupils in lots of turn-taking which is authoritative in nature as the teacher focuses attention on the scientific point of view, ignoring contributions from pupils that are not consistent with that view. This is not dialogic interaction.

Alexander (2017, p.27) emphasized that dialogic teaching "works only if the classroom culture [moves] beyond that one-sided transmissive relationship in which the stock techniques of recitation teaching are traditionally embedded". Thus, engaging with students, and paying

more attention to students' contributions, can create a positive climate for an effective dialogic teaching approach.

In Saudi Arabia, Almuntasheri et al. (2016) conducted a study with six teachers to compare a dialogic inquiry-based teachers' professional development programme with a current teacher-directed approach. The researchers found that there is a distinct lack of dialogic inquiry strategies among teachers. The study also confirmed the necessity to engage with students as the inquiry-based learning context demands, instead of maintaining an authority-based classroom.

Another study, conducted by Alanazi (2016), employed an evaluative case study approach, and interviewed three mathematics teachers. The purpose of this investigation was to develop Saudi mathematics teachers' understanding of the dialogic approach. The researcher determined that a traditional pedagogic culture of teachers and their resistance to change formed the main barriers to applying the dialogic approach. Such barriers often result in a tendency for students to remain in a passive, non-interactive role and lack skills in classroom dialogue.

The evidence, therefore, clearly indicated that there is a need to train teachers to strengthen their dialogue skills to create an appropriate environment of dialogue in the classroom. In this respect, a recent study was conducted by Almuntasheri (2020) using observations to examine the impact of a professional development programme on two Saudi science teachers' implementations of dialogic inquiry. The researcher concluded that the science teachers' practices of dialogic teaching were developed after attending the professional development programme. Hence, training is essential to improve teachers' knowledge of how to employ an effective dialogic approach in the teaching and learning process.

Further challenges that may prevent teachers from employing dialogic teaching are related to students' discipline and behaviour. Lehesvuori et al. (2011) referred to disciplinary problems as one of the main issues that concern teachers during use of the dialogic approach. Furthermore, Ucak and Bag (2018) reported that issues regarding students' discipline, such as disrespecting others' opinions and interrupting others, make the dialogic approach difficult to use, particularly with a crowded classroom. This crowding can also prevent some students from participating.

Another major factor that may hinder teachers from implementing dialogic teaching is the limitation of time. Research has indicated that the implementation of dialogic teaching consumes a significant amount of time because the teacher and students need a sufficient period to discuss and listen to each other's opinions through several activities to achieve the objectives of the lesson (Chin, 2006; Scott et al., 2006; Scott and Ametller, 2007; Lehesvuori et al., 2011; Bansal, 2018; Ucak and Bag, 2018).

Additionally, an over-crowded curriculum is considered another fundamental challenge that prevents teachers from implementing dialogic teaching (Chin, 2006; Lefstein, 2010; Sedova et al., 2014; Bansal, 2018). This issue is linked with the question of limited time in that teachers may find it challenging to cover the national curriculum, particularly with the science curriculum (Scott et al., 2003; Chin, 2006; Bansal, 2018). Furthermore, teachers may be under accountability pressures to cover the full content of the curriculum (Chin, 2006; Bansal, 2018). Accordingly, Scott and Ametller (2007, p.6) suggested that, in order to address the issue of limited available time in which to cover the curriculum using a dialogic approach, teachers could "identify those parts of the curriculum where dialogic discourse will be important, simply because there are big conceptual gaps between everyday and scientific points of view".

In the Saudi Arabian context, the time allocated for each lesson is limited; a lesson is approximately 45 minutes. Teachers are, therefore, often prevented from adopting questioning and inquiry strategies in science lessons (Almuntasheri, 2015; Alabdulkareem, 2017). As a result, it may be difficult to involve all students in an exchange and discussion of ideas in the limited time. Thus, the role of the teacher can shift to using direct instruction, lecturing students rather than using dialogic teaching.

Moreover, the number of students in each class can be a barrier to the implementation of dialogic teaching. With a large number of students, science teachers can find it difficult to provide opportunities for every student to participate (Chin, 2006; Alabdulkareem, 2017; Bansal, 2018; Ucak and Bag, 2018). To solve this issue, Lefstein (2010) has proposed that, with a class size of 30-40 students, it is difficult to create a space within which each student can actively contribute to the dialogue. However, it is possible for a few students from a large group to become involved on behalf of the majority; while some students are involved with the dialogue, the other students participate as the audience.

Having discussed the dialogic teaching approach, the following sections present the use of ICT tools in teaching and learning processes.

3.8. Information and communication technology

The term information and communication technology (ICT) has been given various definitions within the literature. As a result of different uses and purposes around the world, and the fast development of technology, there is a lack of a clear and universal definition of the ICT (Apulu and Latham, 2011; Zuppo, 2012). Moreover, Almaghlouth (2008) and Albugami (2016) have argued that, because ICT is used in many different fields and sectors, such as education, healthcare, and business, the term of ICT can often be defined by its field of use.

Furthermore, Gholami (2005) stated that the term ICT combines two different concepts: information technology (IT) and communication technology (CT). Therefore, the term ICT arises from the integration of these two concepts. Gholami (2005, p.5) stated that:

> information technology (IT) is the term used to describe the equipment and software elements that allow us to access, retrieve, store, organize, manipulate and present information by electronic means. Communication technology (CT) is the term used to describe equipment, infrastructure, and software through which information can be received and accessed, for example phones, faxes, modems, digital networks, and DSL lines.

According to Blurton (1999, p.46), ICT can be defined as a "diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information". Some simple examples include computers, the internet, telephones, and televisions. Therefore, the term ICT includes both hardware and software tools used in different fields and for different purposes.

In education, ICT can be used by teachers and students for the teaching and learning process. Mumtaz (2000) argued that ICT tools can be used to manage information and encourage communication for educational purposes. Furthermore, Alharbi (2014) stated that ICT in education refers to the tools that can be used to communicate, send, and collect information, including software applications, internet access, and devices such as computers and tablets.

In this study, the term ICT is used to refer to the hardware and software used by primary science teachers in their classrooms for the purposes of teaching and learning.

3.9. Using ICT in teaching science

The use of ICT can play a vital role in teaching science (Suduc et al., 2011). Meadows (2012, p.83) argued that "science teaching is supposed to use everyday contexts so that children can see the connection between science at school and their own lives". The main purpose of science teaching is to prepare young students for their life by developing their independent learning and critical thinking; such development can be supported by using technology (Kang, 2008). Warwick et al. (2006, p.14) identified three central aims of primary science: "to develop scientific process skills, to foster the acquisition of concepts and to develop particular attitudes". These aims can be achieved by using ICT to support learning and teaching science activities.

According to Salihi (2015, p.2), the use of ICT in science classrooms "can make the teaching and learning of science more interesting, versatile and goal-oriented. It can motivate and activate students and promote co-operation". In the same vein, Meadows (2012) stated that using ICT in science lessons makes the learning and teaching process more fun and enjoyable for students because ICT offers certain tools and contexts that may not be provided in other subjects and resources such as books. As a result, teachers can avoid resorting to a traditional routine in science lessons and, instead, create an active science classroom by using technology in their teaching practices.

Additionally, Hopkins (2014) argued that science teachers could use technology to present scientific information, simulations and virtual experiments. According to Byrne and Sharp (2002, p.3), the use of ICT within primary science lessons provides opportunities to:

- Model some of the ways in which scientists work.
- Provide access to rich and varied source materials.
- Speed up processes that would normally take time.
- Allow safe access to difficult, costly, or hazardous activities.

Although science is often practical and, as a result, teachers may need time for scientific experiments, ICT can be used to present experiments, virtual measurements, record scientific

results, communicate, and research within a limited time (Wellington and Ireson, 2012). Moreover, the use of ICT provides major features that help science teachers to plan science lessons and design learning activities appropriately (Warwick et al., 2006).

Several studies have been conducted on the topic of using ICT tools in teaching and learning science within different contexts around the world. For instance, Williams et al. (2017) undertook a study in a New Zealand high school using surveys, observations, and interviews to explore how technology supported science inquiry. They determined that using technology helps students to learn and understand science content, such as seasons, moon phases, and planets. Although students enjoyed using ICT tools in science learning, technical issues occurred while using technology.

Another study was carried out by Maharaj-Sharma and Sharma (2017) in Trinidad and Tobago with 30 secondary school science teachers using questionnaires and observation methods. The aim of the study was to examine the perspective of teachers and students on the effect of using ICT-based instructional technologies in teaching science lessons. The results showed that teachers use a variety of ICT tools when teaching science which facilitated learning in a meaningful way and attracted students' attention. However, Maharaj-Sharma and Sharma found that all teachers used the whiteboard in science teaching because of a combination of the challenges faced while using ICT and their own learning experiences using traditional teaching methods.

In the Saudi context, Bingimlas (2013) applied mixed methods research to understand the ICT-supported environments of learning and teaching science. This study indicated that teachers use ICT in various ways while teaching science. However, using ICT tools in an effective way was limited because teachers appeared to use technology only to transmit knowledge and the students, therefore, seemed to be in a passive role. Despite this limitation, Bingimlas determined that the use of ICT can increase students' engagement by offering interesting activities that encourage students to explore scientific concepts and phenomena.

A more recent study was undertaken in Saudi Arabia by Alharthi (2018) which used questionnaires and interviews to assess the integration of ICT into science education in primary schools. The results indicated that using ICT when teaching science is found to be interesting and enjoyable. Further, the teachers found it easier and faster to teach when using

ICT in the teaching process or to prepare the science lessons in advance. Additionally, Alharthi asserted that integrating ICT into science education enhances student understanding, stimulates students' interest, and motivates students to learn independently. However, the results of Alharthi's study showed that the use of the iEN portal was low among primary science teachers in Saudi Arabia.

Conversely, Bitter and Legacy (2008) argued that using ICT in the teaching and learning process has a negative impact on student outcomes. Additionally, using ICT may increase a primary school's budget due to the expense. This can create a difference between schools in providing ICT tools based on available resources. Moreover, an ethical issue may be raised related to searching for inappropriate or unauthorised information by young students, such as unsuitable pictures or texts. There are also common barriers hindering the use of ICT in education, particularly in primary science schools, that are discussed in the following section.

3.10. Challenges of using ICT

While the use of ICT may create a positive environment in teaching and learning science, various challenges could hinder the using of ICT in education. Within the literature, researchers classified the challenges of using ICT into several categories, including external and internal challenges (Bingimlas, 2009; Younie and Leask, 2013). External challenges are related to factors outside the school, while internal challenges are related to issues within the school (Alharbi, 2019). These challenges may be linked to or influenced by other challenges. In this study, some of the external and internal challenges are explained in detail.

3.10.1. External challenges

In this section, three external challenges are explained in detail: lack of ICT resources; lack of effective training; and lack of technical support**.**

3.10.1.1. Lack of ICT resources

The unavailability of ICT tools has been identified as a major challenge that prevents teachers from using technology in the education process (Alhawiti, 2013; Almulhim, 2014). Research has suggested that a lack of ICT tools in schools directly influences teachers' classroom practice (Goktas et al., 2013; Albugami, 2016; Villalba et al., 2017; Lawrence and Tar, 2018).

Similarly, Becta (2004, p.11) historically reported that "the lack of good ICT resources in a school will not only prevent teachers from making good use of ICT in their teaching, but it is also likely to have a detrimental effect on pupils' achievement". Alkahtani (2017) has identified that insufficient ICT resources is the greatest barrier to teachers using technology effectively.

From the last decade, several studies conducted in Saudi Arabia have asserted that a lack of ICT tools is one of the critical challenges facing Saudi teachers, particularly in science education. For instance, Alsulaimani (2010) undertook a study on the integration of ICT in the science curriculum of intermediate schools. The findings indicated that inadequate ICT resources in classrooms and science laboratories was one of the major impediments to the integration of ICT into the science curriculum. Bingimlas (2013) also investigated the barriers to the integration of technology in science education and identified a lack of ICT access as one of the primary obstacles. Moreover, Alharthi (2018) evaluated the integration of ICT in teaching and learning science in primary schools in Riyadh and found that a lack of access to technology affected the success of ICT integration in science classrooms.

Other recent Saudi studies performed at different school levels and in different subjects have indicated that a lack of ICT resources and a shortage of facilities are the most significant challenges currently experienced by Saudi teachers (Alkahtani, 2017; Algharbi, 2019; Alharbi and Alotebi, 2019; Almaini, 2020). Furthermore, the literature review referred to the lack of accessibility and availability of ICT in different countries around the world as one of the major barriers to the use of ICT in education (Ahmad, 2014; Williams et al., 2017; Lawrence and Tar, 2018; Obaydullah and Rahim, 2019).

3.10.1.2. Lack of effective training

Insufficient teacher training in the use of ICT was identified as a major factor influencing teachers' ability to fully benefit from technology in education (Bingimlas, 2009; Albugami and Ahmed, 2015; Salinas et al., 2017; Lawrence and Tar, 2018). Although the lack of training is an external challenge, it may exert an internal influence on teachers' confidence and skills (Almofarreh, 2016). According to the historic Becta report (2004, p.10):

> The issue of training teachers in how to use ICT to effectively manage children's learning, both during the lesson and also in the preparation of lessons before hand

(pedagogical training), rather than simply training them in the skills of using ICT equipment, is an important one.

Younie and Leask (2013, p.95) argued that "it is not enough to know about a range of technologies, in and for themselves. What teachers need to understand is how these technologies interact with and provide opportunities for learning". Nevertheless, a lack of ICT skills may still prevent teachers from using technology in the classroom altogether. According to Alshmrany and Wilkinson (2017) and Hismanoglu (2012), a lack of teacher training in the use of ICT tools may lead to a lack of confidence in using ICT during teaching and learning processes. This, in turn, could make using ICT in teaching processes much more difficult to implement. Furthermore, such a lack of teacher training may ultimately lead to a general lack of ICT skills, even if a school can provide ample ICT resources.

In the Saudi context, many studies, which have been conducted to examine teachers' use of ICT in the classroom, showed that there is inadequate ICT training. For example, Almulhim's (2014) study found a lack of effective in-service training, particularly in primary school teachers, due to a lack of professional development from the MoE. Alenezi (2015) carried out a study to evaluate the factors that help teachers to use ICT in secondary schools. The study argued that there is a need for effective training to support teachers' ICT use. However, Alnosiaan (2019) indicated that teachers' lack of ICT skills is due to their unwillingness to leave their school, which can affect their teaching plan, to attend training courses that usually focus on the theory of ICT use without practical experience.

Regarding training science teachers, Ahmad (2014, p.7) argued that:

> Science teachers' needs for training in ICT use may differ from those of other teachers. For example, science teachers may benefit more from skills in using screencasts, simulation and spreadsheet than other ICT applications such as database, programming or word processing.

It is, therefore, vital that new science teachers are trained to improve their pedagogical skills rather than simply training them with basic ICT skills to successfully use technology in science lessons (Dawson et al., 2006).

3.10.1.3. Lack of technical support

One of the most significant external factors concerning teachers is the poor quality of technical support and maintenance, which may impede teachers in the use of ICT tools provided by schools (Becta, 2004; Alenezi, 2015). Both Albugami (2016) and Lawrence and Tar (2018) have indicated that the successful use of ICT in classrooms requires sufficient technical support and maintenance. The availability of technical support is essential to repair damaged devices for continued use in the teaching process.

Furthermore, a lack of technical staff may be a contributing factor to poor technical support; this can result in a longer amount of time needed for the implementation of technical solutions and repairs to broken devices (Albugami, 2016; Alharbi 2019). Additionally, Lawrence and Tar (2018, p.100) stated that "if there is a lack of technical support available in a school, then it is likely that technical maintenance will not be carried out regularly, resulting in a higher risk of technical breakdowns". Therefore, teachers may stop using ICT tools due to poor maintenance and subsequent device failure.

Alharthi (2018) asserted that a lack of technical support was the most common issue preventing Saudi primary school science teachers from effectively using ICT in science lessons. Similar results were delineated in Alsulaimani's (2010) study; a lack of technical support and maintenance constrained science teachers from using ICT to present science content. Thus, training teachers how to fix small problems, and increasing the number of technical support workers, may help to maintain the use of technology in education.

3.10.2. Internal challenges

In this section, three internal challenges are explained in detail: factors related to the school; factors related to the teacher; and factors related to the student.

3.10.2.1. Factors related to the school

Designing the school building can be an important factor when accommodating ICT tools to ensure easy access to resources and successful use. Engels et al. (2004, p.138) claimed that:

> What should be noted is the low scores for 'infrastructure and facilities' at school […] If the buildings are in a poor state of repair, are not properly maintained and classrooms poorly laid out, this is closely connected with a negative view.

Therefore, providing an appropriate environment, including a well-designed school building that can accommodate a good ICT infrastructure, supports teachers in their tasks and helps students to learn (Albugami, 2016). Additionally, an adequate school building may facilitate and encourage teachers' ICT application in the classroom (Albugami and Ahmed, 2015). However, inappropriate school buildings are usually associated with a lack of ICT resources, unlike modern buildings which are adequately equipped and provide science teachers with laboratories (Alsulaimani, 2010).

In the Saudi educational system, there are two types of school building: rented schools, which are built for residential use, and government-owned schools, which are built for educational purposes (Alsulaimani, 2010; Zalah, 2018). A study undertaken by Albugami (2016) in Saudi secondary schools found that most of the school buildings are unsuited to accommodating and storing ICT tools. This is often due to the small capacity and size of classrooms and a lack of rooms to store ICT equipment in old and rented school buildings. A recent study conducted by Zalah (2018) to evaluate the use of E-learning technology by Saudi secondary teachers showed that the provision of ICT tools in rented schools is poor. This often results in some teachers bringing their own ICT tools, while government schools are provided with technology.

3.10.2.2. Factors related to the teacher

The teacher can hinder the application of technology in the teaching process because of negative attitudes, a lack of skills, and a lack of confidence. Teachers' attitudes towards ICT are important factors related to the successful use of ICT (Alharthi, 2018; Alnosiaan, 2019). Lawrence and Tar (2018, p.93) defined attitudes towards ICT as "the teachers' general feeling of favourable or unfavourable for the use of ICT in teaching and learning process". Thus, attitudes towards ICT may encourage or discourage teachers from using technology within the classroom, which render teachers themselves a barrier or motivator to the use of technology. For example, teachers may have a negative attitude towards ICT as it unfamiliar

to them. Therefore, they may prefer not to change their traditional teaching style (Oyaid, 2009).

Recent studies conducted in Saudi Arabia asserted that teachers' effective use of ICT is associated with positive attitudes and beliefs regarding using educational technology in classroom activities (Alenezi, 2019; Almarri et al., 2019; Alnosiaan, 2019). However, Zalah (2018) concluded that teachers may have negative attitudes towards ICT due to a lack of ICT training and skills. Alharbi (2019) identified a cultural issue related to teachers; most hardware devices and software packages are written or described in terms of English language, which may hinder teachers as they do not speak English.

A lack of teachers' ICT skills can prevent teachers from using technology in the classroom. A deficiency in teacher competence is considered one of the main barriers to the successful use of ICT in education (Becta, 2004; Dawson et al., 2006; Bingimlas, 2009). As discussed in earlier, a lack of teacher training in the use of educational technology may lead to inadequate technical skills. Teachers with good ICT skills can use technology for different educational purposes, such as preparing lessons in advance and integrating ICT into the curriculum to achieve learning objectives.

Oyaid (2009, p.11) stated some time ago that "Saudi teachers' lack of training in ICT skills and low awareness of their advantages in their teaching practice are also likely to hinder the successful introduction of educational innovations". Accordingly, Alsulaimani (2010) found that even a decade ago many Saudi science teachers have only basic technical skills due to a lack of ICT training courses.

Another study conducted by Almalki (2017), which compared Saudi and Australian teachers in the use of ICT in primary schools, found that Australian teachers had more sufficient ICT capabilities and were more skilled in ICT than Saudi teachers. Moreover, although Zalah (2018) reported Saudi teachers' level of ICT skill between advanced, intermediate, and beginner, many teachers commented that they needed more technical ability to easily operate modern ICT tools. It is vital for teachers to know how ICT can be used to support learning.

A lack ICT skills creates a lack of confidence and anxiety among teachers which, in turn, prevents them from using technologies in the classroom (Becta, 2004; Ahmad, 2014; Almalki,

2017). Teachers' confidence in using ICT may support their beliefs in the importance of integrating ICT into the education process, and increase its use in the future (Bingimlas, 2009; Albugami, 2016). In support of this, Zalah (2018, p.82) claimed that:

> The competence of teachers is directly connected to their confidence to utilize technological devices in the classroom and especially to the perceived competence of their students; and is considered one of the most important factors that aid in the development of higher confidence in the use of [ICT].

Alsulaimani (2010) argued that increasing ICT skills among science teachers leads to an increase in their confidence in using ICT tools in the classroom. Further, Maharaj-Sharma and Sharma (2017) argued that a lack of ICT skills and confidence forces teachers to use traditional teaching methods. Several Saudi studies have asserted that some teachers tend not to use technology due to the lack of ICT skills to avoid making mistakes and failing in front of their students (Albugame, 2016; Zalah, 2018; Alharbi, 2019). According to the Becta report (2004, p.29), "many teachers who do not consider themselves to be well skilled in using ICT feel anxious about using it in front of a class of children who perhaps know more than they do". Thus, providing courses for teachers in the use of ICT is crucial.

3.10.2.3. Factors related to the student

Although ICT can enhance students' learning and understanding, students themselves can present challenges to the use of ICT in the classroom. Students at different school levels usually differ in their age, thinking skills, and behaviour. For instance, the age of primary school students in the Saudi educational system is ranged between 6 and 12 years (Oyaid, 2009). Accordingly, Alharthi (2018) found that technology can be used to find information that fits students' age. Consequently, teachers may need more time to find appropriate knowledge through technology that can be understood easily by students.

It may be difficult for teachers to control secondary school students while using ICT due to the problem of students' misuse of technology (Oyaid, 2009; Albugami, 2016; Blikstad-Balas and Davies, 2017). Further, prolonged use of ICT may cause health issues among students (Alsulaimani, 2010; Alharbi 2014; Albugami, 2016; Alharthi, 2018; Alharbi 2019). The use of ICT in the classroom may also raise ethical issues rooted in culture and upbringing, such as

unwanted pictures and videos. In this respect, Szeto and Cheng (2014, p.58) stated that several issues arise from using technology in the classroom, including:

> unwanted information, excessive advertisements, inappropriate video clips, and the ethical evaluation of the video content. It is critical for teachers to consider these factors when making decisions about teaching with ICT tools or websites.

These concerns may prevent teachers from using educational technology and result in a return to a more traditional teaching style. Such a reversion is based on teachers' desire to control the classroom and to avoid ethical issues that may affect students negatively.

3.11. Technology adoption theories

This section presents the theories and models that have been developed to explain and understand individuals' implementation, acceptance, and adoption of technologies. Since this study investigates teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia, it is important to discuss some of these theories and models. In the next sub-section, the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technological Pedagogical and Content Knowledge (TPACK) framework are presented.

3.11.1. Technology Acceptance Model (TAM)

The TAM model, as shown in Figure 3.1, was developed by Davis in 1989. Straub (2009) argued that the TAM model can be seen as the first research to look at how an individual's perceptions of technology affect the use of that technology. The TAM model uses both perceived usefulness and perceived ease of use to identify attitudes towards adopting a new technology (Davis, 1989). According to Davis (1989, p. 320), perceived usefulness can be defined as "the degree to which a person believes that using a particular system would enhance his or her job performance", while perceived ease of use can be defined as "the degree to which a person believes that using a particular system would be free of effort". Thus, the perceived usefulness and the perceived ease of use may affect teachers' attitudes towards using ICT tools in their teaching process. However, the model has been criticised for not recognising the importance of the influence of gender, age, and prior experience on users' adoption of technology (Straub, 2009).

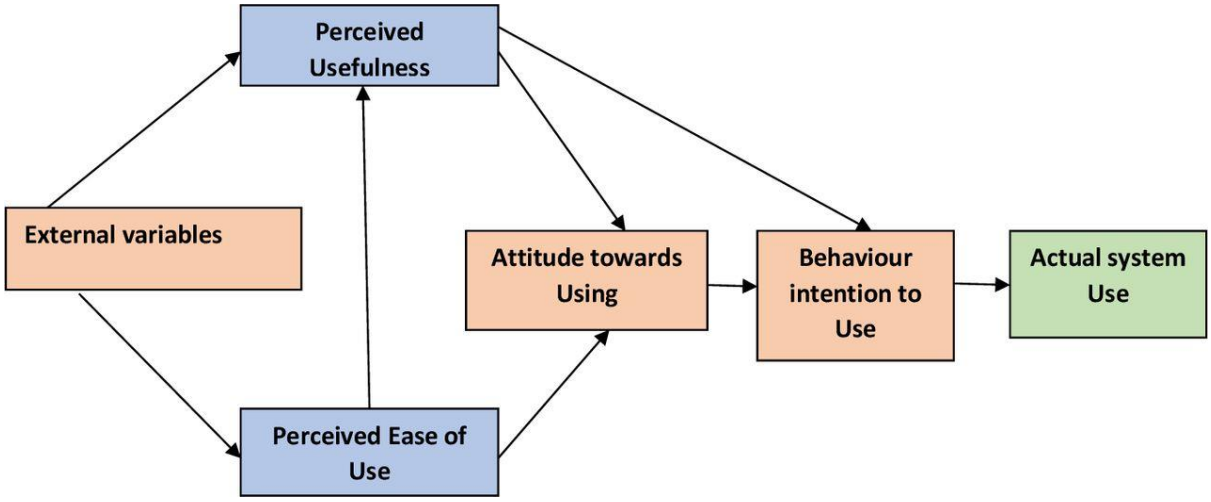

Figure 3. 1: Technology Acceptance Model (Davis, 1989)

3.11.2. The Unified Theory of Acceptance and Use of Technology (UTAUT)

The UTAUT model was developed by Venkatesh et al. (2003); Qingfei et al. (2008) considered it an improved version of the TAM model. The UTAUT model includes four variables that influence intention and usage of technology (see Figure 3.2):

- Performance expectancy, which is defined by Venkatesh et al. (2003, p.447) as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance".
- Effort expectancy, which is "the degree of ease associated with the use of the system" (Venkatesh et al., 2003, p.450).
- Social influence, which is defined by Venkatesh et al. (2003, p.451) as "the degree to which an individual perceives that important others believe he or she should use the new system".
- Facilitating condition, which is "the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system" (Venkatesh et al., 2003, p.453).

Moreover, this model includes four moderating variables: gender, age, experience, and voluntariness of use, as shown in Figure 3.2.

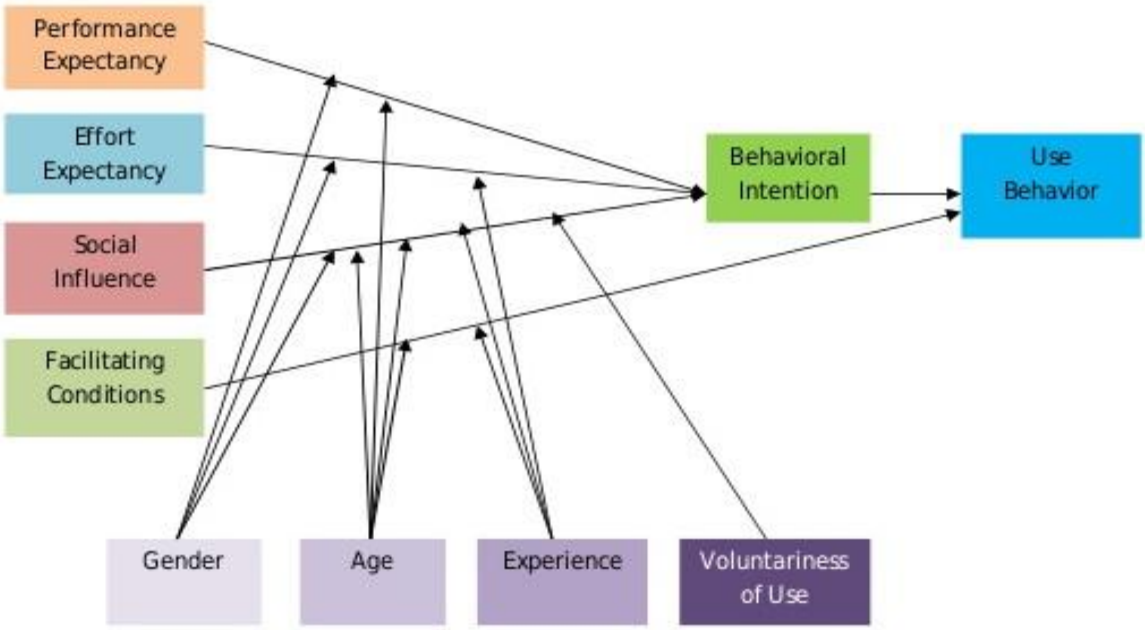

Figure 3. 2: Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003, p.447)

3.11.3. Technological Pedagogical Content Knowledge (TPACK) framework

In order to develop teachers' knowledge about the integration of technology in their classrooms, Mishra and Koehler (2006) developed the theoretical framework of Technological Pedagogical Content Knowledge (TPCK) to link the three components of knowledge needed for teaching: content, pedagogy, and technology. In 2007, Thompson and Mishra had changed the name of TPCK to Technological Pedagogical and Content Knowledge (TPACK). Thompson and Mishra (2007, p.38) argued that:

> We see TPACK as capturing two key aspects of our work with technology integration. It emphasizes, through the letters, the three kinds of knowledge (Technology, Pedagogy And Content) that we believe are essential building blocks for intelligent technology integration. Second, and as important, it captures the fact that these three knowledge domains should not be taken in isolation, but rather that they form an integrated whole, a "Total PACKage" as it were, for helping teachers take advantage of technology to improve student learning.

In Thompson and Mishra's model, as shown in Figure 3.3, there are three domains of teachers' knowledge. First, Content Knowledge (CK), which is defined by Mishra and Koehler (2006,

p.1026) as teachers' "knowledge about the actual subject matter that is to be learned or taught". Second, Pedagogical Knowledge (PK), which is a teacher's "deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses, among other things, overall educational purposes, values, and aims" (Mishra and Koehler, 2006, p.1026). Third, Technological Knowledge (TK), which is a teacher's "knowledge about standard technologies, such as books, chalk and blackboard, and more advanced technologies, such as the Internet and digital video. This includes the skills required to operate particular technologies" (Mishra and Koehler, 2006, p.1027).

Figure 3.3 also illustrates the interactions between and within these three domains of knowledge as:

- Pedagogical Content Knowledge (PCK), which is defined by Shulman (1986, p.9) as "the ways of the representing and formulating the subject that make it comprehensible to others".
- Technological Pedagogical Knowledge (TPK), which is "an understanding of how teaching and learning can change when particular technologies are used in particular ways" (Koehler and Mishra, 2009, p.65).
- Technological Content Knowledge (TCK), which is "an understanding of the manner in which technology and content influence and constrain one another" (Koehler and Mishra, 2009, p.65).
- Technological Pedagogical and Content Knowledge (TPACK), which is defined by Koehler and Mishra (2009, p.66) as:

    > the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old one.

Based on the TPACK framework, ICT can be used to support students' dialogue and discussion about their prior knowledge and, thus, to facilitate students' meaning-making. In this regard, the main aim of the current study is to investigate teachers' perceptions of using ICT and dialogic teaching in primary science classrooms.

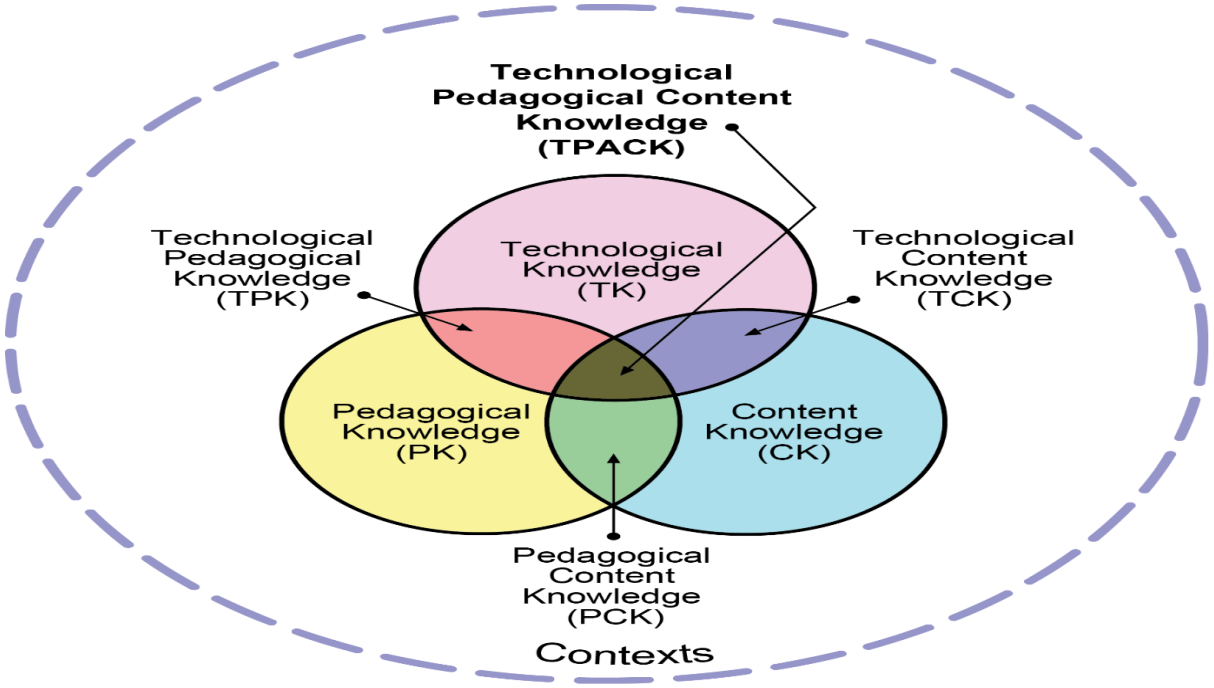

Figure 3. 3: The TPACK framework and its components (Koehler and Mishra, 2009, p.63).

Having discussed the implementation of dialogic teaching, the use of ICT in teaching and learning processes separately, the use of ICT for supporting and stimulating dialogic teaching are explained in the following section.

3.12. Using ICT to support dialogic teaching approach

Technology may be viewed as a mediating cultural tool that can play a critical role in promoting students' dialogue, engagement, and meaning-making (Dawes and Wegerif, 2004; Wegerif, 2007). Research has indicated that interactive technologies provide opportunities to support and established dialogic pedagogy, thinking together, and productive classroom talk (Hennessy, 2011; Major and Warwick, 2019; Mercer et al., 2019). Furthermore, Wegerif

(2007) argued that technology can be used as a cognitive tool in the dialogic approach, supporting students' knowledge construction.

According to Mercer et al. (2019, p.192): "using technology with a dialogic intention thus opens up new kinds of opportunities for learners and teachers publicly to share, explain, justify, critique and reformulate ideas". Additionally, Wegerif (2007, p.15) stated that "the dialogic alternative is of technology as a tool opening up and resourcing the kind of dialogic spaces that enable people to think, learn and play together". Moreover, using ICT in the teaching process increases the interactivity of teaching and provides opportunities for dialogic space and knowledge building (Beauchamp and Kennewell, 2008; Younie and Leask, 2013).

According to Kent and Holdway (2009, p.21), to develop teachers' practices in the classroom, digital technologies can be used in "presenting a concept, exploring the implications, placing the concept in various contexts, creating links with existing knowledge, and leading discussions that probe student understanding". Thus, it can be argued that using ICT may empower teachers to achieve Alexander's (2017) five principles of dialogic teaching: collective, reciprocal, supportive, cumulative, and purposeful. Based on Alexander's theory of dialogic teaching, through the use of ICT, teachers and students can address tasks together, share ideas and listen to others' opinions, talk freely and support each other, build knowledge and think together, and allow teachers to achieve the educational aims. ICT can, therefore, play a central role in mediating students' engagement and dialogue, enhancing their meaning-making, and facilitating knowledge building. This may be because ICT attracts students' attention, and they can find it more exciting and enjoyable than traditional resources.

However, teachers can implement the dialogic teaching approach with or without technology. For example, Higgins et al. (2007, p.217) claimed that:

> Good teaching remains good teaching with or without the technology; the technology might enhance the pedagogy only if the teachers and pupils engaged with it and understood its potential in such a way that the technology is not seen as an end in itself but as another pedagogical means to achieve teaching and learning goals.

Consequently, the teacher may use, for instance, textbooks or the whiteboard for initiating dialogue and discussion, which can be cheaper and easier than using modern technology.

However, Beauchamp and Kennewell (2008, p.313) argued that "new technologies that can not only mimic but extend the affordances of traditional media are continually emerging and reducing in cost". Thus, both ICT tools and traditional resources can be used to support collective knowledge building to achieve teaching and learning objectives.

3.13. Using ICT to support dialogic teaching in science education

Introducing technology to the science classroom may provide opportunities for dialogue, collaborative communication, and scientific thinking (Warwick et al., 2010; Kerawalla et al., 2013). Williams et al. (2017) noted that the use of ICT tools plays a key role in supporting students' inquiry learning in science, which develops students' ability to understand scientific concepts. Accordingly, Murcia and Sheffield (2010) indicated that the use of IWB and ICT more generally in science lessons can engage and motivate primary school students in science discussion and help them to understand scientific concepts. Therefore, teachers who use ICT tools effectively when teaching science can enhance students' learning by providing richer opportunities for students to discuss and exchange scientific ideas.

A study was conducted by Kershner et al. (2010) in England to investigate primary students' communication and thinking during the use of technology in science lessons. Kershner and her colleagues determined that the use of technology supports students' joint communication and thinking, promotes their knowledge building, and stimulates productive dialogue. Murcia (2014, p.86) carried out a case study in an Australian primary school to explore how [IWB] technology can be used to improve intentional primary school science teaching and learning, and listed the following principles:

- Engage and elicit students' prior knowledge through visually and conceptually appealing multimodal interactive displays.
- Generate exploration and explanation opportunities that are rich in dialogic discourse about multimodal representations and re-representations of concepts.
- Provide opportunities through higher-order questioning for students to transfer their learning to new or different contexts.
- Create opportunities for students to generate their own representations and re-representations of concepts.
- Review learning by moving flexibly through an interactive learning sequence.

Although these five principles emerged from only two classroom observations in an IWB technology context, they can be achieved through the use of other technologies. However, it is important to focus on how technology is used to facilitate more participation and interaction between teachers and students rather than on the importance of technology itself (Edwards-Groves, 2012). Therefore, teachers who use ICT tools effectively when teaching science can enhance students' learning by providing richer opportunities for students to discuss and exchange scientific ideas.

There remains a lack of studies in the Saudi context regarding the use of technology to support dialogue and discussion in general primary classrooms. Thus, this study aims to investigate teachers' perceptions of using ICT and dialogic teaching in primary school science lessons in Saudi Arabia.

3.14. Summary

Chapter Three was divided into sections which present the theoretical ideas of the dialogic teaching approach, the use of ICT in general teaching, and the use of ICT to support dialogic teaching. The first sections reviewed the literature relevant to the dialogic teaching approach, including its definition, principles, criteria, strategies, and the purposes of the dialogic teaching approach. The main roles of the teacher and student during dialogue and discussion were highlighted. Then, the literature related the implementation of dialogic teaching in science lessons was reviewed, including studies conducted in different contexts. This indicated that there is a lack of studies related to the implementation of dialogic teaching in Saudi schools. Additionally, Mortimer and Scott's (2003) communicative approach framework was described. Following this, several challenges were presented that may hinder the implementation of dialogic teaching in the classroom. These challenges included those related to the teacher, to the students, to the science curriculum, to a lack of time, and to the number of students in the classroom.

The middle sections reviewed the definitions and importance of ICT in the teaching and learning process. This was followed by a presentation of the existing literature related to the use of ICT in teaching science, including the advantages of using ICT in science lessons. However, several challenges which face teachers using ICT in the classroom were examined. For this study, these challenges were divided into two types. The first type covers external

challenges, which involved three factors: a lack of ICT resources; a lack of effective training; and a lack of technical support. The second type covers internal challenges, which also involved three factors: challenges related to the school; challenges related to the teacher; and challenges related to the student. This was followed by an explanation of the technology adaption theories including the TAM model, the UTAUT theory and the TPACK framework.

The later sections highlighted the literature relevant to the use of ICT as a cultural tool to support dialogue and discussion. This was followed by an outline of the literature relevant to the importance of using ICT to support dialogic teaching in science education. This section referred to the lack of studies in the Saudi context regarding the use of technology to support dialogue and discussion in the classroom. This study attempts to fill this gap in knowledge. Consequently, it is important to explore the effect of using ICT and dialogic teaching in primary school science classrooms to provide new evidence within the Saudi context. Chapter Four will describe the research methods that were used to investigate teachers' perceptions of using ICT and dialogic teaching in Saudi primary school science classrooms.

Chapter Four: Research Methodology

4.1. Introduction

Chapter Four outlines the research methodology used in this study, including: the paradigms, the research design, population, and sampling technique. Then a description of the methods used to collect the data are presented in detail, including both quantitative and qualitative phases; namely, the questionnaire and semi-structured interviews. The procedures employed for analysing the data are also explained. The concepts of trustworthiness, validity and reliability are examined. The chapter ends with an outline of the ethical considerations.

4.2. Research paradigms

Hammond and Wellington (2021, p.141) defined the research paradigm as "the dominant framework in which research takes place". Additionally, Punch and Oancea (2014, pp.16-17) referred to the research paradigm as "a set of assumptions about the world, and about what constitute proper techniques and topics for inquiring into the world … it has been used as a broad term encompassing elements of epistemology, ontology, theory and methodology". A pragmatic paradigm was adopted in this current research. Creswell and Creswell (2018, p.10) stated that, with the pragmatic paradigm "researchers are free to choose the methods, techniques, and procedures of research that best meet their needs and purposes". Furthermore, Creswell and Creswell (2018, p.10) argued that "pragmatists do not see the world as an absolute unity. In a similar way, mixed methods researchers look to many approaches for collecting and analysing data rather than subscribing to only one way (e.g., quantitative or qualitative)". As a result, sequential, mixed-methods research was applied in this study to understand the phenomena being investigated and to achieve the research objectives which will be explained in section 4.3.

Furthermore, according to Coe et al. (2017, p.16), it is important for researchers to understand the four dimensions and their related questions when conducting research: ontology, "what is the nature or form of the social world?"; epistemology, "how can what is assumed to exist be known?"; methodology, "what procedure or logic should be followed", and methods, "what techniques of data collection should be used?".

The current research interest was inspired by the researcher experience as a primary science teacher and by the first year of his doctoral program which matched the researchers previous experience and interest. The main aim of this study is to investigate teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia. In this study, the ontological assumption is that every primary science teacher has his own educational experience, motivating beliefs and personal perspectives that can be interpreted and measured. Cohen et al. (2018, p.17) stated that "the social world can only be understood from the standpoint of the individuals who are part of the ongoing action being investigated". Hence, the researcher's role in this study is to obtain participants' understandings and views about the nature of the investigated phenomena.

Regarding epistemology, Denzin and Lincoln (2000, p.157) indicated that "epistemology asks how do we know the world? What is the relationship between the inquirer and the known?". Hence, the epistemological assumption in this study is that teachers' perceptions of using ICT and dialogic teaching can be investigated though self-report, through questionnaires and interviews. Then, the researcher's role is to interpret teachers' perceptions of using ICT and dialogic teaching. The methodology applied in this study and the methods used to collect the data are explained in the following sections.

4.3. Research design

Cohen et al. (2018, p.38) defined research design as "the plan for, and foundations of, approaching, operationalizing and investigating the research problem or issue". Research design is associated with the research aims, research methodology, and methods of data collection. In the current study, a sequential, mixed-methods, triangulated design was adopted to achieve the research objectives, answer the research questions and to enable methodological triangulation. Mixed methods can be described as methods "where there is a substantial element of qualitative data collection as well as a substantial element of quantitative data collection in the same research project" (Robson and McCartan, 2016, p.174). According to Creswell and Creswell (2018, p.14):

> Mixed methods [involve] combining or integration of qualitative and quantitative research and data in a research study. Qualitative data tends to be open-ended

> without predetermined responses while quantitative data usually includes closed-ended responses such as found on questionnaires or psychological instruments.

According to Cohen et al. (2018), combining quantitative and qualitative research supports data triangulation and increases the validation and the reliability of the study, which is discussed in section 4.8. Cohen et al. (2018, p.265) defined triangulation as:

> Techniques in the social science attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint and, in so doing, by making use of both quantitative and qualitative data.

Furthermore, Creswell and Creswell (2018, p.213) stated that, by using mixed methods "more insight into a problem is to be gained from mixing or integration of the quantitative and qualitative data". Thus, to achieve the research aim, both a quantitative method and a qualitative method were used to examine participants' perceptions of using ICT and dialogic teaching in primary science classrooms.

According to Creswell and Creswell (2018, p.217), a mixed-methods approach consists of three core designs "the convergent design, the explanatory sequential design, the exploratory sequential design". In this study, the explanatory sequential mixed-methods design was chosen to investigate primary science teachers' perceptions of using ICT and dialogic teaching in Saudi Arabia. A sequential explanatory (Creswell and Clark, 2017), two-phase mixed-methods design was used: questionnaires followed by interviews. With sequential explanatory mixed methods, the researcher begins by collecting quantitative data in the first phase, followed by using qualitative data in the second phase to obtain deeper information about the research questions (Creswell and Clark, 2017).

The main purpose of using sequential explanatory mixed methods research is to explain initial quantitative findings, to purposefully select the participants for the qualitative method and to formulate the questions that will be asked in the interviews (Creswell and Clark, 2017). Hence, this approach was useful for initially collecting data from a large sample in the first phase, and for purposively selecting primary science teachers for the second phase of this research. However, adopting sequential explanatory mixed methods is often criticised because it consumes time and requires more effort from the researcher when collecting and analysing the data (Cohen et al., 2018), compared to using only one method of research. In

the following sub-section, both phases of the mixed methods approach are defined and outlined.

4.3.1. The quantitative phase

In the first phase of this study, a quantitative approach was used. Creswell and Creswell (2018, p.4) defined the quantitative approach as "an approach for testing objective theories by examining the relationship among variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analysed using statistical procedures". Moreover, Punch (2009, p.3) described the quantitative approach as an "empirical research where the data are in the form of numbers". In quantitative research, the researcher collects, analyses, interprets, and writes the results of a study (Creswell and Creswell, 2018). The quantitative design has several features. For instance, it can be analysed using statistical programs, such as SPSS (Cohen et al., 2018). Moreover, Robson and McCartan (2016) argued that results derived from a quantitative approach can be generalised.

In the quantitative phase of this study, the researcher aimed to descriptively explore primary science teachers' perceptions of using ICT and dialogic teaching. In the quantitative phase, a questionnaire was used to collect the data from participants. Relevant personal information from participants was collected, such as the length of their teaching experience, age, qualification level, and attendance on training courses.

4.3.2. The qualitative phase

In qualitative approach was employed in the second phase of this study. Creswell and Creswell (2018, p.4) defined the quantitative approach as "an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem". Cohen et al. (2018, p.289), explained in more detail what is involved in this method: "qualitative research provides an in-depth, intricate and detailed understanding of meanings, actions, non-observable as well as observable phenomena, attitudes, intentions and behaviours".

One of the main characteristics of the qualitative approach is that it allows insight into the way "individuals construct reality in interaction with their social worlds" (Merriam, 2002, p.37). Moreover, Robson and McCartan (2016) argued that phenomena can be described

from the perspectives of a small number of participants. Patton (2015) argued that using qualitative research provides rich detail regarding participants' perception of a problem, which enables that problem to be better understood and interpreted. Therefore, through qualitative research, a deeper understanding and interpretation of using ICT and dialogic teaching can be obtained from primary science teachers' attitudes and perspectives, based on their experiences in real life. However, Robson and McCartan (2016, p.20) stated that, in the qualitative approach, "the generalizability of findings is not a major concern". In the qualitative phase of this study, semi-structured interviews with 12 primary science teachers were conducted, which are described in detail in sections 4.5 and 4.6.3, to increase the transferability of this study.

The limitations of both quantitative and qualitative approaches have been discussed in the methodology literature; however, the researcher combined these methods, using the best parts of both to strengthen the validity of this study. Punch (2009) argued that, through adopting a mixed methods design, the researcher can benefit from the strengths of both quantitative and qualitative methods and compensate for the weaknesses of both, which will be explained in more detail in section 4.6. Indeed, the two approaches complement each other. The quantitative method provides a greater range in terms of the size of the data set, while the qualitative method is a smaller sample that has greater depth and uses open questions.

Having briefly outlined mixed methods and the quantitative and qualitative phases used in this study, the next section outlines the population of this research.

4.4. Population

Given that the main aim of this study was to investigate primary science teachers' perceptions of using ICT and dialogic teaching in Saudi Arabia, the population is an important aspect that needs to be carefully considered before choosing the sample (Alsalahi, 2018). According to Creswell (2012, p.142), the population is defined as "a group of individuals who have the same characteristics". This study was conducted with teachers from 672 state primary schools located in Riyadh, the capital city of Saudi Arabia, in 2020. The total population of science teachers was 923, all of whom work in primary schools in Riyadh. All the teachers who participated in this study are male. The reason for choosing male teachers is that Saudi culture

and government rules prohibit males from entering female schools. Consequently, a limitation of this study is that it will not consider a comparison of gender perspectives.

4.5. Sampling

Sampling is an important element when conducting research (Cohen et al., 2018). According to Creswell (2012, p.358), sampling is defined as a "group of participants in a study selected from the target population from which the researcher generalizes to the target population". Cohen et al. (2018) identified several factors that should be considered in sampling, such as the sample size, the representativeness of the sample, and the kind of research that is being conducted. The main aim of the sampling in this study was to achieve responses from the participants (primary science teachers) about their perceptions of using ICT and dialogic teaching in primary science classrooms.

The researcher used two strategies for the quantitative and qualitative phases. Firstly, in the quantitative phase, the questionnaires were electronically distributed to all 923 primary science teachers in Riyadh, which was chosen as an urban city and as the capital of the Kingdom of Saudi Arabia. The total number of completed responses from primary science teachers was 305, while another 28 responses were not completed, and 40 participants did not accept the invitation to participate. The remaining number of 550 primary science teachers did not respond to the invitation at all.

Secondly, primary science teachers were invited to participate in the qualitative phase. A group of 37 teachers from the total number of participants who had completed the questionnaire volunteered to be interviewed. In this study, semi-structured interviews were used, and purposive sampling was employed. According to Cohen et al. (2018, p.218), "in purposive sampling, often … a feature of qualitative research, researchers handpick the cases to be included in the sample on the basis of their judgement of their typicality or possession of the particular characteristic(s) being sought". A total of 12 interviewees were purposively selected for several reasons: first, to search for different properties; second, to select teachers from different areas of Riyadh, based on their different schools, years of experience, age, qualifications, and training courses; finally, based on the issues they raised in the open-ended qualitative question in the questionnaires to be investigated in depth. More details regarding the interviews are presented in section 4.7.2.

4.6. Data collection

In the current study, the researcher is concerned with primary science teachers' perceptions, practices and attitudes towards using ICT and dialogic teaching. The researcher obtained written permission by letter from the MoE, to collect data from primary science teachers in Riyadh. In the following sub-sections, the instruments used to collect data are presented.

4.6.1. Questionnaire

Cohen et al. (2018, p.471) defined the questionnaires as "a widely used and useful instrument for collecting survey information, providing structured, often numerical data, able to be administered without the presence of the researcher and often comparatively straightforward to analyse". Several benefits can be obtained from using questionnaires. For instance, it is possible to collect data from many people within a short time; participants can fill questionnaires out at their own convenience; and the data can be analysed quickly once it is entered into appropriate software (Gray, 2018). Furthermore, Alsalahi (2018) stated that using questionnaires is useful in terms of generalising the data collected. However, there is often a low response rate and there is no opportunity for clarification of participants' responses (Gray, 2018). Creswell and Creswell (2018, p.251) stated that a questionnaire design "provide plans for a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population".

In terms of designing the questionnaires, Somekh and Lewin (2005, p.219) argued that "the researcher should ensure that the data will be relevant and sufficient to answer the research questions" by reviewing the related literature "to enable us identify the main issues and set the theoretical and methodological framework for survey research" (Hartas, 2010, p.261). Therefore, a questionnaire was developed to address the research questions. Cohen et al. (2018, p.472) stated that, the planning of the questionnaire "involves the formulation of the research questions to be answered". Cohen et al. (2018) listed several questionnaire types, such as those using closed- and open-ended questions. Cohen et al. (2018, p.467) defined closed-ended questions as "prescrib[ing] the range of responses from which the respondent may choose". Cohen et al. (2018, p.467) pointed out that using closed-ended questions is useful because it "can generate frequencies of response amenable to statistical treatment and analysis". Moreover, closed-ended items are: quick to answer and complete;

straightforward to code and analyse (De Vaus and De Vaus, 2013); and easy to answer and directly to the point (Cohen et al., 2018). Furthermore, by using close-ended questions, the researcher can have specific answers that might reduce response bias. However, using close-ended questions does not enable participants to elaborate about their responses (Cohen et al., 2018).

In this study, the questionnaire was designed by the researcher based on the review of literature in the field of using ICT in education and dialogic teaching. The questionnaire consisted of several structured closed-ended questions and one open-ended question, which is discussed in section 4.6.2. The researcher piloted the questionnaire before conducting the actual study, which is explained in detail in section 4.8.1.

The questionnaires contained an informed consent form regarding the study's aims (see Appendix 5), an invitation to participate, a description of the ethical issues, and contact details, all of which are explained in section 4.9. The questionnaire consisted of three sections and was designed to be completed within 10-15 minutes. The first section requested the demographic variables of participants: work experience, age group, qualification, number of students in the class, training related to using ICT in education and inquiry-based science.

The second section of the questionnaire was concerned with primary science activities that can be used in the classroom by teachers. In this section, the implementation of science classroom activities was rated on 15 items divided into three sub-sections. The first sub-section asked participants how often they use five specific activities that support dialogue in science lessons. In the second sub-section, participants were asked to rate their frequency of using ICT tools in science lessons, which involved rating seven statements provided by the researcher. The final sub-section involved three items evaluating participants' use of traditional teaching resources. Primary science teachers were asked to rate how often they implement such activities on a scale ranging from 'very often' to 'never'. The questionnaire was a five-point Likert-type instrument. For each item, the response was recorded in SPSS as very often = 5, often = 4, sometimes = 3, hardly ever = 2, and never = 1. The results will be discussed is section 4.7.1.

The third section of the questionnaire involved 30 items divided into four sub-sections. The first sub-section involved 17 items designed to explore teachers' attitudes towards using

dialogic teaching. The second sub-section involved three items related to the use of ICT tools. The third sub-sections involved seven items intended to investigate the use of ICT to support dialogic teaching. The final sub-sections involved three items related to the challenges that may hinder the implementation of dialogic teaching and the use of ICT tools. For each item, the response was scored in SPSS as follows: strongly agree = 5, agree = 4, neutral = 3, disagree = 2, and strongly disagree = 1. Additionally, the questionnaire included an open-ended question, which is explained in section 4.6.2. Finally, the questionnaire ended with a request for primary science teachers to participate in the second phase of the study. A copy of the questionnaire is provided in Appendix (4).

The questionnaire was based on literature published in English. Thus, before being distributed online, the questionnaire was translated from English to Arabic, the official language in Saudi Arabia (see section 4.8.1). The researcher used the Qualtrics platform to collect the data.

The researcher obtained written permission to distribute questionnaires from the MoE in Saudi Arabia. All questionnaires were distributed electronically to primary science teachers in Riyadh. The General Department of Education in Riyadh used their database of teachers' emails to send the Qualtrics survey link to all participants. One of the problems the researcher encountered was that, although a large number of teachers filled out the questionnaire once they had received the electronic link, many participants stopped participating over the course of the subsequent days. This was, perhaps, because the teachers did not have enough time to fill out the questionnaire or thought that the questionnaire might be too complex.

Accordingly, the researcher took several steps to enhance the response rate. The researcher contacted the General Department of Education in Riyadh to remined teachers three times to participate. The researcher also visited the principals of 15 primary schools to remined science teachers to volunteer in the questionnaire. As a result, a total of 305 questionnaires were completed and returned.

4.6.2. The open-ended question

At the end of the questionnaire, the participants were asked, using an open-ended question, to write their personal comments in their own words based on their experience. Cohen et al. (2018, p.475) stated that "an open-ended question can catch the authenticity, richness, depth of response, honesty and candour which … are hallmarks of valid qualitative data".

Participants' comments helped the researcher to design the interview questions to gain more in-depth information in the subsequent qualitative stage. For example, most of the comments in the open-ended question were concerned with the challenges that teachers face regarding implementing dialogic teaching and using ICT. This focus helped the researcher to investigate and explore these aspects in more detail in the qualitative phase.

However, using an open-ended question may result in problems, such as too much information that is difficult to summarise and analyse (Cohen et al., 2018). For example, some teachers provided information not related to the study, or just wished the researcher success. Participants' comments were translated from Arabic into English by the researcher and analysed as qualitative data, as the results and discussion would be presented in English (see section 4.7.2).

4.6.3. Interview

Semi-structured interviews were used to collect the data for the qualitative phase of this study. Kvale (1996, p.14) defined an interview as "an inter-change of views between two persons conversing about a theme of mutual interest". Cohen et al. (2018) claimed that one purpose of the interview is to understand, examine, and evaluate situations or events. Moreover, Cohen et al. (2018, p.506) stated that "interviews enable participants – interviewers and interviewees – to discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view". Furthermore, interview data were important as they triangulate the quantitative data results and provide more in-depth findings from interviewees to address the research questions. For instance, a major area of enquiry for this study is concerned with subjective attitudes and perceptions regarding dialogic teaching and ICT, which can be captured by using interviews.

Interviews can be divided into three types: structured, semi-structured and unstructured interviews (Punch, 2009). According to Williamson (2002, p.243), semi-structured interviews:

> have a standard list of questions, but allow the interviewer to follow up on leads provided by participants for each of the questions involved. The semi-structured interview is closer to the unstructured, in-depth interview, than to the structured, standardised form.

In this study, semi-structured interviews were used to collect the qualitative data. Cohen et al. (2018, p.511) defined a semi-structured interview: “the topics and questions are given, but the questions are open-ended, and the wording and sequence may be tailored to each individual interviewee and the responses given, with prompts and probes”. Conducting semi-structured interviews allowed the researcher the flexibility to collect a rich source set of data and gain a deeper understanding of the participants’ perspectives and attitudes towards the research issue. Kvale and Brinkmann (2009) noted that using semi-structured interviews with open-ended questions offers the researcher greater opportunity to ask the participants additional questions to clarify their meaning and to provide further information. However, interviews can be expensive as well as time consuming (Denscombe, 2017). The researcher was not limited by budget or time constraints; however, the researcher was limited by the impact of COVID-19.

Before conducting the actual interviews, the researcher piloted the interview questions, which are explained in detail in section 4.8.2. In practice, the researcher used face-to-face, semi-structured interviews which took place in schools; the aims were to provide an opportunity for the participants to talk about the use of ICT and dialogic teaching, and to follow up ideas that arose from the participants’ responses. The interview questions were first written in English, and then translated into Arabic (see section 4.8.2).

At the outset, the researcher intended to interview 15 to 20 primary science teachers drawn from the 37 participants who had volunteered to be interviewed. However, due to the COVID-19 pandemic, the number of interviewees was reduced from 15-20 to 12 in March 2020, because schools had been closed by the Saudi government. The researcher contacted the remaining participants to conduct the rest of the interviews online, but they did not accept the researcher’s request as some of them were unfamiliar with online video interviews.

Ethical issues are discussed in greater depth in section 4.9. Briefly, the researcher contacted all participants to gain initial consent and allocate a suitable place and time for the interview during March 2020. All the participants preferred to meet in their schools in Riyadh. Moreover, the interviews were conducted in Arabic, which is the first language of the participants. Most of the interviews lasted approximately 45 minutes and were conducted in quiet rooms in each school. Having secured a letter of approval from the MoE, the researcher was granted automatic access to any school to conduct interviews in Riyadh.

The interviews were transcribed by the researcher for analysis. Cohen et al. (2018, p.646) described transcripts as "very time-consuming to prepare". Although the transcriptions were very time consuming, it was the first level of analysis. All the transcripts and translated data for each participant were given a unique name, in order to protect the identities of the participants, and stored on a secure drive with a password in the researcher's email address that provided by the University of Warwick to protect and avoid losing the data.

4.7. Data analyses

The data collected from questionnaire and interview phases were analysed separately. In the following sub-sections, the data analysis processes are explained.

4.7.1. Quantitative data analysis

The quantitative data from completed questionnaires were analysed using SPSS software. A descriptive analysis of the data explored the participants' perceptions and implementation of and attitudes towards using ICT and dialogic teaching in primary science classrooms. According to Robson and McCartan (2016, p.418), descriptive analysis can be defined as "ways of representing some important aspect of a set of data by single numbers". For instance, percentages, mean scores, and standard deviations were used to summarise and describe the quantitative data.

Moreover, a cross-tabulation test was used to categorise a set of ICT tools items to compare findings on variables. Additionally, three types of inferential statistical tests were used to perform a deeper investigation of the phenomena being researched, including: a Mann-Whitney test; a Spearman's rank correlation, and multiple regression analysis. The quantitative data analysis is presented in Chapter Five.

4.7.2. Qualitative data analysis

The researcher adopted a thematic analysis approach to analyse the qualitative data collected through both the interviews and the open-ended question included with the questionnaires. The researcher followed the Braun and Clarke (2006, p.87) technique to analyse the interview data, which consists of six phases: "familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report".

The qualitative data were inductively analysed. Braun and Clarke (2006, p.83) defined inductive analysis as "a process of coding the data without trying to fit it into a pre-existing coding frame, or the researcher's analytic preconceptions". Thomas (2006) argued that the process of analysing the qualitative data is commonly inductive.

All the qualitative data collected through both the interviews and the open-ended question included with the questionnaire were translated and transcribed by the researcher, as noted above. During this process, the researcher was able to listen to the recorded interviews and read the transcripts many times, which enabled the researcher to gain greater familiarity with the data. The researcher used NVivo software to analyse the data collected and, partially, to mitigate researcher bias. All the transcriptions were imported into an NVivo file to help the researcher to manage and organise the data. Then, the researcher began generating codes by identifying every meaningful word, key idea, or sentence. Creswell and Creswell (2018, pp.193-194) indicated that coding "involves taking text data or pictures gathered during data collection, segmenting sentences (or paragraphs) or images into categories, and labeling those categories with a term". In this stage, the researcher created many codes that emerged from the data while using NVivo.

In the next stage, the researcher grouped similar codes by "sorting the different codes into potential themes and collating all the relevant coded data extracts within the identified themes" (Braun and Clarke, 2006, p.89). The themes were then reviewed and checked several times to ensure that the codes matched the themes that emerged from answers to the research questions. During the reviewing process, the researcher made some changes to the themes and, as a result, the final major themes, sub-themes, and categories were identified and named. Finally, once the themes were identified and named, the researcher presented and reported the qualitative analysis, which is outlined in Chapter Six.

4.8. Validity and reliability

The validity and reliability play a key role in effective research (Cohen et al., 2018). In this section, the issues of the validity and reliability of both questionnaire and interview Instruments are detailed.

4.8.1. Quantitative phase validity and reliability

Heale and Twycross (2015, p.66) defined validity in a quantitative method as "the extent to which a concept is accurately measured in a quantitative study". Moreover, Robson and McCartan (2016, pp.104-105) argued that validity, "from a realist perspective, refers to the accuracy of the result". Therefore, in order to check the validity of the questionnaire (Cohen et al., 2018), the researcher piloted the questionnaire to ensure the clarity of the questions. The pilot study allowed the researcher to check the length of questionnaire response times and to ensure that participants understand the questions. The researcher sent the Qualtrics survey link to 19 science teachers, inviting them to provide any notes and feedback regarding the content validity of the questionnaire items. A total of 15 pilot study of questionnaires were completed and returned. As a result, the comments of these participants were considered when designing the final version of the questionnaire.

The questionnaire was also reviewed and discussed with the researcher's supervisors. Furthermore, a version of the questionnaire, translated from English to Arabic, was checked and reviewed with a PhD student who study in the Centre of Education at the University of Warwick and speaks Arabic as a first language. The comments from this process were important to ensure that the items of the questionnaire were clear, and to avoid any confusion or repetition.

The second important measure of a questionnaire is reliability. Heale and Twycross (2015, p.66) stated that "reliability relates to the consistency of a measure". Heale and Twycross (2015) noted that Cronbach's Alpha is the most frequently used test to measure the internal consistency of an instrument. In this study, Cronbach's Alpha coefficient was conducted to assess the internal consistency of the questionnaire. According to Cohen et al. (2018), the value of the Cronbach's Alpha coefficient ranges between 0 and 1; it can be very highly reliable if the reliability coefficient is greater than 0.90; it is deemed highly reliable if between 0.80–0.90; reliable if between 0.70–0.79; marginally/minimally reliable if between 0.60–0.69; and display unacceptably low reliability if less than 0.60.

The questionnaire's reliability was calculated using SPSS as shown in Table 4.1. The Cronbach's Alpha of the science classroom activities items was measured at 0.808, which is considered highly reliable. The findings also showed that the Cronbach's Alpha of the effect

of using ICT and dialogic teaching items was measured at 0.877, which is also considered highly reliable. The Cronbach's Alpha coefficient was measured at 0.891 for all 45 items, which is considered highly reliable.

Table 4. 1: The Cronbach's Alpha reliability

Scales	Cronbach's Alpha	No. of items
Science classroom activities	0.808	15
The effect of using ICT and dialogic teaching	0.877	30
All items	0.891	45

Table 4.1 has demonstrated that the reliability of all scales is valid and acceptable because the Cronbach's Alpha values are all between 0.80–0.90.

4.8.2. Qualitative phase validity and reliability

It is important for the researcher to consider the accuracy and credibility of findings (Creswell and Creswell, 2018, p.199). Regarding qualitative validity, "the researcher checks for the accuracy of the findings by employing certain procedures", while, in terms of qualitative reliability, "the researcher's approach is consistent across different researchers and different projects" (Gibbs, 2007, cited in Creswell and Creswell, 2018, p.199). In this study, the researcher followed several procedures to ensure as much as possible the validity and reliability of both the interviews and the open-ended question included with the questionnaire. To ensure the validity of the interview questions, the researcher checked the questions with two supervisors in terms of their language, clarity, and accuracy. Additionally, the interview questions were translated by the researcher and both the Arabic and English versions were checked by a PhD candidate. All comments and feedback from this process were considered to design and complete the final version of the interview questions.

Moreover, before conducting the actual interviews, the researcher piloted the interview questions with two Saudi primary science teachers to evaluate the length of the interview and to ensure clarity of the questions. These teachers were not included in the main study.

Additionally, piloting allowed the researcher to check the translation of the interview questions from English to Arabic and offered the researcher a chance to avoid leading questions, such as “those which influence the response and indicate a desired response” (Cohen et al., 2018, p.500). Furthermore, the pilot study helped the researcher to be more confident and familiar with conducting interviews.

Cohen et al. (2018) suggested that the researcher should minimise bias in order to achieve greater validity in interviews. Several factors can have an impact on the degree of bias in a research project. For example, Cohen et al. (2000, p.121) noted the impact of “race, religion, gender, sexual orientation, status, social class and age in certain contexts can be potent sources of bias”. The researcher’s position shared the same gender and religion as the participants who were all male and Islamic. If there had been a difference in gender, it could be argued that the results may have been less valid given the gender segregation in the schools in Saudi Arabia. Moreover, the researcher’s position was of similar class and status to the participants; he was not superior, for example, in terms of being their senior manager. Furthermore, as an external visitor to the school, the researcher could maintain professional detachment as he was not a school employee and could draw upon the objectivity gained from having studied abroad for three years. The researcher’s position aimed to reduce bias by maintaining a friendly but objective relationship with the interviewees. Thus, the researcher was aware of his role during the collection of data from the participants and also during analysis, which was guided by the researcher’s supervisors.

During the interviews, the researcher cautiously avoided any transference of emotive hopes and fears, or prompting of desired or admirable responses, and did not overtly signal pleasure or displeasure as a reaction to responses. The researcher adhered to the wording of the questions, and avoided shifting the order of the questions, to maintain consistency across all the interviews. Moreover, the participants were given enough time to adequately respond to the questions.

According to Creswell and Creswell (2018, p.202), one of the strategies used to assess the accuracy of findings is to “check transcripts to make sure that they do not contain obvious mistakes made during transcription”. Therefore, in order to check the trustworthiness, the transcribed and translated Arabic and English interview transcriptions, and the responses to the open-ended question included with the questionnaire, were checked by a PhD candidate

at Warwick University and speaks Arabic as a first language. Three interview samples were selected randomly and sent to him to ensure the transcribed and translated versions were accurate. This student had already been trained in ethical issues in line with the University of Warwick policies and procedures. Additionally, each participant was provided with a copy of his Arabic interview transcription to confirm that it reflected his responses; "in this way, the participants add credibility to the qualitative study by having a chance to react to both the data and the final narrative" (Creswell and Miller, 2000, p.127). However, no-one made any changes to their transcript, but two participants re-emphasized the challenges of using ICT in classrooms.

Regarding qualitative data analysis, the coding process and the data analysis were discussed and reviewed with the researcher's supervisors. They recommended some changes in ordering and combining some sub-themes and categories. Further, the researcher sought to present clear details of the methodology employed, the methods used to collect the data, and the participants.

4.9. Ethical considerations

Wellington (2000, p.3) stated that "ethical concerns should be at the forefront of any research project and should continue through to the write-up and dissemination stages". In this study, various ethical procedures were followed and observed. Ethical approval of the current study was obtained from the University of Warwick prior to conducting the study (see Appendix 1). Similarly, a letter of approval was obtained from the MoE giving the researcher permission to collect the data from primary science teachers in Riyadh.

The researcher distributed a link to the Arabic version of the questionnaire to the participants via the General Department of Education in Riyad. The questionnaire included a brief description of the purposes of the study, the participants rights regarding issues like privacy, and the researcher's contact details. The participants were informed that their participation was optional, and that they could withdraw at any time. They were also informed that privacy and confidentiality were both guaranteed, and the data would be used for educational research only. Furthermore, in the questionnaire, the participants were asked to volunteer to participate in the qualitative phase of this research.

For the qualitative phase of this study, the participants were contacted to allocate a convenient time and place for the interviews. Each participant was given an informed consent form, written in Arabic, which included the purpose of the study, the participants' right to withdraw at any time, and confidentiality information. All participants read and signed the informed consent form (see Appendix 7). Prior to conducting the interviews, the researcher sought permission from each participant to record the interviews. The data collected from participants was kept in a secure place. When analysing and presenting the results, each participant was given a pseudonym to protect their identity.

4.10. Summary

This chapter has presented the research methodology used in the current study. It began by highlighting the research paradigm appropriate for this study. This was followed by an explanation of the research design. The researcher used an explanatory, sequential, mixed-methods design, combining both quantitative and qualitative methods. Furthermore, the researcher described the data collection procedures, including population, sampling, and the instruments used to collect the data. The processes used to analyse the quantitative and qualitative data were outlined. Finally, the validity and reliability of the quantitative and qualitative data, and the ethical considerations, were discussed.

Chapter Five: Quantitative Findings

5.1. Introduction

The main aim of this study is to investigate teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia. The current chapter presents the quantitative data collected using questionnaires, and the analysis of these data using the Statistical Package for Social Science (SPSS). This chapter is divided into six sections, based on the design of the questionnaire. The first section provides a description of the response rate of the study. The second section presents the background information of the participants, including their experience, age, qualifications, number of students in class, and training courses attended. The third section reports on additional analysis of these background information variables. The fourth section examines teachers' implementation of different science classroom activities, including dialogic teaching activities, the use of ICT tools, and the use of traditional teaching resources. The fifth section explores teachers' attitudes towards the effect of dialogic teaching and the use of ICT tools on students' learning and interaction in science classrooms, followed by a section related the challenges that teachers encounter. The final section presents different inferential statistics analyses which have been performed during this study. At the end of this chapter, the findings from the quantitative data gathering and analysis are summarised.

5.2. Response rate

A questionnaire method was used to collect the quantitative data. The questionnaire was distributed electronically to 923 primary science teachers in Riyadh in Saudi Arabia. In total, 373 teachers responded to the questionnaire, of which 305 (81.77%) respondents completed the questionnaire by answering all questions, 40 (10.72%) respondents refused to participate as shown in Figure 5.1, and 28 (7.51%) respondents were excluded as they did not complete the questionnaire.

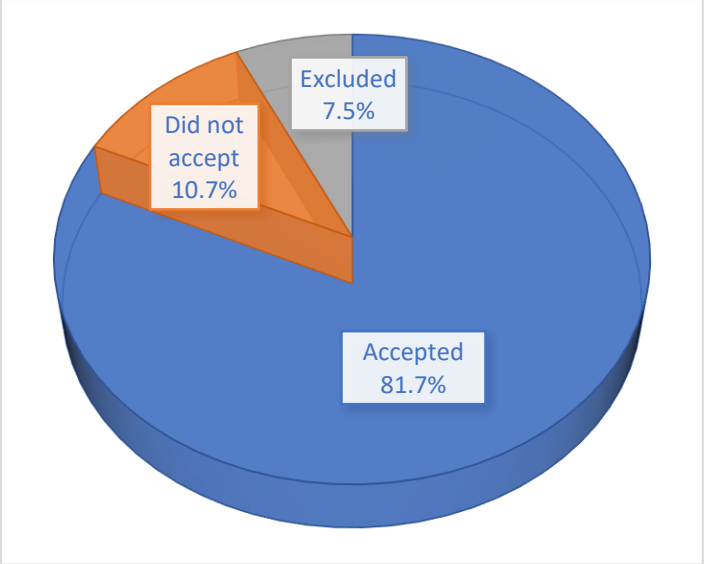

Figure 5. 1: The response rate

5.3. Background information

This section presents the demographic variables of participants about work experience, age group, qualification, number of students in the class, courses training related to using ICT in education and inquiry-based science.

In terms of teaching experience as shown in Figure 5.2, it is evident that more than half of 305 respondents (153) had more than 16 years' experience. This may be because of the option (more than 16) includes 3 categories of teachers who had experience from16 to 20, 21 to 25 and 26 to 30 years of experience. In addition, only 39 (12.7%) teachers had taught from 11 to 15 years; 70 (22.9%) teachers had experience ranging from 6 to 10 years, and finally, 43 (14.1%) teachers had the least experience, ranging from 1 to 5 years.

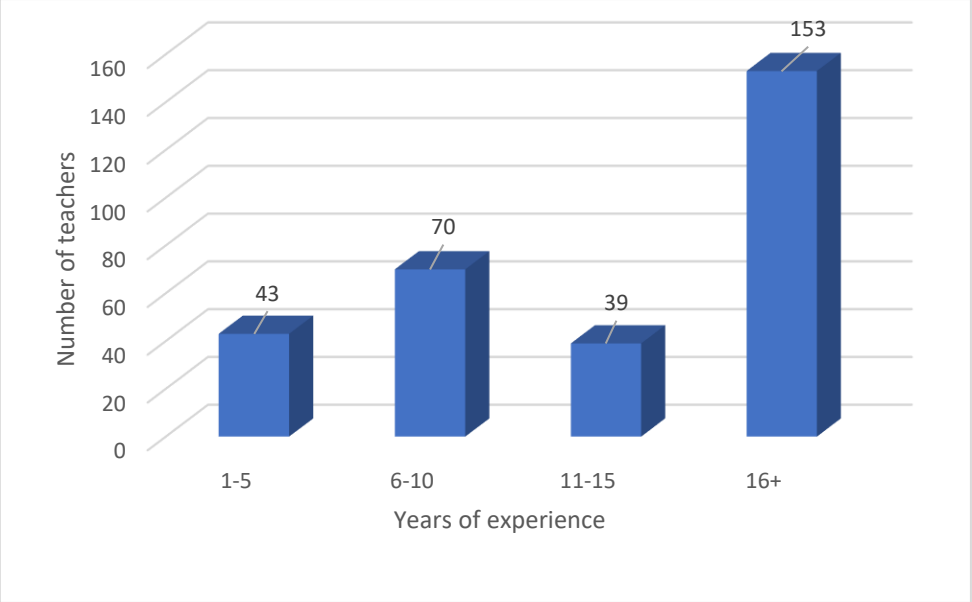

Figure 5. 2: The participants' years of experience

The results also showed that 110 (36%) teachers were in the age group from 31-40, and 104 (34.1%) teachers in the 41-50 age range. It can be noted that most of the teachers' age ranged from 31 to 50. In addition, 57 (18.7%) teachers were aged above 50, and only 34 (11.1%) teachers were in the lower age group, from 20 to 30, as shown in Figure 5.3 below.

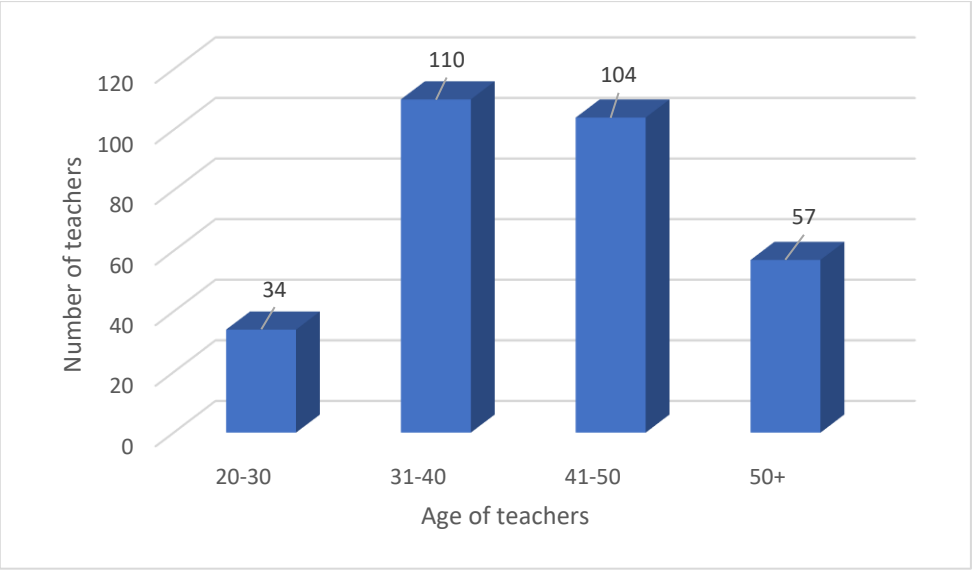

Figure 5. 3: The participants' age

In terms of teachers' educational qualifications, the findings in Figure 5.4 illustrated that their qualifications varied from Diploma to PhD degree. The majority of teachers 262 (85.9%) had a Bachelor's degree and only one science teacher had a PhD degree. Meanwhile, 37 (12%) teachers had a Master's degree and 5 (2%) teachers had a Diploma degree.

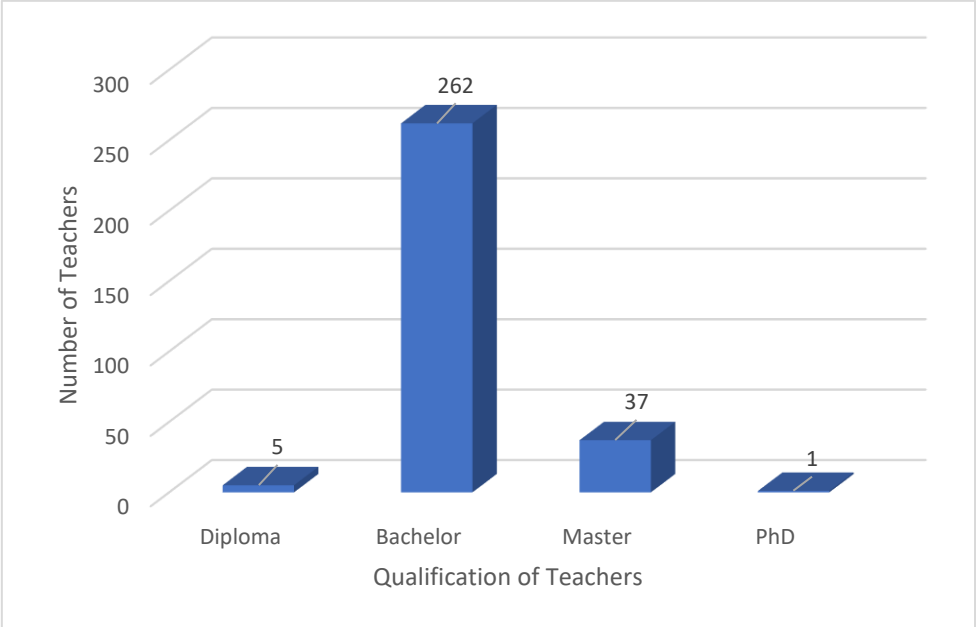

Figure 5. 4: The participants' qualification

In response to the number of students in the class as shown in Figure 5.5, 129 (42.3%) teachers reported that the number of students was between 20 and 30. Meanwhile, 119 (39%) teachers indicated that the class size ranged from 31 to 40. Unexpectedly, the result also showed that 42 (13.8%) teachers reported that the number of students in their class was more than 40, which is seen as a high number. However, only 15 (4.9%) teachers indicated that the number of students in their class was less than 20. The data therefore reveals that most science classes have between 20-40 students in their classes.

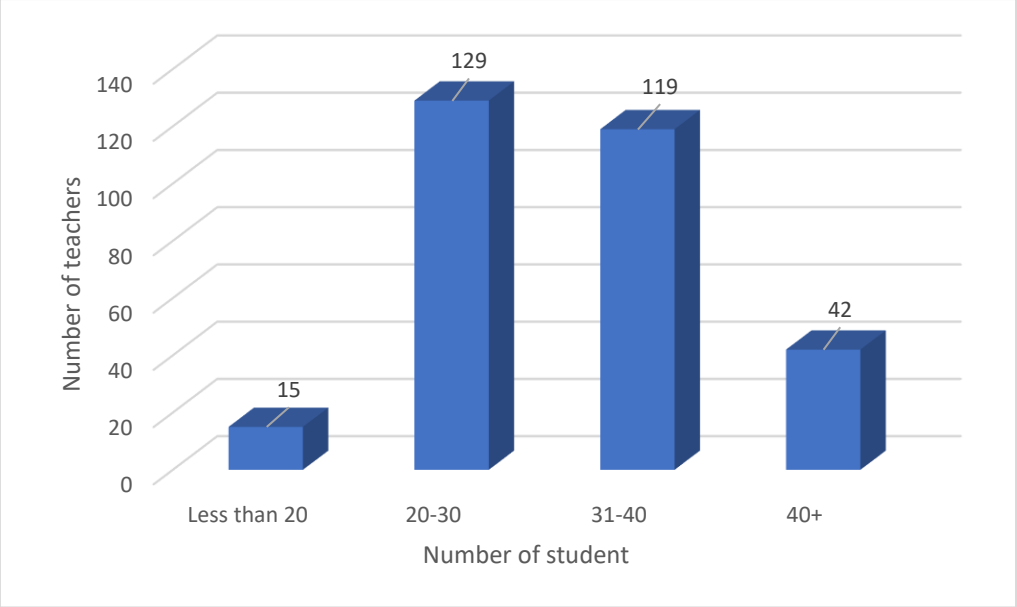

Figure 5. 5: The number of students in the class

Regarding teachers training courses, the results, as shown in Figure 5.6, showed that almost half of teachers 156 (51.1%) had attended ICT training courses, whilst 149 (48.8%) teachers had not attended ICT training courses. It is apparent from the participants that almost half of the teachers had attended such an important course.

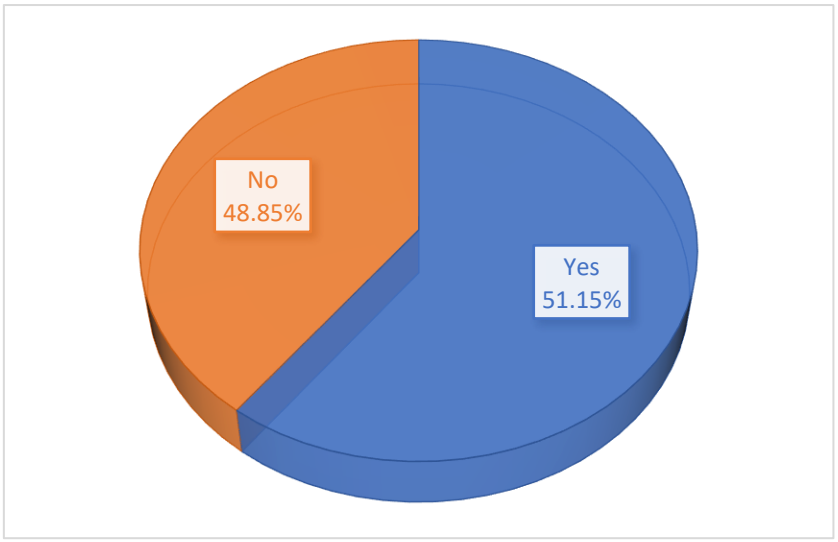

Figure 5. 6: ICT training courses

The Figure 5.7 showed that 184 (60.3%) teachers attended an inquiry-based learning course while 121 (39.7%) did not attend this type of course. It is clear from the participants that two thirds of the teachers had attended such an important course.

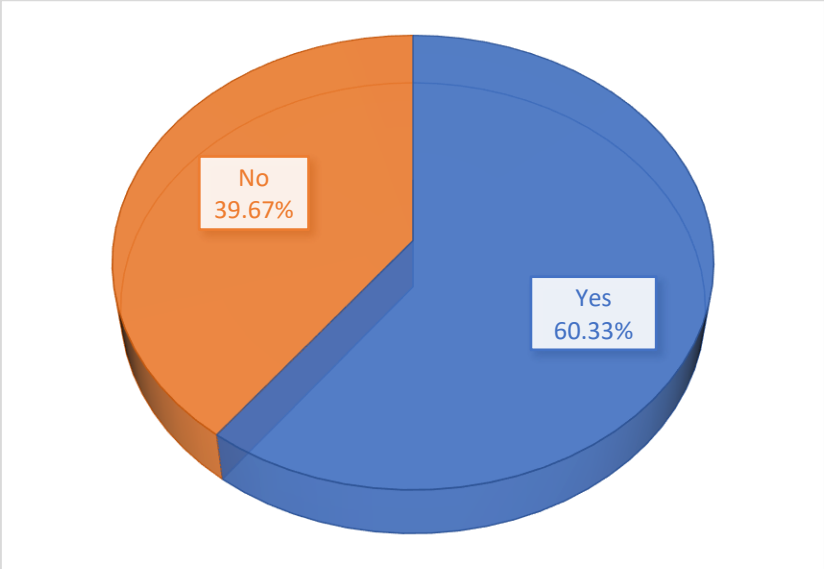

Figure 5. 7: Inquiry-based-learning

In summary, the background information of this study showed that teachers have different levels of experience, age, qualifications, participation in training courses, and number of students in their classes. The majority of the participants have more than 16 years of experience, most of them have a Bachelor's degree, almost half of them had attended ICT training courses, and two thirds of the participants had attended inquiry-based learning courses.

5.4. Additional analysis of background information variables

Based on the participants' responses, the researcher split their attendance of ICT training courses across their experience, age and qualification to describe the difference between the groups of each variable.

The researcher split the participants' ICT training courses attendance across their experience, shown in Table 5.1 and Figure 5.8. The result indicated that almost half of teachers who had experience ranging from 1-5, 11-15 and more than 16 years had not attended ICT training

courses. However, the results showed that the number of teachers with an experience ranging from 6 to 10 years who had not attended ICT training courses (40) is higher than those who had attended the courses (30). So, overall, the results showed no significant association between teachers' attendance at an ICT training courses and the length of teachers' experience.

Table 5. 1: Experience * ICT training courses Cross-tabulation

		ICT training courses		Total
		Yes	No	
Experience	1-5	24	19	43
	6-10	30	40	70
	11-15	21	18	39
	16+	81	72	153
Total		**156**	**149**	**305**

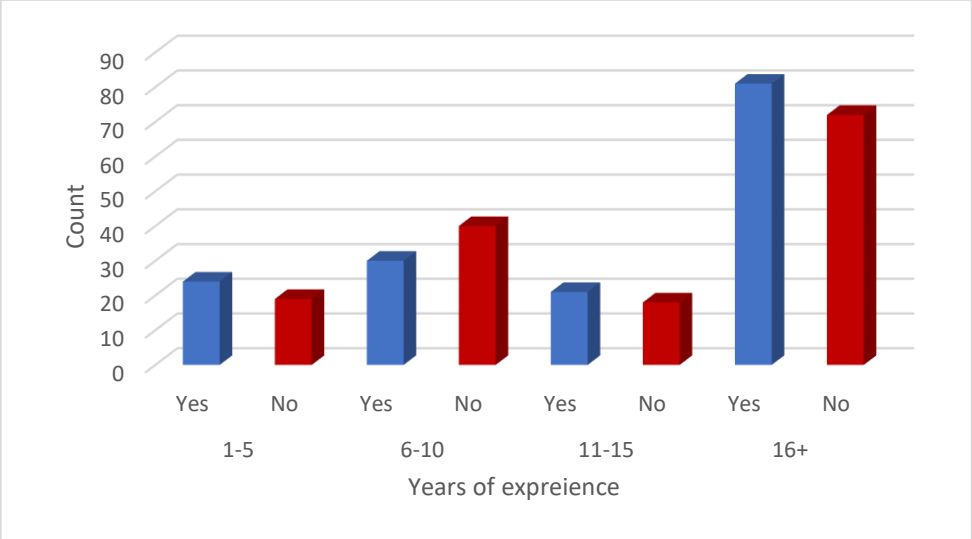

Figure 5. 8: Participants' ICT training courses across their experience

Furthermore, in terms of teachers who had attended ICT training courses across their age range as shown in Table 5.2 and Figure 5.9, the results revealed that almost half of teachers

whose ages ranged from 20-30, 31-40 and more than 51 years had not attended ICT training courses. However, the findings illustrated that the number of teachers with age ranging from 41 to 50 years who had attended ICT training courses (61) is higher than those who had not (43). So, there is no significant association between attending ICT training courses and age of teaches.

Table 5. 2: Age * ICT training courses Cross-tabulation

		ICT training courses		Total
		Yes	No	
Age	20-30	16	18	34
	31-40	52	58	110
	41-50	61	43	104
	51+	27	30	57
Total		**156**	**149**	**305**

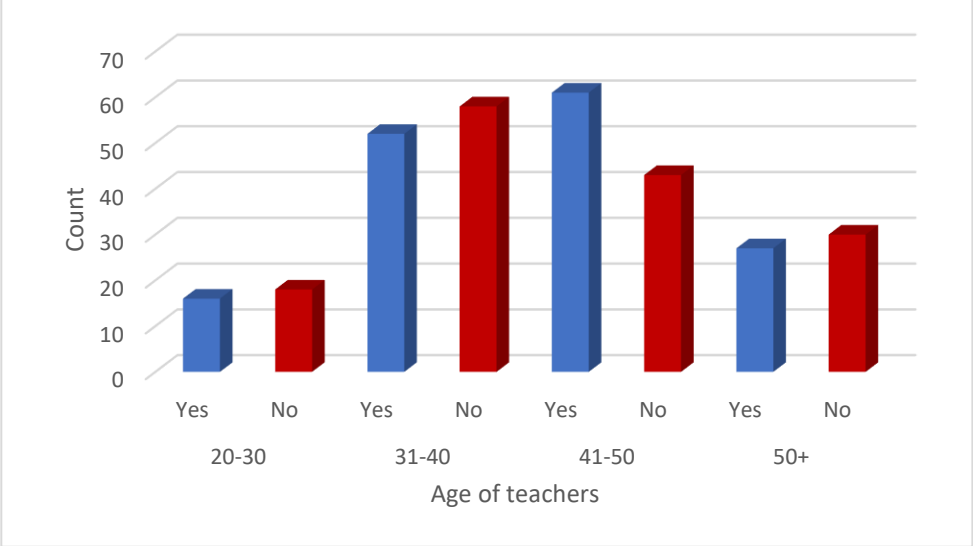

Figure 5. 9: Participants' ICT training courses across their age

With regard to teachers who had attended ICT training courses across their qualification, Table 5.3 and Figure 10 revealed that the majority of teachers (262) have a Bachelor's degree and almost half of them (133) had not attended ICT training courses. Also, unexpectedly, 14

from 37 teachers who have a Master's degree had not attended ICT training courses. So, there is no significant association between attendance at an ICT training courses and the teachers' level of qualification.

Table 5. 3: Qualification * ICT training courses Cross-tabulation

		ICT training courses		Total
		Yes	No	
Qualification	Diploma	3	2	5
	Bachelor	129	133	262
	Master	23	14	37
	PhD	1	0	1
Total		**156**	**149**	**305**

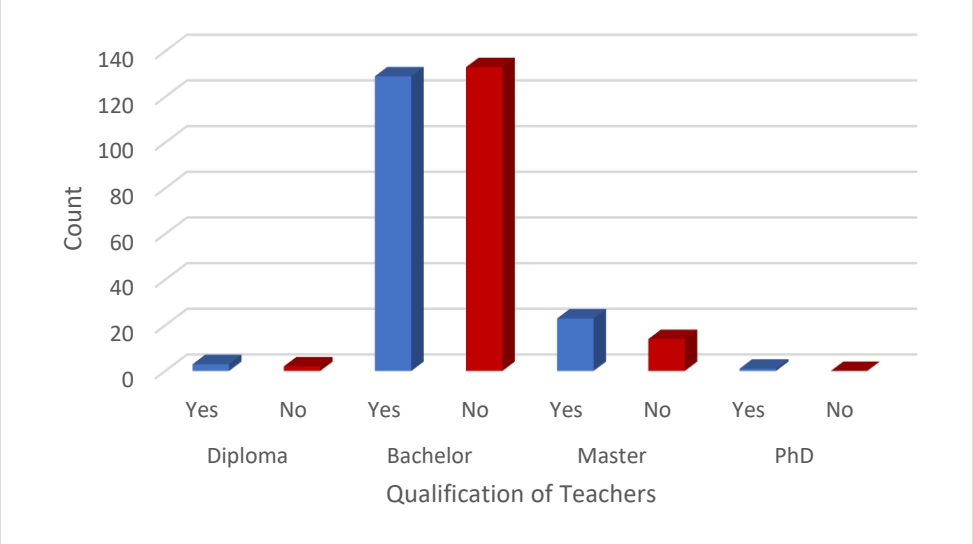

Figure 5. 10: Participants' ICT training courses across their qualification

5.5. Teachers' Implementation of different science classroom activities

This section of the questionnaire was concerned with the implementation of science classroom activities by teachers in science lessons. The implementation of science classroom activities was rated based on 15 items which were divided into 3 parts: dialogic teaching

activities; the use of ICT tools; and the use of traditional teaching resources. Teachers were asked to rate how often they implemented such activities on a scale ranging from 'very often' to 'never', as shown in Table 5.4.

Table 5. 4: The response scale of teachers' implementation item

very often	often	sometimes	hardly ever	never
5	4	3	2	1

In this section, central tendency measures were used to present a descriptive statistic of the results. The mean averages and standard deviation were used to measure to what extent primary teachers implemented dialogic teaching, the use of ICT tools, and the use of traditional teaching resources in their science lessons. Moreover, a standard scale for the use of science classroom activities and teachers' attitudes was constructed based on the mean averages. The standard scale consists of 3 levels (high, medium, low) derived from the following equation (Alharbi, 2014, p.97):

$$\frac{\text{the scale's highest value } - \text{ the scale's lowest}}{\text{Number of levels}} = \frac{5-1}{3} = 1.33$$

Alharbi (2014) defined high, medium and low levels to indicate to the level of the mean of each statement and the total mean of each theme based on the following levels shown in Table 5.5.

Table 5. 5: Interpretation of standard scales

Scales range	Scales levels
3.68 to 5.00	High
2.34 to 3.67	Medium
1.00 to 2.33	Low

5.5.1. Dialogic teaching activities

Regarding the classroom activities which support dialogue, Table 5.6 reveals that teachers often implemented activities that support dialogue in the science classroom with a mean score ranging from (4.54) to (3.26). Question and answer sessions were given the highest mean rating of (4.54) according to teachers' responses. On the other hand, the lowest-scoring activity was student-student talk (3.26). The results also showed that teacher-led, whole-class discussion, and teacher-student talk, were given high mean scores of (4.38) and (4.32) respectively. In terms of organising a small group for talk and discussion, teachers rated themselves with a mean score of (3.44).

Table 5. 6: Descriptive statistics for the classroom activities that support dialogue

NO.	Dialogue activities	Mean	Std. Deviation	Statement level
1	Question and answer	4.54	0.653	High
2	Teacher-led whole class discussion	4.38	0.693	High
3	Teacher-student talk	4.32	0.792	High
4	Small group discussions	3.44	1.031	Medium
5	Student-student talk	3.26	0.985	Medium

5.5.2. Teachers' use of ICT

In terms of teachers' usage of ICT tools, as shown in Table 5.7, the data projector was the most widely used ICT tool with a mean score of (4.01). Conversely, digital microscopes were the least used ICT tool, with a mean score of (1.92). The use of a classroom computer, and watching video and images, had nearly the same result, with mean scores of (3.78) and (3.80) respectively. There is a surprising result related to using the IWB, with a low mean score of (2.15) as rated by teachers. The findings also indicated that teachers rated their use of the Internet with a mean score of (3.02). On the other hand, teachers rated their usage of electronic books with a mean score of (2.38).

Further, the findings shown in Table 5.7 illustrate higher standard deviation for the level of use of each item than is in Table 5.6. This might indicate that many teachers use each ICT tool more than others.

Table 5. 7: Descriptive statistics for the use of ICT tools

NO.	ICT tools	Mean	Std. Deviation	Statement level
1	Data projector	4.01	1.156	High
2	Watching a video/Images	3.80	1.084	High
3	Classroom computer	3.78	1.248	High
4	The internet	3.02	1.391	Medium
5	E-books	2.38	1.428	Medium
6	Interactive whiteboard	2.15	1.356	Low
7	Digital microscope	1.92	1.157	Low

5.5.3. Traditional teaching resources

Regarding the use of traditional teaching resources by teachers, the results shown in Table 5.8 indicate that most teachers used science books, with a significant mean score of (4.64). The results also illustrate that the level of use of science books shows lower standard deviation, which indicates more similarity of use by different teachers. Further, teachers rated their use of white/blackboards, which resulted in a high mean score of (4.40). Finally, the use of science displays had a mean score of (3.98).

Table 5. 8: Descriptive statistics for traditional teaching resources

No.	Traditional resources	Mean	Std. Deviation	Statement level
1	Science books	4.64	0.699	High
2	White/blackboard	4.40	0.966	High
3	Science displays	3.98	0.958	High

It is clear that teachers used traditional resources in a high level compared to their use of ICT tools. This may be because teachers need to use science textbooks to teach science content in order to follow the Ministry of Education's instructions to cover science curriculum by the end of the term. Teachers also use the white/blackboard as provided to all classrooms to assist teachers in their teaching practices.

In brief, teachers use dialogic teaching at a high level, with a total mean score of all items at (3.99). The total mean score of using ICT tools in science classes was (3.01), which can be described as a medium level of use. The use of traditional teaching resources was the highest total mean score (4.34), as shown in Table 5.9.

Table 5. 9: Descriptive statistics for all science classroom activities groups

No.	Use of science classroom activities groups	Total mean	Total Std. Deviation	Statement level
1	Dialogue activities	3.99	0.547	High
2	ICT tools	3.01	0.900	Medium
3	Traditional resources	4.34	0.569	High

5.6. Analysis of teachers' attitudes

In this part of the questionnaire, the participants were asked to rate their level of agreement with statements regarding their attitudes towards the effect of dialogic teaching and the use of ICT on students' learning and interaction in science classrooms. This part consists of 27 items divided into three parts: the first part includes various items to explore teachers' attitudes towards using dialogic teaching; the second part related to the use of ICT tools; the third part investigates the use of ICT to support dialogic teaching. For each item, the response was scored in SPSS as follows: strongly agree = 5, agree = 4, neutral = 3, disagree = 2 and strongly disagree = 1 as shown in Table 5.10. Thus, the mean score, standard deviation and the statement level were used to measure teachers' attitudes. The standard scale presented

in section 5.5 was also used in this section to indicate the level of the mean of each statement and the total mean of each theme.

Table 5. 10: The response scale teachers' attitudes items

strongly agree	agree	neutral	disagree	strongly disagree
5	4	3	2	1

5.6.1. Teachers' attitudes towards dialogic teaching

The results shown in Table 5.11 indicated that teachers strongly supported implementing dialogic teaching in the science classroom with a total mean score of (4.39). Interestingly, the results revealed that all items showed a high level of teachers' attitudes towards interacting and talking with their students and the effect of dialogic teaching on students' learning and interaction in science lessons.

Teachers' attitudes towards using dialogic teaching were assessed, as shown in Table 5.11, with reference to ratings 17 items. The mean of participants' responses ranged from (4.87) to (4.01). For instance, the statement 'I feel satisfied when students answer difficult questions' was most strongly endorsed by teachers, with a mean score of (4.87), followed by strong support for the statement 'I think that science talk is useful in the science classroom', where the mean score was (4.65). However, the findings also showed that the lowest ranked item was the statement 'Students often ask their peers when they need help in the classroom or with homework', where the mean score was (4.01).

Table 5. 11: Descriptive statistics for the effect of dialogic teaching

No.	Statement	Mean	Std. Deviation	Statement level
1	I feel satisfied when students answer difficult questions	4.87	0.375	High
2	I think that science talk is useful in the science classroom	4.65	0.549	High
3	I think that science talk promotes student learning	4.62	0.562	High
4	Science talk stimulates the development of reasoning skills	4.59	0.606	High
5	Science talk encourages student to understand the objectives of the science lessons	4.55	0.577	High
6	I think that science talk increases students' engagement	4.55	0.653	High
7	Teacher-student talk develops students' problem solving and critical thinking	4.53	0.618	High
8	I often use different methods to engage my students in science talk	4.53	0.579	High
9	I try to develop shared understanding of science.	4.50	0.618	High
10	Science talk challenges students to clarify, or re-state ideas	4.49	0.664	High
11	I encourage my students to participate and share ideas	4.46	0.643	High
12	Science talk encourages students to help each other	4.44	0.677	High
13	Science talk support students to be more independent learners	4.34	0.718	High
14	Students often ask me when they need help in the classroom or with homework	4.25	0.675	High
15	Student-student talk develops students' problem solving and critical thinking	4.23	0.814	High
16	Students prefer talking science with peers rather than in front of the class	4.02	0.901	High
17	Students often ask their peers when they need help in the classroom or with homework	4.01	0.765	High

5.6.2. Teachers attitudes towards ICT

In terms of the effect of using ICT tools on learning and interaction, teachers' attitudes were measured by asking them to rate 3 items, as shown in Table 5.12. The total mean score of participants' responses was (4.55) which indicates a strong belief in and high level of use of ICT tools in primary science lessons.

The mean scores for the three statements were nearly the same. The mean score for the statement 'I use ICT tools to promote student-student talk about science subject', was (4.56). There was similarly strong support for the statements 'ICT tools improve students' understanding of science concepts' and 'ICT tools support me to achieve teaching aims', where the mean scores were (4.55) and (4.54) respectively.

Table 5. 12: Descriptive statistics for the effect of using ICT tools

No.	Statement	Mean	Std. Deviation	Statement level
1	Using ICT tools increases science classroom interaction	4.56	0.667	High
2	ICT tools improve students' understanding of science concepts	4.55	0.658	High
3	ICT tools support me to achieve teaching aims	4.54	0.716	High

5.6.3. Teachers attitudes towards using ICT to support dialogic teaching

In terms of using ICT tools to support dialogic teaching in science lessons, teacher's attitudes were assessed by asking them to rate 7 items. Considering Table 5.13, there is a significant perceived effect of using ICT to support dialogic teaching on students' learning and interaction. The total mean score was (4.35), which clearly indicates a high level of support for using ICT to support dialogic teaching among teachers.

For instance, the results showed that the statement 'Using ICT tools and science talk improves students' motivation to learn' was most strongly endorsed by participants, with a mean score

of (4.49). The mean scores for the statement 'ICT tools provide opportunities for the explanation and exchange of ideas' and the statement 'I use ICT tools to promote teacher-student talk about science subject', were (4.37) and (4.34), respectively. The participants also strongly agreed with the statement 'In the future I plan to make more use of ICT to support talk and discussion in science classrooms' where the mean score was (4.44). However, the mean score of the statement 'I use ICT tools to promote student-student talk about science subject' was the lowest at (4.21).

Table 5. 13: Descriptive statistics for the effect of using ICT tools to support dialogic teaching

No.	Statement	Mean	Std. Deviation	Statement level
1	Using ICT tools and science talk improves students' motivation to learn	4.49	0.684	High
2	In the future I plan to make more use of ICT to support talk and discussion in science classrooms	4.44	0.637	High
3	ICT tools provide opportunities for the explanation and exchange of ideas	4.37	0.681	High
4	I use ICT tools to promote teacher-student talk about science subject	4.34	0.727	High
5	ICT tools provide opportunities for class discussion in the science classroom	4.31	0.724	High
6	Using ICT tools and science talk supports students to express and reformulate ideas	4.30	0.736	High
7	I use ICT tools to promote student-student talk about science subject	4.21	0.793	High

5.7. Challenges

This part of the questionnaire examined the challenges that hinder the use of dialogic teaching and the use of ICT in science classrooms. This section is limited to 3 items as shown in Table 5.14. However, the qualitative data revealed further challenges that may hinder the implementation of dialogic teaching and the use of ICT tools as detailed in section 6.6 in the next chapter.

As shown in Table 5.14, teachers strongly agreed that 'The number of students in the class hinders students' talk and discussion', where the mean score for the statement was (4.35). The mean score for the statement 'I think that science talk would leave less time for other activities', was (3.63). However, the mean score of the statement 'I (do not) find it challenging to talk and interact when using ICT tools with primary science students' was the lowest mean at (2.97). The code of this item was reversed by the researcher to preserve the tone of the statements of the questionnaire.

Table 5. 14: Descriptive statistics for the challenges of the use of dialogic teaching and ICT

No.	Statement	Mean	Std. Deviation	Statement level
1	The number of students in the class hinders students' talk and discussion	4.35	0.895	High
2	I think that science talk would leave less time for other activities	3.63	1.078	Medium
3	I (do not) find it challenging to talk and interact when using ICT tools with primary science students	2.97	1.218	Medium

5.8. Inferential statistical tests

In this section, three types of inferential statistical tests were used: Mann-Whitney test; Spearman's rank correlation and Multiple regression analysis. The aim of using these different tests is to investigate the difference between the groups of this study, to make inferences from the data of this study, and suggest a deeper explanation for the phenomena being investigated. These tests were used based on the type of the data, which are discussed in the following section.

5.8.1. Test of normality

It is an important step to investigate whether the type of data is parametric or nonparametric to conduct further inferential statistics. According to Cohen et al. (2018, p.727), "nominal and ordinal data are often considered to be non-parametric". Moreover, Cohen et al. (2018, p.727) stated that "Non-parametric data are often derived from questionnaires and surveys". In this study, the ordinal data was collected using questionnaires. In addition, the data is considered non-parametric if it fails to satisfy the normal distribution criterion (Field, 2013). Therefore, in order to determine whether the data of this study were normally distributed or not in a statistical test, the following techniques were used. Firstly, the values of skewness and kurtosis of items were farther away from 0.000, which means that the data were not normally distributed. Secondly, the test of normality using Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that all variables were statistically significant (less than 0.05), therefore, the data were not normally distributed. Accordingly, the data of this study is considered not normally distributed, hence, non-parametric tests were used to examine the data.

5.8.2. The Mann-Whitney test

According to Cohen et al. (2018), the Mann-Whitney test is a non-parametric test that can be used to compare the difference between two independent samples. In this study, the Mann-Whitney test was used using the SPSS program to find if there is a statistically significant difference between the results of participants who attended ICT training courses and those who did not attend ICT courses on variables (ICT tools). The null and alternative hypotheses of the Mann Whitney test in this study are:

H0: The two groups of participants are equal

H1: The two groups of participants are not equal

In the following, the Mann-Whitney tests were performed to examine the null hypotheses which were stated as follows:

1. **Null hypothesis.** There is no statistically significant difference regarding teachers who use the computer between teachers who attended ICT training courses and teachers who did not attend ICT courses.

Based on the Mann Whitney test, as shown in Table 5.15, the results showed that the p-value is 0.026 and since this is less than 0.05, therefore, the result of the two groups of participants is statistically significantly different and that the null hypothesis is rejected. Thus, it seems that teachers who attended ICT training courses might use classroom computer in primary science lessons more than those who did not attend ICT courses.

Table 5. 15: The Mann-Whitney test output for using a classroom computer

Test Statistics[a]	
	Classroom computer
Mann-Whitney U	9976.500
Wilcoxon W	21151.500
Z	-2.233
Asymp. Sig. (2-tailed)	0.026

a: Grouping Variable: ICT training courses

2. **Null hypothesis.** There is no statistically significant difference regarding teachers who use the data projector between teachers who attended ICT training courses and teachers who did not attend ICT courses.

Using the Mann-Whitney test, shown in Table 5.16, the results presented that the p-value is 0.067, therefore, the results of the two groups of participants is not statistically significantly different and the null hypothesis is accepted since the p-value is greater than 0.05. Thus, there is sufficient evidence to conclude there is no statistical difference between participants who

attended ICT training courses and those who did not attend ICT courses in using data projector in science lessons.

Table 5. 16: The Mann-Whitney test output for using data projector

Test Statistics[a]	
	Data projector
Mann-Whitney U	10298.000
Wilcoxon W	21473.000
Z	-1.835
Asymp. Sig. (2-tailed)	0.067

a: Grouping Variable: ICT training courses

3. **Null hypothesis.** There is no statistically significant difference regarding teachers who use the video and images between teachers who attended ICT training courses and teachers who did not attend ICT courses.

Based on test statistics using Mann-Whitney, shown in Table 5.17, the results presented that the p-value is 0.043, which means that the results of the two samples of participants is statistically significantly different and that the null hypothesis is rejected since the p-value is less than 0.05. Thus, it seems that teachers who attended ICT training courses might use video and images in primary science lessons more than those who did not attend ICT courses.

Table 5. 17: The Mann-Whitney test output for using video and images

Test Statistics[a]	
	Video and images
Mann-Whitney U	10126.500
Wilcoxon W	21301.500
Z	-2.023
Asymp. Sig. (2-tailed)	0.043

a: Grouping Variable: ICT training courses

4. **Null hypothesis.** There is no statistically significant difference regarding teachers who use the IWB between teachers who attended ICT training courses and teachers who did not attend ICT courses.

Based on test statistics, as shown in Table 5.18, the results showed that the p-value is 0.031 and since this is less than 0.05, the result of the two groups of participants is statistically significantly different and the null hypothesis is rejected. Thus, it seems that teachers who attended ICT training courses might use IWB in primary science lessons more than those who did not attend ICT courses.

Table 5. 18: The Mann-Whitney test output for using an IWB

Test Statistics[a]	
	IWB
Mann-Whitney U	10062.000
Wilcoxon W	21237.000
Z	-2.153
Asymp. Sig. (2-tailed)	0.031

a: Grouping Variable: ICT training courses

5. **Null hypothesis.** There is no statistically significant difference regarding teachers who use the internet between teachers who attended ICT training courses and teachers who did not attend ICT courses.

Using the Mann-Whitney test, shown in Table 5.19, the results presented that the p-value is 0.006 which is less than 0.05, therefore, the results of the two groups of participants is statistically significantly different and the null hypothesis is rejected. Thus, it seems that teachers who attended ICT training courses might use the internet in primary science lessons more than those who did not attend ICT courses.

Table 5. 19: The Mann-Whitney test output for using the internet

Test Statistics[a]	
	Internet
Mann-Whitney U	9538.000
Wilcoxon W	20713.000
Z	-2.768
Asymp. Sig. (2-tailed)	0.006

a: Grouping Variable: ICT training courses

6. **Null hypothesis.** There is no statistically significant difference regarding teachers who use the digital microscope between teachers who attended ICT training courses and teachers who did not attend ICT courses.

Based on test statistics using Mann-Whitney, shown in Table 5.20, the results presented that the p-value is 0.007, which means that the results of the two samples of participants is statistically significantly different, and the null hypothesis is rejected since the p-value is less than 0.05. Thus, it seems that teachers who attended ICT training courses might use digital microscope in primary science lessons more than those who did not attend ICT courses.

Table 5. 20: The Mann-Whitney test output for digital microscope

Test Statistics[a]	
	Digital microscope
Mann-Whitney U	9703.500
Wilcoxon W	20878.500
Z	-2.712
Asymp. Sig. (2-tailed)	0.007

a. Grouping Variable: ICT training courses

7. **Null hypothesis.** There is no statistically significant difference regarding teachers who use the E-books between teachers who attended ICT training courses and teachers who did not attend ICT courses.

Using the Mann-Whitney test, shown in Table 5.21, the results presented that the p-value is 0.001 which is less than 0.05, therefore, the different between the two groups of participants is statistically significantly different and the null hypothesis is rejected. Thus, it seems that teachers who attended ICT training courses might use E-Books in primary science lessons more than those who did not attend ICT courses.

Table 5. 21: The Mann-Whitney test output for E-Books

Test Statistics[a]	
	E-Books
Mann-Whitney U	9160.500
Wilcoxon W	20335.500
Z	-3.337
Asymp. Sig. (2-tailed)	0.001

a. Grouping Variable: ICT training courses

5.8.3. Spearman's correlation analysis

The Spearman's correlation (Muijs, 2011) was used to investigate the correlation between teachers' usage of dialogic teaching and their attitudes towards dialogic teaching. Based on the correlation coefficient shown in Table 5.22, the results showed that there was a moderate positive correlation between teachers' usage of dialogic teaching and their attitudes towards dialogic teaching. However, some teachers might believe in the effect of dialogic teaching on students' learning and interaction, but some of them may not yet use such an approach in their science lessons.

Table 5. 22: Spearman correlation between dialogue use and dialogue attitude

			Dialogic teaching use	Dialogic teaching attitude
Spearman's rho	Dialogic teaching use	Correlation Coefficient	1.000	0.443**
		Sig. (2-tailed)		0.000
		N	305	305
	Dialogic teaching attitude	Correlation Coefficient	0.443**	1.000
		Sig. (2-tailed)	0.000	
		N	305	305

**. Correlation is significant at the 0.01 level (2-tailed).

Spearman's correlation was also used to investigate the correlation between teachers' use of ICT and their attitudes towards ICT. Based on the correlation coefficient shown in Table 5.23, the results showed that there was a weak but significant positive correlation between teachers' use of ICT and their attitudes towards ICT. However, some teachers might believe in the effect of ICT on students' learning and interaction, but they may not yet use ICT tools as much as they believe in their science lessons.

Table 5. 23: Spearman correlation between ICT use and ICT attitude

			ICT use	ICT attitude
Spearman's rho	ICT use	Correlation Coefficient	1.000	0.285**
		Sig. (2-tailed)		0.000
		N	305	305
	ICT attitude	Correlation Coefficient	0.285**	1.000
		Sig. (2-tailed)	0.000	
		N	305	305

**. Correlation is significant at the 0.01 level (2-tailed).

The Spearman's correlation was used to investigate the correlation between teachers' use of dialogic teaching and their attitudes towards using ICT and dialogic teaching together. Based on the correlation coefficient shown in Table 5.24, the results showed that there was a weak but significant positive correlation between teachers' use of dialogic teaching and their attitudes towards using ICT and dialogic teaching. Hence, teachers might believe in the effect of using ICT and dialogic teaching on students' learning and interaction, but some of them may not yet use dialogic teaching in their science lessons as much as they believe in the effect of using ICT and dialogic teaching.

Table 5. 24: Spearman correlation between dialogue use and attitudes towards ICT and dialogue

			Dialogic teaching use	**ICT and dialogue attitudes**
Spearman's rho	**Dialogic teaching use**	Correlation Coefficient	1.000	0.273**
		Sig. (2-tailed)		0.000
		N	305	305
	ICT and dialogue attitudes	Correlation Coefficient	0.273**	1.000
		Sig. (2-tailed)	0.000	
		N	305	305

**. Correlation is significant at the 0.01 level (2-tailed).

The Spearman's correlation was used to investigate the correlation between teachers' use of ICT and their attitudes towards using ICT and dialogic teaching. Based on the correlation coefficient shown in Table 5.25, the results showed that there was a weak but significant positive correlation between teachers' use of ICT and their attitudes towards using ICT and dialogic teaching. Hence, teachers might believe in the effect of using ICT and dialogic teaching on students' learning and interaction, but they may not yet use ICT tools in their science lessons.

Table 5. 25: Spearman correlation between ICT use and attitudes towards using ICT and dialogue

			ICT use	ICT and dialogue attitudes
Spearman's rho	ICT use	Correlation Coefficient	1.000	0.240**
		Sig. (2-tailed)		0.000
		N	305	305
	ICT and dialogue attitudes	Correlation Coefficient	0.240**	1.000
		Sig. (2-tailed)	0.000	
		N	305	305

**. Correlation is significant at the 0.01 level (2-tailed).

Thus, an increase of teachers' implementation of dialogic teaching in science lessons may lead to improving their attitudes towards using ICT and dialogic teaching. Similarly, an increase of teachers' use of ICT in science lessons may lead to improving their attitudes towards using ICT and dialogic teaching.

5.8.4. Multiple regression analysis

According to Muijs (2011, p.139), multiple regression can be used to investigate "the relationship between one 'effect' variable, called the dependent or outcome variable, and one or more predictors, also called independent variables". It might be expected that positive attitudes towards dialogic teaching and positive attitudes towards ICT leads to an increase in positivity of attitudes towards using ICT and dialogic teaching together.

Osborne and Waters (2002) noted that the normal distribution of variables should be considered as it one of the important assumptions of multiple regression. Moreover, Williams et al. (2013) stated that investigating the regression residuals is important to check the assumption of the normal distribution. Figure 5.11 reveals that regression residuals are approximately normally distributed.

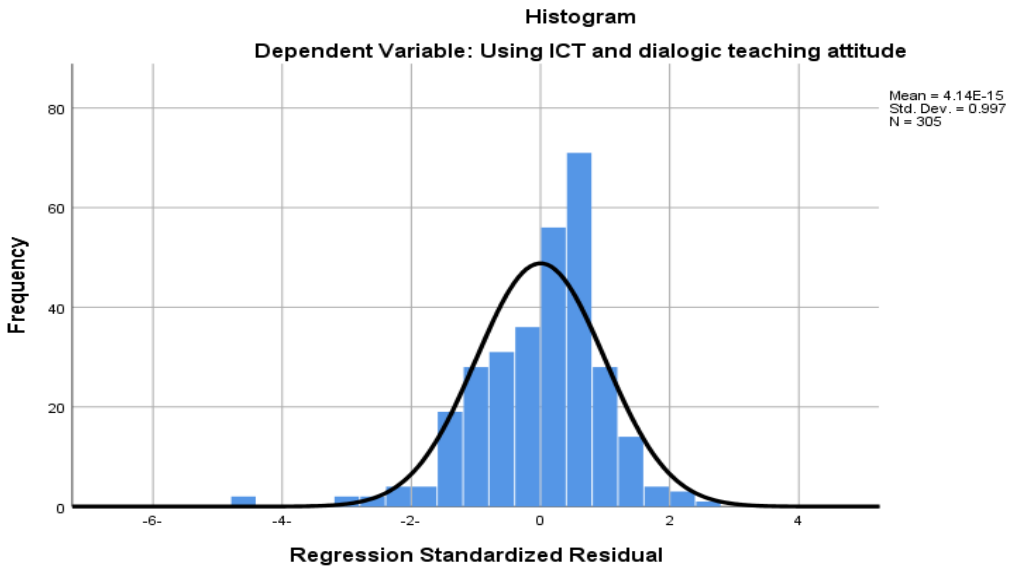

Figure 5. 11: Histogram of regression standardized residual

In addition, a normal predicted probability (P-P) plot of regression standardized residual was used to examine if the residuals are normally distributed. Figure 5.12 shows an approximately normal distribution of P-P plot of regression standardized residual.

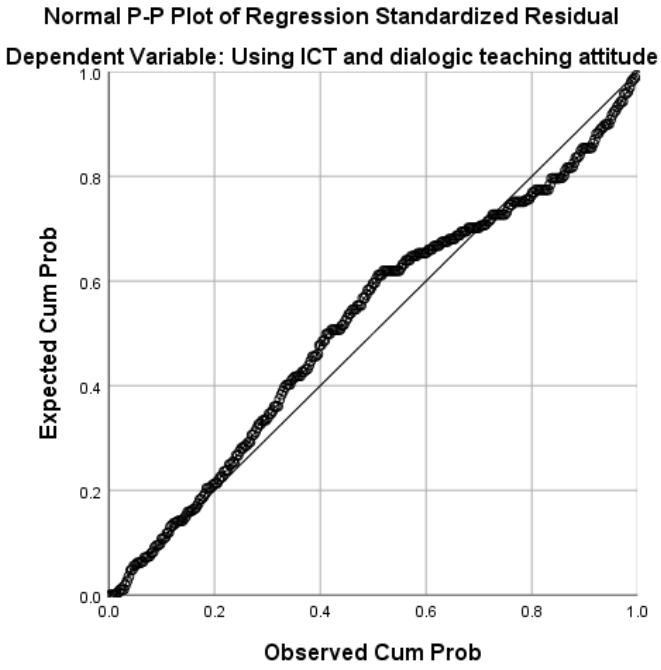

Figure 5. 12: Normal P-P plot of regression standardized residual

As a result, the multiple regression analysis was used to examine the effect of the independent variables - teachers' attitudes towards use of dialogic teaching and their attitudes towards using ICT tools - on the dependent variable used which was teachers' attitudes towards using ICT and dialogic teaching together.

As shown in Table 5.26, The R squared value is 0.599, which indicates that the model fit is about 59.9% of the variance of using ICT and dialogic teaching attitude. The fitted regression model of using ICT and dialogic teaching attitude is very highly significant (ANOVA: F=225.153, p-value < .001, as shown in Table 5.27). Therefore, the results suggest that the model used in this study is sufficient for explaining the relationship between the dependent and independent variables. In this study, the model predicted that dialogic teaching attitude will contribute to increase in attitude towards using ICT and dialogic teaching by 0.460 which is very highly significant (t=8.590, p-value < .001) as shown in Table 5.28. Also, as shown in Table 5.28, positive attitudes to use ICT will lead to increase in the attitude towards using ICT and dialogic teaching by 0.572 which is very highly significant (t=16.661, p-value < .001).

Table 5. 26: Model regression summary

Model Summary [b]				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.774[a]	0.599	0.596	0.362

a: Predictors: (Constant), ICT attitude mean, dialogic teaching attitude mean

b: Dependent Variable: Using ICT and dialogic teaching attitude mean

Table 5. 27: Regression mode; analysis of variance ANOVA

ANOVA [a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	58.925	2	29.463	225.135	0.000[b]
	Residual	39.522	302	0.131		
	Total	98.447	304			

a: Predictors: (Constant), ICT attitude mean, dialogic teaching attitude mean

b: Dependent Variable: Using ICT and dialogic teaching attitude mean

Based on the results shown in Table 5.28, the regression equation that predicts attitude towards using ICT and dialogic teaching based on the linear compilation of dialogic teaching attitude and attitude towards ICT use is as follows:

$$Y = a + (b1 \times X1) + (b2 \times X2)$$

$$\text{Using ICT and dialogic teaching attitude} = 0.270 + (0.460 \times \text{Dialogic teaching attitude}) + (0.527 \times \text{ICT attitude})$$

Table 5. 28: Regression model estimating parameters

Coefficients [a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	*Std. Error*	*Beta*		
1	(Constant)	-0.270	0.249		-1.087	0.278
	Dialogue attitudes mean	0.460	0.054	0.323	8.590	0.000
	ICT attitudes mean	0.572	0.034	0.627	16.661	0.000

a. Dependent Variable: Using ICT and dialogic teaching Attitude mean

To conclude, the results indicate that there is a very highly significant relationship at the .05 level between teachers' attitudes towards using ICT and dialogic teaching and teachers'

attitudes towards use of dialogic teaching and their attitudes towards using ICT tools. As expected earlier, the results showed that dialogic teaching attitudes and attitudes towards ICT are equal predictors of the attitude towards using ICT and dialogic teaching based on the result shown in Table 5.28.

5.9. Summary

In this chapter, the findings of the quantitative phase are presented in detail. The chapter begins by describing the response rate and background information of participants, including experience, age, qualifications, number of students in classes, and training courses attended. This section is followed by a presentation of the additional analysis of background information variables in order to describe the differences between the groups of each variable. Then, teachers' implementation of science classroom activities was examined. For instance, teachers used different activities to support dialogic teaching in a high level, with a total mean score of (3.99). The total mean score of the use of ICT tools was (3.01), which can be described as a medium level of use. The use of traditional teaching resources was the highest total mean score (4.34).

The fifth section of this chapter examines teachers' attitudes towards the effect of dialogic teaching, and the use of ICT tools, on students' learning and interaction in science classrooms. Teachers strongly supported the implementation of dialogic teaching in the science classroom, with a total mean score of (4.39). Teachers also expressed strong belief in the use of ICT tools in primary science lessons, with a total mean score (4.55). In terms of using ICT tools to support dialogic teaching in science lessons, the total mean score was (4.35), which clearly indicates a high level of support for the use of ICT and dialogic teaching among teachers. This was followed by an investigation of the challenges that hinder the use of dialogic teaching supported by ICT tools, such as the number of students in the classroom and general time constraints.

In the final part of this chapter, three inferential statistical analyses were performed to test hypotheses, to make inferences from the data of this study, and to suggest a deeper explanation for the phenomena being investigated. In the following chapter, the qualitative findings are presented in order to more deeply understand teachers' perceptions of the use of ICT and dialogic teaching in primary science classrooms in Saudi Arabia.

Chapter Six: Qualitative Analysis

6.1. Introduction

This chapter aims to present the qualitative findings derived from the semi-structured interview and the open question in the questionnaire. The quantitative findings described in the previous chapter revealed some issues that needed to be investigated deeply. Therefore, semi-structured interviews were conducted with 12 primary science teachers to gain a more comprehensive understanding of the use of ICT and dialogic teaching in primary science classrooms in Saudi Arabia. A description and analysis of the qualitative findings collected from the participants were presented. Furthermore, some findings related to some advantages and challenges of both dialogic teaching and ICT are repeated. The reason for repeating these advantages and challenges is to provide more explanation and support them with examples and to enrich the discussion of the findings. The following section provides a short summary of the qualitative data analysis techniques.

6.2. Qualitative analysis technique

The researcher conducted face-to-face interviews with 12 primary science teachers in Riyadh in March 2020. A thematic analysis approach was used to analyse the data collected from the participants. The researcher followed the Braun and Clarke (2006, p.87) technique to analyse the data which consists of six phases: “familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report”. The data were analysed using NVivo software to facilitate the process of generating codes and themes and classifying them into categories. The software was used to create a neutral perspective on the data (see Chapter 4). Each teacher was given a unique name starting with (ST) from (Science Teacher) followed by a number from 1 to 12.

6.3. Qualitative analysis themes

The qualitative analysis revealed three main themes: attitudes and perceptions, implementation, and challenges. The three main themes were then categorised into several subthemes, some of which were categorised further, as shown in Table 6.1.

Table 6. 1: Analysis of themes of the interviews

Themes	Sub-themes	Categories
Attitudes and perceptions	Dialogic teaching attitudes and perceptions	Teachers' attitudes towards using dialogic teaching
		Teachers' perceptions of the purpose of dialogic teaching
		Teachers' perceptions of the advantages of dialogic teaching
	ICT attitudes and perceptions	Teachers' attitudes towards the use of ICT
		Teachers' perceptions of the advantages of using ICT
	Attitudes towards using ICT and dialogic teaching	
Implementation	Dialogic teaching activities	Teacher-student dialogue
		Student-student dialogue
		Questions and answers
		Student group-discussions
		Teacher-led class discussion
		The teacher's role in dialogue activities
		The student's role in dialogue activities
	Teachers' use of ICT	
	Using ICT and dialogic teaching	
	Using traditional teaching resources	
Challenges	Dialogic teaching challenges	Challenges related to the teacher
		Challenges related to the student
		Challenges related to the school
		Challenges related to the science curriculum
		The number of students in the class
		The time constraints
	ICT challenges	External challenges: Lack of sufficient ICT tools Lack of technical support Lack of training courses
		Internal challenges: Challenges related to the teacher Challenges related to the student Challenges related to the school

Table 6.1 presents the themes, sub-themes and categories that emerged from the interviews and the open question in the questionnaire. These are presented in detail in the following sections.

6.4. Theme One: attitudes and perceptions

This first main theme concerns science teachers' attitudes towards and perceptions of using ICT and dialogic teaching in primary science classrooms. This theme was divided into three sub-themes: first, dialogic teaching attitudes and perceptions; second, ICT attitudes and perceptions; third, attitudes towards using ICT and dialogic teaching. Each of these sub-themes is discussed in detail in the following sub-sections.

6.4.1. Dialogic teaching attitudes and perceptions

This sub-theme concerns the primary science teachers' attitudes towards and perceptions of the use of dialogic teaching in their science lessons. One interviewee provided a short description of dialogue as *"consisting of questions and answers, when I ask my students and they respond, this is a dialogue"* (ST12). In addition, the components of the dialogue that needed to be achieved before conducting a dialogue were identified as follows:

> *the dialogue approach is based on three main points. The first point is the scientific background of the student. The second point is an appropriate environment for dialogue or dialogue area. The third aspect is the way of implementing the dialogue* (ST4).

In the interviews, various perceptions of the participants and several advantages of using dialogic teaching were given which may indicate an interest in and a familiarity with the use of dialogue in the science classroom. This sub-theme highlights the participants' attitudes and perceptions in three categories: teachers' attitudes towards dialogue, teachers' perceptions of the purpose of dialogue, and teachers' perceptions of the advantages of dialogue. In the following subsections, these categories are explained further.

6.4.1.1. Teachers' attitudes towards using the dialogic teaching approach

Most teachers (10 out of 12) demonstrated a positive attitude towards dialogic teaching in science lessons. These teachers perceived that the implementation of dialogic teaching in

primary science classrooms is considered as an important approach for interaction and communication in the classroom. For instance, one of the interviewees stated that:

> *regarding the use of dialogue in primary science classrooms, it is considered a very important factor as the fact that we are dealing with people. Dealing with people is dealing with relationships or dialogue and discussion. Dialogue is not limited to the teacher only, but also from both the teacher and the student (ST10).*

Positive attitudes towards dialogue were explicitly pointed out, for instance *"dialogue and discussion are a positive thing, especially from primary grades"* (ST10). Moreover, teachers referred to the importance of using dialogue in different ways, including the dialogue between the teacher and students and among students either in groups or pairs. The dialogue between a teacher and the students was seen as *"important and essential in any topic"* (ST5). In addition, the dialogue between students was perceived as *"a positive thing"* (ST12) to encourage students to learn through talking.

Some teachers also emphasized engaging students in classroom dialogue as a way of teaching because *"students themselves must be at the centre of the dialogue"* (ST10); therefore *"the student must participate in the lesson"* (ST12). Other experiences were reported that illustrate teachers' positive feelings when engaging students in learning activities. Teachers identified four main kinds of positive feelings towards engaging students in the learning process. One feeling was that "*students must be involved, and this is what I love because I engage students in a better way"* (ST2). The second feeling was that the teacher *"would be happy if students exchange with things or information they saw at home"* (ST12). The third feeling about implementing dialogic teaching was described by a participant as follows: "*I was enjoying it while teaching them"* (ST2). The final comment on positive feeling was explained as *"the more students participate, the more comfortable I am; the students' connection with me is good, meaning that the student's thoughts are engaged with me"* (ST12).

In addition, teachers were asked about their preference for using dialogue or direct instructions and lecturing students in science lessons. The interviews revealed that almost all teachers (11 out of 12) prefer using dialogue and discussion in their science lessons. For example, a teacher commented that he preferred talking with his students because he thought that it was *"an essential thing and linking the information to the lessons that [they*

have had] previously" (ST3). In this regard, instead of dominating the classroom talk and just delivering the science curriculum, teachers seemed to *"prefer using discussion and dialogue more and consider it a basic thing"* (ST7). As a result, teachers revealed that, in general, they *"do not prefer just telling and delivering the information"* (ST1) in science activities.

However, the use of dialogic teaching in primary schools was sometimes criticised for being ineffective compared to its use with the intermediate and secondary students. One perception expressed that *"If they are in an intermediate or secondary school, this method can be effectively implemented"* (ST6). In contrast, other teachers supported talking with primary students because they *"like to talk with students, especially in the primary grades"* (ST12). One interviewee explained his feelings about why he promotes talking and discussing with primary students: *"students are my children, and I must talk and discuss with them. I feel that the same upbringing of my children must be given in the classroom"* (ST8). Another reason was that teachers *"believe in using dialogue even with children"* (ST12).

Thus, many teachers have positive attitudes towards using the dialogic teaching approach in science lessons. They believe in talking and discussing with primary students to promote their learning rather than just telling and delivering information without engaging them. However, some teachers prefer using dialogue with intermediate and secondary students more than primary students.

6.4.1.2. Teachers' perceptions of the purpose of dialogic teaching

Teachers were asked about the purpose of using dialogic teaching in science lessons. Teachers identified several goals involved in using dialogue in science lessons. One of the goals was that the use of dialogue supports students' learning and understanding so that they can help *"students to learn as much as they can"* (ST1) and they *"will get the information as much as possible"* (ST10). Moreover, other teachers reported further points related to the information that students studied through dialogue and discussion for instance, *"it will be consolidated in their mind [and] the information is linked to the reality of the student's life"* (ST2).

Also, one of the purposes mentioned was that *"we connect the science topics with the environment to provide an opportunity for students to share and discuss"* (ST1) which promotes *"students' confidence in themselves"* so they can *"express what is in their mind comfortably"* (ST12). Another goal reported was that *"the aim of the dialogue is to reach*

persuasion, when the student discusses with you, finds out the information, and is convinced that this information is correct" (ST4). Therefore, it was considered by one teacher that *"the participation of all students is an essential thing, and the student extracts the information by himself"* (ST3) to be convinced.

Another important goal mentioned was that teachers supported *"moving away from the routine and the traditional way, avoiding the traditional methods"* (ST7). Similarly, one response supported the idea of avoiding using the traditional method in teaching science: *"I have a special goal that I am trying indirectly to transfer the information to students with their understanding, or that I alert students to an important point that they were not aware of"* (ST5).

Generally, it can be seen from the above that there are several purposes connected with using the dialogic teaching approach that help students in their learning process. In the following section teachers' perceptions of advantages of dialogic teaching are presented.

6.4.1.3. Teachers' perceptions of the advantages of the dialogic teaching approach

Regarding the advantages of using dialogic teaching, teachers mentioned several benefits of using dialogue in science lessons. Teachers' perceptions are presented in the following sub-sections. The section starts with ways of supporting students' learning and then examines attracting students' attention; improving the learning environment; developing the students' competence in using dialogue and developing students' characteristics.

6.4.1.3.1. Supporting students' learning

Most teachers (9 out of 12) agreed that supporting learning is one the main advantages of using dialogue. Teachers perceived using dialogue in science lessons as an important strategy for students *"to understand the lesson through discussion and dialogue"* (ST6). In addition, the use of dialogue as a strategy helps teachers as it *"determines the students' background scientific level and determines the student's level of understanding of the lesson; therefore, the information from the lesson reaches the student quickly. [it involves] moving the student's mind to think and search for answers"* (ST8). This can be achieved by challenging students' thinking, exposing students to new ideas and involving students in dialogue and discussion rather than just receiving their answers passively. Thus, through implementing the dialogic

approach teachers can observe the result and can ensure that students are understanding the lesson.

6.4.1.3.2. Attracting students' attention

Attracting students' attention is one of the advantages perceived by teachers of using dialogue in science lessons. More than half of the participants (7 out of 12) revealed that using dialogue helped them to increase students' concentration and keep them attentive and alert. For example, one of the participants (ST9) said that *"the dialogue has the benefit of changing students from being silent, calm and sleepy, to being active, participative and attentive".* Another response to this question included an observation of the process: *"when I make the lesson dialogical and there is a discussion, students concentrate more, and of course, they benefit more"* (ST1). As a result, while implementing the dialogic approach students concentrate more which is reflected in their learning outcomes.

6.4.1.3.3. Improving the learning environment

Teachers mentioned that one of the advantages of using dialogue in science lessons is to develop an optimal classroom climate to support the social, psychological and cultural aspects of students' learning. Teachers reported four advantages related to the improvement of the learning environment: increasing interaction and cooperation; the freedom to express their views; increasing respect; breaking down barriers. Accordingly, these advantages are presented below.

First, almost all teachers agreed that using dialogue in science lessons increase interaction and cooperation in the classroom. For instance, one teacher expressed that using dialogue in science lessons *"enrich[es] the cooperation between [students], support[s] the social aspect and interaction with each other"* (ST3). Consequently, the use of dialogue promotes connection of all people in the class as it *"helps students to collaborate with each other and with the team they represent, so that there will be a cooperation between them and me"* (ST4). In addition, another benefit of using dialogue is that it supports *"opening the door for the social relations between students; the student cannot become isolated in the session"* (ST8). As a result, building such a positive environment would increase students' interaction and enhance their engagement in the learning activities.

Second, half of the participants reported that talking with students encouraged the students to represent their points of view freely and enable them to speak without fear and interruption which impacts on their learning effectively. For instance, a teacher observed that *"it is important in science subjects that students express their points of view"* (ST10). Therefore, teachers try to *"give students the value of saying their opinion, differentiating, knowing and saying that I have nothing wrong"* (ST1). Similarly, it is important in science lessons to *"let the student talk comfortably and without interrupting him, [you] let the student talk about what is in his mind, even if he is wrong"* (ST12). Therefore, teachers can challenge students' thinking, enabling them to address misconceptions and increase their understanding of scientific concepts.

Third, some teachers considered respect as an essential factor to develop a healthy learning environment in the classroom, either for teachers or for students. Therefore, to build a healthy learning environment *"the student must be respectful, students raise their hands if they want to participate in the dialogue, not disturbing the class"* (ST8). When students follow their teachers' role *"during the discussion with each other, there is mutual respect between them"* (ST3). As a result, the advantage is that *"he will be polite with you … and benefiting from you"* (ST8).

Fourth, some of the respondents indicated that the use of dialogue in the classroom helped to break down the barriers between them and their students and among students themselves, to build a positive learning environment. For example, some students feel shy during dialogue and discussions; then, *"they would greatly break the barrier starting with their classmates then they can discuss with the teacher"* (ST7). In addition, it was mentioned that by using the dialogue method with students, *"the most important point I see is breaking down the barrier between the student and the teacher… so that the student is not afraid to say or present the information he has"* (ST4). Therefore, breaking down the barriers and encouraging students to talk and discuss may help them in their learning and in their life.

6.4.1.3.4. Developing the students' competence in using dialogue

Another advantage reported by four interviewees was that talking with students develops their skills of dialogue and to be respectful when they talk and deal with others. Using the dialogue strategy helps students to *"learn the way of the dialogue and speech. Providing students' skills on how to respond and discuss"* (ST2). Additionally, talking with other students

helps them to *"develop the skill of dialogue with the teacher [and] with students that are trying to help their classmates"* (ST4).

In addition, some teachers believed that students have the skills of dialogue, but *"it needs to be strengthened, it needs explanation, it needs patience"* (ST1). However, another teacher pointed out that students lack dialogue skills and *"the dialogue has become very bad at home and at school, so even the dialogue in the classroom has become very limited"* (ST12). The probable reason for that was mentioned: *"I see this even in our society now, the ethics and culture of dialogue are missing"* (ST12). Therefore, in order to solve this issue, it was suggested that *"students are supposed … to be trained in using dialogue strategies"* (ST4).

6.4.1.3.5. Developing students' characteristics

All teachers agreed that implementing the dialogic teaching approach developed some primary students' traits which help them in their learning and in their life in general. The interviewees perceived four characteristics that are affected by dialogue: confidence, boldness, thinking and problem-solving skills, and leadership. Accordingly, these characteristics are presented below.

Firstly, the participants believed that using dialogue with primary students developed their self-confidence and assisted them to avoid shyness and be *"confident of themselves even if they make a mistake and they should not be afraid of making mistakes"* (ST5). It was confirmed that one of the main reasons for talking with students is *"that it gives them confidence in themselves"* (ST12).

Secondly, improving the self-confidence of students may enable students to be bold during discussions in science lessons. It was commented that it is important to give students opportunities to talk either in groups or in pairs because *"the weak student is strengthened and becomes bold, and his character is built, and he becomes an excellent student and tries his best"* (ST8). Similarly, when teachers ask students to discuss with each other, *"there will be boldness among the students; some students may not be bold when discussing with the teacher, but the boldness will be increased among their classmates"* (ST7).

Thirdly, implementing the strategy of dialogue in the classroom can stimulate students' thinking and problem-solving skills. It was indicated that using the dialogical approach is

crucial *"for the development of the students' thinking"* (ST1). In addition, giving a student the opportunity to discuss *"will strengthen his way of thinking"* (ST1). Regarding problem-solving skills, one teacher mentioned that one of the benefits of using dialogue is it *"makes students able to solve problems they may face in life"* (ST8). This is confirmed by the following point of view from another teacher: *"I see that it develops problem solving skills"* (ST2).

Fourth, in some interviewees' responses, it was pointed out that dividing students into groups and giving them an opportunity to talk and discuss and make a competition between these groups contributes to developing the leadership skill for some students. For instance, one response explained that *"you will be amazed to see that they are leading everywhere, and they may develop their leadership skills"* (ST6). In addition, some students are willing to lead their classmates in science activities. This can be noticed by teachers as they *"realize that some students are already looking for leadership qualities and want to come out to have the role of a leader or a teacher"* (ST5).

In summary of the advantages of dialogic teaching, the interviewees reported a variety of advantages of using the dialogic teaching approach in science lessons that related to students, the learning environment, and the skills of dialogue. These advantages support students' learning and help develop their cultural and psychological aspects.

6.4.2. ICT attitudes and perceptions

This section illustrates teachers' attitudes towards the use of ICT and teachers' attitudes towards the advantages and disadvantages of using ICT in teaching science. This section is divided into two categories: teachers' attitudes towards the use of ICT, and teachers' perceptions of the advantages of using ICT. In the following subsections, these categories are presented.

6.4.2.1. Teachers' attitudes towards the use of ICT

The interviews revealed that almost all teachers have positive attitudes towards using ICT tools in science lessons. It was reported that using ICT in science lessons plays a key role in students' daily life *"because science is about acquiring new experiences and knowledge and linking students to the daily life"* (ST2). In addition, positive attitudes towards specific ICT tools were expressed such as teachers' attitudes to the IWB *"as it can solve 80% of the lesson for*

me, 80% means its use is significant" (ST11) as well as *"it serves [teachers] in terms of content presentation and explanation"* (ST4). Moreover, although the internet access was not provided in most classrooms, it was seen as an important tool that can be used effectively when teaching science lessons. For instance, one teacher perceived that *"the internet is very important nowadays in lessons"* (ST8). In the following quote is an explanation about the importance of the internet in teaching in science lessons "*The internet has shifted me a great way in teaching science. I mean anything I want to explain to students, I can bring it up"* (ST8). Moreover, another teacher described e-books as *"one of the best things the Ministry of Education has provided* (ST9).

However, the use of ICT was also criticised for not having an impact on student learning and achievement. For instance, one teacher mentioned that the use of applications available for students which provide ready answers for all questions may *"destroy their thinking skills, instead of thinking about how they can answer the questions"* (ST4). Another teacher commented that when using ICT tools, *"it is possible that the student will be distracted from me, and I will not be able to control them"* (ST9). In contrast, one response explained that *"it is better to have an iPad with students so that they use it during the lesson to search, see images and videos where the focus is more"* (ST5).

In sum, teachers generally have positive attitudes towards using ICT tools when teaching science lessons. However, some teachers expressed negative aspects of using ICT such as the effect of insufficient ICT tools which are discussed in more detail in the challenges theme. Other teachers pointed out the negative impact of ICT on students' thinking skills and the teacher's management of the classroom

6.4.2.2. Teachers' perceptions towards the advantages of using ICT

Primary science teachers mentioned four advantages related to using ICT in teaching science: usability; supporting learning; attracting students' attention and using ICT for preparation. In the following subsections, these advantages are explained in detail.

6.4.2.2.1. Usability

From the interviews, eight out of twelve teachers revealed that feeling comfortable is one of the main advantages of using ICT in science lessons. It was perceived that using ICT *"helped*

us and put us at ease more than before" (ST3). That might be because the *"modern technology has highly facilitated [their work]"* (ST8). As a result, from their experience, teachers found that using ICT facilitates science concepts for students because. For example, when explaining *"the cell, I have a picture of the plant and animal cells in the e-book. I show the pictures of the cell directly"* (ST8). Moreover, in the open question of the questionnaire, one of the participants commented that *"the technology is useful for clarifying information to students in the shortest and easiest way".* Thus, most teachers have positive feeling towards ICT as it facilitates their teaching practice and saves their time and effort.

6.4.2.2.2. Supporting learning

Supporting learning was considered a core benefit of using ICT to understand science concepts and consolidating information. In the interviews with teachers, it was stated that *"the more technologies are available, the more information is understood by students"* (ST12). As a result, this might emphasize the importance of the availability of ICT to increase students' understanding. However, it depends on teachers' competency in ICT use to enhance students' learning and achievement. An example was given in the interviews of using ICT tools to explain *"the chemical changes, when I show it on the projector, the student sees a fire, sees a gas and some things that have changed, and the information can be understood"* (ST5). It was also believed that using ICT to present information and science concepts *"will consolidate information in students' minds … provide enrichment for students in an excellent way"* (ST8). Therefore, as noted by some teachers, using ICT tools in classrooms and science labs can enhance students' experiences and extend their scientific knowledge.

6.4.2.2.3. Attracting students' attention

With regard to attracting students in science lessons, it was indicated that using ICT tools helps students to pay more attention during science lessons. For example, when students *"saw images and the movements of colours in the lesson, they would pay attention [more]through the school day"* (ST9) because *"students feel excited when I use technology"* (S12). Consequently, teachers try to use a variety of ICT tools to attract students' attention such as *"the use of sounds, images, particularly videos and screens as students like it"* (ST1). Therefore, it might be important to use a variety of ICT tools to attracts students' attention and imagination and increases their concentration in science lessons.

6.4.2.2.4. Preparation of the lessons

The use of ICT can help teachers to prepare science lessons in advance. It was explained that the use of ICT is beneficial for science lessons' preparation. For instance, one of the participants explained that *"I can search and prepare things from home and save it on my email so that I can display it to students, discuss questions and present lessons"* (ST12). In addition, teachers referred to the importance of using the internet in preparing science lessons. For example, teachers may use the internet *"for the preparation and distribution of the topics, sometimes [they] need to look for more information"* (ST1).

In sum, teachers identified four main benefits of using ICT in science lessons: usability of ICT; supporting students learning; attracting students' attention; and helping teachers to prepare and explain science lessons. In the next section, teachers' attitudes towards using ICT and dialogue are presented.

6.4.3. Teachers attitudes towards using ICT to support dialogic teaching

Having discussed teachers' attitudes and perceptions towards the dialogic teaching approach and teachers' attitudes to and perceptions of using ICT in primary science classrooms, it is important to highlight teachers' attitudes towards using ICT to support dialogic teaching in science lessons.

Teachers can use ICT tools to promote interaction and engagement in the classroom. Most of the participants (10 out of 12) agreed that the use of ICT in science lessons supports the interactivity between teachers and students and between students themselves. For instance, it was believed that *"technology supports dialogue and discussion with students and broadens their perceptions, so the benefits in the end are that information will reach students in a better way, which saves a lot of time and provides more spaces for dialogue"* (ST12). In addition, the use of ICT when teaching science may increase the opportunities for talking because *"the more we present and display using devices to students, the more dialogue and discussion we have in the classroom"* (ST3). Moreover, in the open question in the questionnaire, one of the participants commented that *"I consider the use of devices and tools with discussions has a very positive impact on students' learning and understanding of science"*. Also, some teachers referred to the importance of using specific ICT tools to support dialogue. For instance, using the IWB *"is significant even for the dialogue, the student can participate, answer and discuss.*

the interactive whiteboard is called an interactive board because everyone interacts with it" (ST11).

However, it was indicated by some teachers that the use of ICT does not necessarily promote the dialogue in the classroom. One of the reasons was that the role and tendency of the teacher is more important than using, for example, CDs prepared by teachers for commercial purposes. For instance, one of the participants revealed that *"I do not think it supports dialogue … it is almost a ready-made thing, this is not interactive. My viewpoint is that I am now in front of them for a real, real interaction"* (ST1). Another reason was that ICT tools do not support the dialogue because *"students' personality differs from one to another, some of them prefer using devices, others prefer teacher teaching, and others prefer to learn with their classmates"* (ST10). On the other hand, teachers believe in using ICT in science lessons because it is *"very comfortable for teachers, therefore, it will give them more time for dialogue and discussion"* (ST12). Teachers also believed that using ICT in science lessons helped students regardless of their different personality to *"talk more … and get more attention … if we choose an image and a video, it is more than one sense which increase their interaction"* (ST10).

In brief, whilst a minority mentioned that using ICT does not support dialogue, most teachers agreed that using ICT promotes students' interaction and engagement and gives more opportunities for dialogue and discussion.

6.5. Theme Two: Implementation

The second main theme presents various activities that can be implemented by teachers in science lessons. In the interviews, teachers identified several strategies and different tools they use in their teaching process. This theme is divided into four sub-themes: dialogic teaching activities, teachers' use of ICT, using ICT to support dialogic teaching, and traditional teaching resources. In the next sections, these sub-themes are explained.

6.5.1. Dialogic teaching activities

This sub-theme discusses the strategies that teachers use to support dialogue and discussion in science lessons. Teachers expressed five potential strategies to promote dialogic teaching in their science classroom: teacher-student dialogue; student-student dialogue; question and

answer; group discussion; and teacher-led class discussion. In addition, the role of teachers and students during implementation of dialogic teaching activities was illustrated. In the following sub-sections, all these sub-themes are presented.

6.5.1.1. Teacher-student dialogue

All teachers agreed that they often talk and discuss with their students in science lessons "*as an educational approach"* (ST12). One of the participants indicated that the dialogue can be used "*at the beginning of any lesson, I mention the topic, and then I start talking with students about the topic"* (ST3). The probable reason for using the dialogue at the beginning of the lesson is "*to know the knowledge of students about the specific topic"* (ST6). Other teachers mentioned that they use the dialogue "*at the beginning and during the lesson"* (ST11) and "*almost at the end of the lesson to know or evaluate students' understanding"* (ST7). Teachers may prefer using the dialogue with their students as a strategy of their teaching because they want "*to control the dialogue of the topic more"* (ST1). This can help the teacher in eliciting students' ideas, challenge students' thinking and control the classroom. Yet, the teacher could consider offering students opportunities to talk with their peers as part of their learning experiences either in pairs or dividing them into groups to develop their social skills.

6.5.1.2. Student-student dialogue

More than half of the participants explained that they provide opportunities for students to talk with each other. Teachers indicated that it is important to give students time to talk and discuss with each other because "*when students learn from their classmates, they can understand even better than the teacher"* (ST4). One teacher also highlighted that the teacher "*encourages students to interact and discuss with each other"* (ST9). In addition, one of the responses explained the way of encouraging students to talk with each other; when a "*student has a question, I direct the question to his classmates to discuss it between themselves, and I act as a listener and observe students' answers"* (ST4). Thus, teachers can ask their students to talk and discuss with each other to build their scientific knowledge and to understand science concepts.

6.5.1.3. Question and answer

In the interviews, all teachers agreed that one of their dialogue activities was to question students and respond to their answers in science lessons. One of the participants (ST5) stated

that "*questions are the gateway of discussion in science subjects"*. Teachers identified three main reasons why they use questioning techniques. The first reason for questioning students is to "*achieve the main goal of the lesson"* (ST3). Secondly, teachers ask students to look for the answer "*which might act as a motivation for students* [*to learn*]*"* (ST1). Thirdly, teachers tend to ask students questions "*in order to attract students and give them space to talk"* (ST12). Therefore, the teacher can ask students probing questions to promote their learning to build their understanding of science concepts.

6.5.1.4. Students' group discussion

Most teachers (10 out of 12) reported that they distribute their students into groups to talk and discuss some scientific points. Teachers can arrange students in groups "*so that the smart and the weak are in the same group to help each other through dialogue and discussion"* (ST8). When dividing students into groups, "*each group has one person as a leader, who is the junior teacher, so each group of students has a pillar"* (ST5) and then teachers try to "*make a competition between them"* (ST7). The main reason for distributing students into groups so that they discuss and "*understand a certain point with each other"* (ST12). And help each other to learn and understand science lessons.

6.5.1.5. Teacher-led class discussion

Most teachers (9 out of 12) indicated that they often lead the whole discussion in their teaching practice. In science lessons, teachers "*try to extract information from the student and discuss it with all students"* (ST1). In addition, one teacher explained that "*I use the dialogue with all students and work together to connect topics to things in the environment. I accept all answers that I receive and direct them to others"* (ST1). One of the main reasons mentioned for using the teacher-led class discussion strategy was to *"come up with a point or an idea that need to be understood"* (ST11). Another reason was to help students to "*focus and I can control their discussion, so they go away from the lesson content"* (ST1).

To sum up, teachers generally use various activities that support dialogic teaching in science lessons to provide opportunities for students to talk and express their points of view which attracts students' attention and supports their learning. However, in the interviews, teachers said they tended to use the teacher-student dialogue and questioning students more than other strategies in their science lessons. This might be because teachers want to control the classroom and prevent unwelcomed behaviour from students. Thus, teachers could become

more aware of using a productive dialogic teaching that enables students to explain, share opinions and engaging with others to obtain greater understanding. In the next section, the teacher's role in using dialogic teaching is presented.

6.5.1.6. The teacher's role in dialogue activities

Teachers were asked about their role when conducting dialogic activities. All teachers mentioned various responsibilities related to using dialogue activities in science lessons. One of the main roles of teachers "*is to control the discussion"* (ST7) and "*manage the dialogue between teachers and students and between students themselves"* (ST1). The reason of controlling classroom dialogue was to "*direct and control [students'] answers if they are far away from the topic until we reach the correct answer"* (ST3). It was also indicated that the role of the teacher is to "*regulate the time of the dialogue and choose the elements to be presented in the dialogue"* (ST10). In addition, one of the participants explained his moderating role during implementing dialogic teaching as: "*my role here is an assistant in education so that I am not constantly delivering information to the student quickly, and instead let the student discover this information by himself"* (ST10). Thus, although teachers support the dialogic approach, some tended to control the class more than others to avoid distraction and diversion from the topic.

6.5.1.7. The students' role in dialogue activities

Teachers were also asked about students' roles during implementing dialogue activities. One of the responses reported that "*students are the main focus of the dialogue"* (ST11). As a result, it was stated that "*the student's role is sometimes to enrich information, sometimes answer a specific question and sometimes may be to express a point of view"* (ST12). In addition, when conducting a scientific experiment, the student's role is to "*describe things to us and tell us what happened"* (ST2). Another role was that "*the student should be attentive and interactive during the discussion"* (ST5). Finally, it was emphasized that "*the student must be respectful, students raise their hands if they want to participate in the dialogue, not disturbing the class"* (ST8). These roles are important to support students' learning during dialogue and discussion.

6.5.2. Teachers' use of ICT

Teachers were asked about their use of ICT tools in science lessons. The interviews indicated that teachers use a variety of hardware and software depending on its availability in classrooms or in science labs or in the LRCs. In the interviews, it was revealed that almost all teachers use a computer, projector, PowerPoint and watching videos and images to show science content to their students. However, these ICT tools may not be fully provided in all classrooms or in science labs. For instance, it was commented that "*I use the projector. It is just in the first, second and third grades"* (ST6). In addition, eight teachers reported that they use e-books, YouTube and Microsoft Word when teaching science. For example, one of the participants explained that "*YouTube is important sometimes. For example, sometimes I need to show the moon, planets and solar system, then I use YouTube"* (ST2).

Additionally, half of the participants mentioned that they use the iEN portal to help them in presenting to students' scientific concepts that are included in the portal. Teachers use the iEN portal, for instance, to show images and videos or download science e-books. The iEN was described as it "*includes lessons that can be displayed in an excellent way"* (ST3). One of the participants expressed his positive feeling towards the portal. He said: "*I use iEN application which is the top application I have"* (ST10).

Moreover, five teachers pointed out that they use their own personal smartphone and the internet when teaching science. For instance, it was explained that "*sometimes I need to search for more information, so I use my mobile phone for the preparation of the lesson, for example, from the internet"* (ST11). In addition, although most teachers reported that they do not have IWBs, only three referred to their use of the IWB in introducing science concepts. One of the teachers commented that "*I use the interactive whiteboard, and frankly, it is good and very comfortable"* (ST10). Moreover, it was mentioned that "*the interactive whiteboard is an excellent tool as it serves us in terms of presentation and explanation"* (ST4). However, due to the lack of some ICT tools in schools, a few teachers indicated use of other tools such as digital microscope, CDs and google. Regarding using digital microscopes, teachers may need to use microscopes in science lessons, for instance, to show cells under the microscope to students.

The results also revealed that some schools are provided with a LRC which contains a variety of ICT tools. For instance, one respondent explained that "*government schools are provided with one learning resources centre and there is a schedule for teachers and their students to go to the learning resources centre"* (ST8). However, it was mentioned that "*sometimes going to another room might waste our time as we have only 45 minutes for the lesson and there are some classes who want to go to it at the same time"* (ST12). Therefore, it would be important to provide all classrooms with essential ICT tools to use them effectively to assist teachers' teaching and support students' learning.

To sum up, teachers use a number of ICT tools that are available in classrooms, science labs and LRCs. Yet, due to the lack of some ICT tools in schools, some teachers use their own devices to show students science concepts. In the following section, the use of ICT to support dialogic teaching is discussed.

6.5.3. Using ICT to support dialogic teaching

In interviews, most teachers (10 out of 12) commented that they use ICT tools that are available in classrooms to initiate dialogue, increase interaction and elaborate elements to start discussion. Teachers mentioned several ICT tools that they usually use to support dialogue such as projector, images and videos, and e-books. Teachers may use ICT at the beginning of the lesson to "*start talking and discussion as a starting point to be used in the dialogue"* (ST7). In addition, it was reported that teachers can "*use technology devices and students themselves can express their points of view about a specific video or images"* (ST10). An experience was expressed that "*I show a group of animals and students begin to engage in a dialogue among themselves to find out what the differences are and what the animals are"* (ST7). Another response was that "*I display several images through the projector and ask my students questions in a dialogical manner"* (ST9).

Furthermore, one of the participants explained his experience of using his mobile phone to start dialogue and discussion with his students. He said *"sometimes I use my mobile phone and my own internet to show a picture or video to discuss the topic... I try to ask and direct questions among my students*" (ST1). An example was given in the interviews of using ICT tools to support the dialogue *"I show pictures of mammals' lesson as an introduction to the lesson and then start a discussion about the topic"* (ST3). Another participant expressed that

"I use the iEN to present the lesson to my students, then I ask questions and start dialogue and discussion" (ST8).

In summary, teachers tend to use several ICT tools to illustrate scientific concepts and thereby help students to be engaged and stimulated to talk and discuss the concepts and express their opinions.

6.5.4. Traditional teaching resources

All teachers mentioned that they use traditional resources in science lessons. The traditional resources used by teachers include textbooks, whiteboard, and science lab materials such as test tubes, funnels and thermometers. In terms of science textbooks, all teachers and students are provided with science textbooks as a main resource for science lessons. Teachers need to follow the science textbook topics and finish the textbook at the end of the term, otherwise "*the supervisor or the principal may come and ask, why you did not complete it?"* (ST12). Moreover, teachers may use science textbooks to promote talking because "*the science curriculum is very excellent for dialogic teaching"* (ST7). In addition, all classrooms in all schools are provided with whiteboards to be used by teachers. For instance, it was explained that "*at the beginning of any lesson, we mention the topic, so I start talking with students about the topic … then I write the information on the whiteboard and talk about it"* (ST3).

Having discussed the implementation theme, all the challenges of implementation that were outlined in the interviews are presented in detail in the following section.

6.6. Theme Three: Challenges

In the interviews, the participants explained several challenges that hinder teachers from implementing the use of dialogic teaching and inhibit them from using ICT in science lessons. Therefore, this theme is divided into two sub-themes based on teachers' responses: challenges of dialogic teaching implementation and challenges of using ICT. Although both challenges were analysed and reported in separate section, there may be an overlap between dialogic teaching challenges and ICT challenges such as issues related to school, teachers and students. However, it is important to present each challenge separately in terms of its

context, causes and consequences. In the following section, the challenges of dialogic teaching implementation are presented.

6.6.1. Challenges of dialogic teaching implementation

Teachers reported several challenges that may prevent them from implementing the dialogic approach. Based on the teachers' responses, this sub-theme is divided into six types of challenges related to: teacher, student, school, science curriculum, the number of students in the class, the time constraints.

6.6.1.1. Challenges related to the teacher

One of the main hindrances of implementing dialogue can be teachers themselves. It was explained that teachers may become an obstacle for talking and discussing with students "*because they come to the class, and ask students to remain silent, so that just the teacher can talk. Just give information directly and go out from the class"* (ST12). One of the reasons of using the traditional teaching style is because they "*are trying to find the easiest way to facilitate their effort"* (ST10). Another reason given was because "*it is difficult to control students in the class"* (ST2). Similarly, some teachers think that "*sometimes the strategy of dialogue may cause annoyance or disturbance in the classroom"* (ST4). As a result, when teachers cannot control the class, they "*cannot use the dialogic approach or achieve the goals of the dialogic approach"* (ST7).

In addition, it was noted that teachers can be an obstacle to using dialogue due to their "*lack of knowledge of what the dialogic teaching approach is or what the correct way of using this strategy is"* (ST7). In this regard, one teacher advised that "*teachers should not [dominate] the educational process"* (ST2). Therefore, as one of the respondents suggested, teachers "*should explore, take training courses … it is essential for the science teacher to understand what is new in education, whether from a scientific point of view or in terms of teaching strategies, teaching method and planning"* (ST10). Thus, teachers may need to be trained to use the dialogic teaching approach effectively in their teaching practices. Avoiding having dominating role is also important in the science lessons particularly.

6.6.1.2. Challenges related to the student

The interviews revealed that students might be an obstacle to the dialogue within the science lessons due to several factors. One of the main factors mentioned was the students' age and knowledge. A comment in the open question in the questionnaire commented that it is difficult to use dialogue and discussion with primary students because "*primary students differ from intermediate and secondary students' levels".* Therefore, it was noted that *"if they are intermediate or secondary students, this method can be effectively implemented. But primary students I do not think so"* (ST6). One of the reasons is that "*the scientific level of [primary school] students does not encourage me to do this [approach]"* (ST4). Another reason reported was that "*the curriculum is dense for their age"* (ST1). However, other teachers, as discussed earlier, promoted talking with primary students to help them to learn effectively in science lessons.

Another perceived challenge was the students' skills of dialogue and their behaviour during dialogic teaching activities. It was highlighted that "*our culture of dialogue is almost non-existent even in our society, so this became very influential on students"* (ST12). In this regard, teachers emphasized two reasons for the absence of the skills of dialogue. The first reason is students' families: "*the father or the mother do not allow talking at home, so how do you expect me to let the student talk?"* (ST12). The second reason was that "*the devices and technology kept students away from what we were observing"* (ST5). This might be "*because the modern devices affected them and made them speak little even at home"* (ST12). It was also explained that *"I see that devices and games have affected them negatively. They do not have an etiquette of dialogue"* (ST11).

In addition, four teachers reported that some students behave negatively during the talking and teaching process. For example, some students "*like to talk, make chaos, laugh, and more. These behaviours became negative"* (ST1). Moreover, it was noted that some students suffer from a "*lack of discipline"* (ST5) because they are "*making noises … talk a lot and disturb the class"* (ST9). Furthermore, during dialogue and discussion, "*some students divert the dialogue away from the subject that we talk about"* (ST1). Therefore, teachers may have to control the dialogue and guide students during dialogue and discussion.

In addition, half of the participants mentioned that some students feel shy, introverted, and have difficulty of talking and discussing with their teachers and classmates. For instance, it was stated that "*I encountered many students who are shy and cannot communicate with me even if they have the right information"* (ST9). Similarly, it was reported that "*some students have difficulty pronouncing words which hinders them. [As a result of a speech impediments] Stuttering sometimes happens, which obstructs the dialogue, and the student will not be able to talk"* (ST12). Therefore, students might find it difficult to talk and might feel anxious, which may cause them to stutter more and make the interaction more difficult. Hence, teachers may need to build a healthy environment to help shy students and those who have difficulty talking to be engaged effectively.

6.6.1.3. Challenges related to the school

In the interviews, teachers illustrated that the school could hinder dialogue for two reasons. Firstly, the kind of school building, for instance a rented building, might make it difficult to use the dialogic teaching approach. In this regard, it was explained that "*we are in a rented building now, so I see it as an obstacle to using the dialogue among students in the classroom"* due to "*the size of the classroom [and] the number of students"* (ST7). Secondly, the lack of resources in schools may hinder teachers' use of dialogue. For example, it was stated that "*the lack of devices is one of the most important reasons that are always negative, so that it would be a hindrance to implementing the dialogical approach"* (ST4). In this regard, one of the respondents emphasized that "*the best way to use the dialogic approach when [ICT] tools are available to implement the dialogic approach in different ways to avoid the traditional teaching way"* (ST7). Therefore, rented buildings and lack of resources in schools may limit the opportunities to implement the dialogic teaching approach. However, the teacher can effectively implement the dialogic teaching approach without the resources and devices availability by encouraging students to explain opinions, share ideas, clarify thoughts and discuss findings.

6.6.1.4. Challenges related to the science curriculum

Most teachers (9 out of 12) reported that the content and information included in the science curriculum are from the main challenges of using the dialogic teaching strategy. For example, many teachers agreed that "*the curriculum is very dense"* (ST11). One teacher explained that

in the science curriculum there is "*an expansion in some topics"* (ST3). Furthermore, it was stated that "*I see that the curriculum of the primary school in particular has a lot of unimportant information"* (ST5), therefore, "*our curriculum focuses on quantity rather than quality"* (ST3). As a result, including non-essential information "*reduces the opportunities for discussion and students would not benefit from them"* (ST6). However, one of the respondents stated that "*in the new science curriculum now, there is a lot of spaces for the dialogue because of the rich information in science book"* (ST12). Thus, the teacher can choose the important topic to be discussed, exclude non-essential information from the dialogue and focus more on the important information.

In addition, due to the rich information in the science curriculum, it is difficult to explain the topics in just a few science lessons per week. For instance, one teacher stated that "*the curriculum is dense, and it needs to be balanced between the number of science lessons … we have many topics and few lessons"* (ST10). In this regard, another teacher suggested that "*science should be taught in five or six lessons a week, three and two lessons are not enough"* (ST11).

6.6.1.5. The number of students in the classroom

In the interviews and the open question in the questionnaire, the large number of students was considered as one of the main challenges of dialogue that face most teachers during science activities. For instance, most teachers agreed that "*we cannot apply the dialogic teaching approach with the large number of students in the class"* (ST3). In this regard, teachers raised questions: "*How do we engage in a discussion with 40 students? How can we distribute them into groups?"* (ST4). One of the respondents to the open question in the questionnaire stated that "*as long as the number of students is large in the classrooms, it is impossible to reach the required goals of the dialogue"*. Thus, it was suggested that "*the best way to implement the dialogic approach is that the number of students should be reasonable"*, ideally not more than 20 (ST4). From the open question in the questionnaire, one of the participants suggested that if "*the number of students exceeds 45 students … we need an assistant teacher"*. Therefore, providing an assistant teacher might be important to share the class tasks and help the teacher to implement the dialogic teaching approach effectively.

6.6.1.6. The time constraints

Half of the participants indicated that the time allocated for a science lesson is one of the main challenges of implementing the dialogic teaching approach. For instance, some teachers agreed that "*it is difficult for us to build a dialogue among students in a short time"* (ST10) because they noted that "*45 minutes for the science lesson is not enough"* (ST9). In this context, one of the participants illustrated one of the reasons for avoiding using dialogic teaching as "*it takes a lot of time. It will waste a lot of lessons time"* (ST11). This might be because the science "*curriculum is very dense"* (ST12) as discussed earlier. Therefore, a suggestion from one teacher was that "*the dialogue needs two lessons"* (ST4) which provide more time to implement dialogue and discussion to achieve science goals. This suggests that using the dialogue approach is reacted to teachers' skills and thus to their training.

6.6.2. Challenges of using ICT

Although most teachers have positive attitudes towards ICT and use a variety of ICT tools, there are a number of challenges that may hinder the use of ICT in science lessons. The participants in the interviews and in the open question in the questionnaire mentioned several challenges that hinder the use of ICT tools in science activities. These challenges were divided into two categories: external challenges and internal challenges.

6.6.2.1. External challenges

This category includes the external challenges that are related to factors outside the schools. The main challenges demonstrated by teachers include insufficient ICT tools; lack of technical support and lack of training courses.

6.6.2.1.1. Lack of sufficient ICT tools

The lack of ICT provision in classrooms and science labs was the major barrier that affected teachers' ICT use. For instance, one interviewee (ST11) stated that "*the unavailability of ICT is the main* challenge". Surprisingly, the main reason for the shortage of ICT tools was that "*there is no cooperation from the Ministry of Education to provide [ICT] tools … we contacted them and also we sent emails but the problem still the same"* (ST11). This was supported by another teacher (ST10), who stated that "*the Ministry of Education sometimes dose not provide the equipment and tools required by the teachers"*.

Additionally, another issue related to the lack of ICT tools in some schools was the inconsistent distribution of ICT tools to schools. It was indicated that "*there are differences between schools in the distribution of devices and maintenance"* (ST1). For example, the participant (ST11) illustrated that *"there are schools that have interactive whiteboard and a computer in each class, and there are other schools do not have any".*

The participants pointed out that both classrooms and science labs lack important ICT tools such as the internet, IWBs, and digital microscopes. Many teachers agreed that the internet was the main tool that they need to be provided to classrooms because "*there are things that we want to present directly by using the internet"* (ST12). Another reason for the importance of the internet for teachers was because "*there are some applications that need a strong [internet] connection"* (ST7). As a result, some teachers use the internet from their own mobile phone; for instance, one teacher (ST9) commented: "*I display e-books and some images through the projector via my mobile"*. Thus, it was suggested in the open question in the questionnaire that "*the internet should be provided for science teachers"*.

Further, many teachers indicated that they do not have IWBs in classrooms. For instance, one of the participants (ST11) stated that "*we do not have interactive whiteboards in our classrooms"*. However, in another interview, it was mentioned that there was "*only one smartboard in the learning resources centre"* (ST4). Thus, providing IWBs in all classrooms is essential for teachers to enhance their effort and save time.

Moreover, some teachers pointed out that science labs were not equipped with the essential tools for science teachers such as digital microscopes. For instance, the participant (ST3) commented that "*we do not have a microscope and our lab is not equipped"*. As a result, it was explained that "*sometimes I talk about the microscope, but my students do not know it"* (ST6).

Although the MoE in Saudi Arabia has allocated a huge budget for the provision of ICT tools to schools, teachers are still concerned about the availability of these tools.

6.6.2.1.2. Lack of technical support

Another critical factor that influences teachers' ICT usage is the lack of technical support and maintenance. Eight teachers were dissatisfied with the technical support that is provided by

the MoE. For instance, it was explained that "*there is a lack of availability of the technical support which is a major obstacle"* (ST7).

However, other teachers reported that there is maintenance, but it is clearly insufficient. For example, one of the participants (ST3) indicated that "*technical support is available, but it is very slow".* This was confirmed by (ST3), who said; "*if there is any damage to devices or one of them is broken, we wait a long time, then we stop using it until they fix it or change it"*. The probable reason for the lack of technical support is "*because there is no response or cooperation"* (ST4) from the MoE. Therefore, teachers may need constant technical support to assist them to use the available ICT tools.

6.6.2.1.3. Lack of training courses

Teachers who participated in the interviews and the questionnaire revealed that that there is a lack of ICT training for teachers which may hinder them from using ICT tools. For instance, one of the participants (ST9) revealed that "*the Ministry of Education did not focus on technology training".* As a result, it was considered that "*the training courses are very few"* (ST4). However, another teacher said: "*I do not see a shortage in the training courses"* (ST2). On the contrary, one of the participants (ST4) indicated that "*in terms of the Riyadh educational department, the number of courses is limited".*

The timing of the training courses was also considered to be an issue because most of training courses are conducted face-to-face in the morning of the school-day. One teacher (ST3) explained that "*it is difficult to attend a training course. We can only attend it in the evening ... while in the morning, I sometimes think that I am wasting my students' time if I leave them for a week to attend a training course".* Thus, it was shown that training courses' number and time are not adequate and suitable for teachers. Having discussed the external challenges of using ICT tools, the internal challenges are presented in the following section.

6.6.2.2. Internal challenges

The internal challenges in this category are related to the factors inside the schools. The interviews and the open question in the questionnaire revealed several internal factors such as school, teacher, and student.

6.6.2.2.1. Challenges related to the teacher

The teacher can be one of the major challenges to the implementation of ICT in the teaching process. One participant commented that "*the teacher's lack of use of educational software [and hardware] is one of the main obstacles"* (ST7). In this regard, the interviewees mentioned two factors that affect teachers' use of ICT tools. The first factor was related to teachers' skills and abilities to use ICT tools in teaching activities. For instance, one teacher (ST4) indicated that *"some teachers do not have skills to use these technologies, applications, and tools".* Further, the same participant (ST4) suggested that the reason for the lack of ICT skills is firstly *"because of the poor preparation, the second thing is that some of them are afraid of renewing their way of teaching, so they follow a certain routine"*.

The second reason mentioned was related to the lack of interest in attending training courses or self-development. One of the participants (ST10) emphasised that "*training courses are available, but teachers do not search for them and maybe less interested in them, I mean poor concern"*. Another teacher (ST9) said that "*many teachers consider the technology difficult, and they are lazy to learn about it".* However, teachers need to be motivated to use ICT tools by training teachers and providing ICT tools to all classrooms and science labs.

6.6.2.2.2. Challenges related to the student

The results revealed that students themselves can limit the use of ICT tools in science lessons. Most teachers reported that the individual differences between students influence the use of ICT tools. These differences can be related to "*their age and thinking level"* (ST4), or students who have "*hearing problems … intellectual disability … wearing glasses and those who cannot see well"* (ST5), or those who may have "*financial issues"* (ST7). Another teacher (ST2) concluded that there are some students who like "*memorisation, and there are visual students and others are analytical students"*.

Another factor related to students is the ethical issues which may arise when using ICT tools in teaching or learning activities. For example, one of the participants in the open question in the questionnaire explained that: "*I usually use YouTube to explain lessons, but students, during searching for the required lessons, browse unwanted channels and sections".* Therefore, another participant suggested that teachers must control and guide their students while using ICT tools to prevent: "*1. students' access to unethical websites and videos; 2.*

students' access to games; 3. students' preoccupation with other matters such as device type, price, clarity; and 4. messing with devices". As a result, students would benefit appropriately from ICT tools.

6.6.2.2.3. Challenges related to the school

The participants pointed out that the type of school building can be a barrier to using ICT tools. For instance, one of the participants explained that "*unfortunately, some schools are rented and not provided with sufficient technology and internet … the student has the right to learn in a suitable way"*. (ST5). Another participant from the open question in the questionnaire described the rented buildings, saying they "*were not prepared to accommodate these tools and devices".*

Another issue related to the school was that many schools were not provided with a science lab that could be successfully used to achieve science objectives. One of the participants from the open question in the questionnaire explained the situation from his experience: "*I work in a rented building, and we do not have a science lab to use technology".* However, it was illustrated that there are science labs in some schools but there are "*no devices included, just tables and chairs"* (ST3). As a result, one teacher (ST8) suggested that "*I want the Ministry of Education to develop the science laboratories with modern technology"*. Thus, schools need to be suitable to accommodate ICT tools and also need to be provided with science labs to achieve the science objectives.

6.7. Summary

This chapter was divided into three main themes: attitudes, implementation, and challenges. Each of these themes was divided into sub-themes which were also divided into categories. The interviews revealed that teachers, in general, have positive attitudes towards the dialogic teaching approach and the use of ICT and the use of ICT to support dialogic teaching. However, some teachers still use traditional teaching methods to deliver the content in their teaching practices. In addition, teachers mentioned several advantages of implementing dialogic teaching and the use of ICT in teaching and learning process. However, some teachers tend to control the dialogue and guide students' discussion to avoid distraction and going away from the topic.

Moreover, teachers mentioned that they use several strategies to promote dialogic teaching in the science lessons. Furthermore, teachers use a variety of ICT tools that are available in classrooms. However, although the government spent a huge budget to build new schools, train teachers and provide equipment, materials and ICT tools to schools, teachers still have critical issues with schools, resources and teachers' professional development that may hinder the implementation of dialogic teaching and the use of ICT.

Chapter Seven: Discussion

7.1. Introduction

The main purpose of this study is to investigate the perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia. For this to be achieved, mixed methods research was conducted by collecting quantitative data followed by collecting qualitative data. In this chapter, the significant findings from both quantitative and qualitative data analysis are discussed to compare them and link the findings with the existing literature. The design of the discussion chapter is related to the main themes of the significant findings that are presented in the quantitative and qualitative analysis chapters. The discussion consists of three main themes: teachers' perceptions and attitudes towards dialogic teaching and ICT; teachers' implementation of dialogic teaching and ICT and outlining the challenges that hinder the implementation of dialogic teaching and using ICT tools in science lessons. These sections are then followed by a summary of Chapter Seven.

7.2. Theme One: Teachers' perceptions and attitudes

In this theme, teachers' perceptions and attitudes towards implementing dialogic teaching, using ICT tools, and using ICT to support dialogic teaching are discussed in the following three sub-sections.

7.2.1. Teachers' perceptions and attitudes towards dialogic teaching

One of the main objectives of this research is to examine teachers' perceptions and attitudes towards implementing the dialogic teaching approach in primary science classrooms in Saudi Arabia. The results of the questionnaire and interviews indicated that primary science teachers, in general, have positive attitudes towards implementing dialogic teaching into their practice in science lessons. Teachers referred to their beliefs in the importance of dialogue and discussion with primary students to enable them to engage and share ideas. Previous studies on the use of dialogic teaching in science indicated that, in general, teachers in developed nations have positive attitudes towards implementing dialogic teaching in science lessons (Mercer et al., 2009; Lehesvuori et al., 2011; Tytler and Aranda, 2015).

From the results, it was found that most of the participants prefer using dialogue and discussion when teaching science rather than using direct instruction and lecturing students. This is perceived to increase students' engagement and interaction with others and support knowledge-building and effective learning. Merely lecturing students may make students feel bored and, as a result, they become passive participants. One of the features of dialogic teaching mentioned by Alexander (2017, p.38) is that dialogic teaching is "collective: teachers and children address learning tasks together, whether as a group or as a class". Thus, engaging students and asking them to participate and share ideas may enable students to be active and attentive. The literature review indicated that the use of dialogue and discussion supports students' engagement and helps them to be active in the classroom (Mercer and Littleton, 2007; Muhonen et al., 2017).

However, the findings of the interviews revealed that some teachers preferred using the dialogic teaching approach with intermediate or secondary school students rather than primary students. This preference might be due to the young age and limited knowledge of primary students compared to students at the higher school level. Previous studies conducted in intermediate and secondary schools found that engaging students in scientific discussion encourages them to share ideas, explain the scientific phenomena they observed, and to interpret evidence (Scott et al., 2006; Lehesvuori et al., 2011; Smart and Marshall, 2013). Yet, other studies carried out in primary science classrooms asserted that primary students have prior scientific knowledge and experiences from their surrounding environment that enables them to engage in science activities, initiate ideas, articulate their own opinions, and discuss this with others (Mercer et al., 2009; Almuntasheri, 2015; Muhonen et al., 2017; Gillies, 2020). Thus, dialogic teaching can be implemented with all students, regardless of their age or level of schooling.

7.2.1.1. Teachers' perceptions of the purposes of dialogic teaching

Understanding the purpose of using dialogue in science lessons is essential to help the teacher to achieve the aims of those lessons. Alexander (2017, p.38) reported that one of the key principles of the dialogic teaching is that it is "purposeful: teachers plan and steer classroom talk with specific educational goals in view". From the teachers' perceptions, several goals, when using dialogue in science lessons, were identified. One of the primary aims was to use dialogue in order to supports students' learning and understanding. This result appears to be

similar to what Scott et al. (2006) found in their study; they recognised that the main purpose of using dialogue in the classroom is to promote the meaningful learning of scientific knowledge.

Another aim of using dialogue was to link the scientific concepts to the students' experiences and environment. Alexander (2017, p.38) stated that 'cumulative' is one of the five essential principles of the dialogic teaching approach where "teachers and children build on their own and each other's ideas and chain them into coherent lines of thinking and inquiry". Thus, providing opportunities for students to express their own previous ideas and knowledge can promote students' confidence in themselves and consolidate the information in their own mind. Previous studies have indicated the importance of linking scientific explanations with students' everyday experiences to support the meaningful learning of science (Chin, 2006; Mercer et al., 2009).

The findings of this research also indicated that one of the purposes of using dialogue is that students can discuss and listen to others, extract the information and decide whether they are convinced by the information. According to Alexander (2017, p.38) 'reciprocal' is one of the five essential principles of the dialogic teaching approach were "teachers and children listen to each other, share ideas and consider alternative viewpoints".

Therefore, understanding the purposes of implementing dialogic teaching in the primary science classroom enhances teaching and learning processes and helps teachers to achieve the educational goals.

7.2.1.2. Teachers' perceptions of the advantages of dialogic teaching

The findings from the current research indicated perceived advantages of using dialogue which are related to students' learning and the classroom environment. Teachers identified five possible features of using dialogue in science lessons: supports students' learning; attracts students' attention; creates a positive learning environment; develops students' characteristics; and develops the students' skills of dialogue. These advantages are presented below.

Supporting students' learning was the main advantage perceived by teachers when using dialogue in science lessons. The literature review indicated that the use of dialogue and

discussion enables students to engage in the learning process, which helps them to build scientific knowledge (Mortimer and Scott, 2003; Scott et al., 2006; Mercer et al., 2009). During dialogue and discussion, teachers can demonstrate the students' existing level of scientific knowledge and connect the prior experiences of students with the science lesson being taught. Therefore, engaging students in dialogue and discussion in science activities may increase students' understanding of science concepts and develop scientific meanings. Hence, the information and new knowledge would be consolidated in students' minds while the teacher works to "draw out misconceptions" (Kerawalla, 2015, p.64).

Attracting students' attention was identified as one of the advantages of using dialogic teaching in primary science lessons. This finding supports what Gillies (2020) argued, that the use of dialogue during cooperative, inquiry-based science attracts students' attention and challenges their thinking. As a result, students are likely to be motivated to share ideas and engage in discussion with others, rather than remaining silent and feeling bored. In contrast, one teacher commented that the use of dialogue sometimes does not attract students' attention. It can be argued that attracting students' interest depends upon teachers' practices and understanding the purposes of the dialogic teaching approach. Some teachers tend to dominate classroom talk and may not provide opportunities for students to discuss each other's ideas. Consequently, a student's role devolves into merely answering a teacher's questions without interacting with peers, which may make the student feel disengaged.

Another advantage underlined by the teachers was that the use of dialogue in science lessons creates a positive learning environment. Teachers mentioned four positive factors that occur when using dialogue in teaching science: increasing students' interaction and cooperation; freedom to express their views; increasing respect; and breaking down barriers. This is consistent with previously reported findings (Mortimer and Scott, 2003; Scott et al., 2006; Mercer et al., 2009; Gillies, 2013; Kerawalla, 2015; Alexander, 2017), which emphasized the key role of using dialogue to enable teacher-student and student-student interactions. Furthermore, it encourages students to express their ideas freely, to respect each other, and to broadly explain their ideas and experiences during dialogue and discussion. In this regard, Alexander (2017, p.38) stated that, in using dialogic teaching, "teachers and children address learning tasks together, whether as a group or as a class, rather than in isolation". Therefore, students should be offered adequate time and opportunity to express their own opinions and

experiences freely to develop a shared understanding of science.

Some teachers mentioned that developing the culture and skills of dialogue among students is an important feature during dialogue and discussion. It is important for students to know how to participate, ask questions, and respond to others. This is closely related to what Kumpulainen and Rajala (2017, p.29) refer to as "the teacher's role in supporting the establishment of a respectful and cohesive classroom culture where every student feels they belong …". Alfayez and Alshammari (2017) also indicated that some teachers in Saudi Arabia face difficulties that hinder the creation of a supportive culture of dialogue, such as the teachers' lack of knowledge and training. These difficulties are discussed in greater depth in section 7.4.1.

The final advantage mentioned in the interviews was that the use of dialogue develops students' characteristics. Teachers demonstrated four features that can be developed when using dialogue in science lessons: confidence, boldness, thinking and problem-solving skills and leadership skills. This is consistent with previously reported findings (Mortimer and Scott, 2003; Gillies, 2013; Smart and Marshall, 2013; Alabdulkareem, 2017; Lehesvuori et al., 2017), which showed that providing opportunities for students to express their thoughts freely increases students' confidence, encourages them to be bold, develops their thinking and problem-solving skills, and nurtures their leadership abilities. According to Alexander (2017, p.38), one of the five key principles of using a dialogic teaching approach is to create a 'supportive' environment, where "children articulate their ideas freely, without fear of embarrassment over 'wrong' answers". Thus, students can be encouraged to talk and discuss effectively, which reflects positively on their characteristics.

7.2.2. Teachers' perceptions and attitudes towards ICT

The findings from the questionnaires and interviews indicated that teachers, in general, have positive attitudes regarding the use of ICT tools in teaching science. Most teachers reported that using ICT in science lessons increases students' interaction, improves their understanding of science concepts and enables them to achieve the science lesson's objectives. The evidence from the literature confirmed this result. Bingimlas (2013) concluded that the use of ICT in teaching and learning science in Saudi primary schools enhances students' interaction and

learning. In addition, Bajpai (2017) found that using ICT in science activities would enhance the quality of learning among students and develop their conceptual understanding.

Although smartboards are not provided in all classrooms and the level of use by teachers was low, some teachers valued its use in science lessons. This might be because the smartboard helped teachers to display texts, video and pictures which might increase the interactivity in the classroom.

The same issue was found with the internet, which was not provided in most classrooms, however, it was seen as an important tool that can be used effectively in teaching science. Murphy (2006, p. 24) stated that "the internet is used in primary science both as a reference source and as a means of communication". Teachers can connect the internet to the devices provided in the classroom and gain access to more information to display the scientific content to students in various ways. This would facilitate the teaching process and save teachers' effort, time and costs.

However, some teachers criticized using ICT tools claiming they do not influence students' learning and achievement. One reason identified by teachers is that there is a considerable shortage of ICT tools in classrooms. As a result, teachers might not feel the impact of using technology due to the shortage. Thus, providing sufficient ICT tools to classrooms is likely to be important to increase the potential positive affect of using ICT in teaching and learning.

Another criticism from teachers was that using scientific websites and applications affected students thinking negatively because students can find information and solutions more easily, without deep thinking and hard work. As a result, these factors may limit students' imagination and weaken students' critical thinking and problem-solving skills.

The final reason mentioned by some teachers was that when teaching science with the use of technology students might be distracted, which leads to issues with classroom control. This finding shows similarity with the findings of previous studies Goundar (2014) study in New Zealand, the use of ICT in the classroom was distracting students from paying attention to the lesson. However, other teachers pointed out that the use of ICT in the teaching and learning process has significant advantages, such as attracting students' attraction, which will be discussed in the following section.

7.2.2.1. Teachers' perceptions of the advantages of using ICT

The findings from the current study indicated perceived benefits of using ICT which are related to students' learning and the classroom environment. Four main features of using ICT were perceived: usability, supporting learning, attracting students' attention, and using ICT for preparation. These advantages are discussed below.

One of the main features perceived by teachers was that using ICT enables teachers to present scientific concepts quickly and easily. This finding is consistent with results from other Saudi researchers (Alsulaimani, 2010; Bingimlas, 2013; Alharthi 2018), all of whom have demonstrated that using ICT facilitates the process of teaching science in Saudi schools. This facilitation also includes using ICT in science labs where teachers can use digital microscopes, for example, to expedite teaching and learning about different types of cells. Consequently, the usability of ICT can reduce teachers' effort and save time for other science activities.

Most teachers who participated in this study perceived that the use of ICT supported students' learning. According to prior research conducted in different contexts (Velle et al., 2007; Bingimlas, 2013; Maharaj-Sharma and Sharma, 2017; Obaydullah and Rahim, 2019), the use of ICT when teaching science promotes students' learning and improves their learning outcomes. However, this depends on the teachers' skills and experience of using ICT in the science classroom effectively, for example, as a pedagogical tool to provide enrichment for students. Meanwhile, face-to-face teaching and learning from the curriculum may contribute to the enhancement of students' communications skills and the development of reading and writing abilities.

Another advantage indicated by some teachers was that their use of ICT when teaching science lessons attracts students' attention and motivates them to learn. Based on other related literature (Oyaid, 2009; Maharaj-Sharma and Sharma, 2017; Williams et al., 2017; Alharthi 2018), the use of ICT in the classroom can create attractive, exciting, and enjoyable lessons and attract students' attention. As a result, it might be easier for students to understand scientific concepts by scaffolding those concepts, allowing for more participation, and keeping boredom at bay. However, students are not uniform in their preferences regarding the use of ICT tools. Therefore, teachers might consider using a variety of teaching

and learning activities, along with the use of ICT tools, in order to capture the attention of the entire class.

The final advantage drawn from the current findings was that ICT is useful for the advanced preparation of science lessons. Similar findings were evident among Saudi teachers in primary science classrooms (Alharthi, 2018), secondary science classrooms (Alsulaimani, 2010), and general secondary lessons (Oyaid, 2009; Albugami, 2016; Alharbi, 2019). Therefore, due to easy access to scientific information which can be consulted in advance, using ICT assists teachers with the management, planning, and preparation of science lessons.

Having discussed teachers' attitudes towards dialogic teaching and their attitudes towards ICT, the next section discusses the use of ICT to support dialogic teaching.

7.2.3. Teachers' attitudes towards using ICT to support dialogue

According to Warwick et al. (2010, p.350), using technology when teaching learning tasks can "provide both a tool and an environment that can encourage the creation of a shared dialogic space within which co-constructed knowledge building can take place". The results of the current study indicated that teachers have positive attitudes towards using ICT and dialogic teaching in primary science classrooms. Most teachers agreed that using ICT to support dialogic teaching can increase students' engagement, support the interactivity between teachers and students, and between students themselves. The literature supports this result; the use of ICT tools has been demonstrated to mediate students' engagement in dialogic exchanges in science lessons and increase students' understanding of science concepts (Warwick et al., 2010; Ekanayake and Wishart, 2014; Kerawalla, 2015).

The results of this study indicated the importance of ICT to teachers because it provides more opportunities for the explanation and exchange of ideas in the classroom. Based on the related literature (Hennessy et al., 2018; Mercer et al., 2019; Pifarre, 2019), using technology in the teaching process offers more space for dialogue which helps students to activate previous experiences and articulate and justify their own opinions. Murcia and Sheffield (2010) argued that using the IWB effectively increases students' participation in scientific discussions and conversations. However, although some interviewees have indicated that students differ in their interest towards technology, previous studies (Beauchamp and Kennewell, 2008; Mercer et al., 2010) have determined that the use of technology for

encouraging and supporting classroom dialogue creates an environment that enhances both students' attention and interaction in the learning process.

7.3. Theme two: Implementation

This section discusses the findings regarding dialogic teaching implementation; the use of ICT in science lessons; the use of ICT to support dialogic teaching and the use of traditional teaching resources.

7.3.1. Dialogic teaching implementation

With respect to the implementation of dialogic teaching, the results of this study demonstrated several strategies that support dialogue and are often used by teachers in science lessons.

From the results of this study, teachers indicated five strategies used to promote dialogue in science lessons, including: teacher-student dialogue; student-student dialogue; question and answer; group discussion; and teacher-led class discussion. These strategies provide opportunities for students to talk and motivate them to express their points of view to support their learning and achieve educational goals. These strategies are in line with Alexander's (2017) argument, that dialogic teaching can be indicated by teacher-students interaction (including teacher-led, whole class teaching and teacher-led group work), individual teacher-student interaction, student-student interaction, and questioning and responses to questioning. Thus, these activities may play a major role in supporting the implementation of dialogic teaching in science lessons.

Teachers may use more than one strategy during their teaching practice to engage students and enable them to talk with others. However, the results of this study indicated that dialogue and discussion between the teacher and students was more dominant than providing opportunities for students to interact with each other. Scott and Ametller (2007) argued that teachers may engage students in dialogue and discussion in an authoritative manner because the science teacher focuses more on the scientific point of view. This often results in the teacher ignoring students' ideas and thoughts, which does not constitute a dialogic interaction.

In the quantitative data, it was clear that the use of question and answer, teacher-led, whole class discussion, and teacher-student talk strategies, was more frequent than using small-group discussions and student-student talk. This result was supported by the qualitative data, where most teachers dominated the classroom talk based on their strategies used in the science lesson. This finding is consistent with results from other studies (Tytler and Aranda, 2015; Hajar and Hendayana, 2019), who found that dialogue and discussion between the teacher and students is more dominant in science lessons. Therefore, providing opportunities for student-student dialogue, either in groups or in pairs, is also important for the exchange and clarification of ideas, and for students to truly learn from each other.

Regarding the teacher's role in dialogic teaching, Scott et al. (2006) stated that, in authoritative discourse, the teacher's role is to direct dialogue and discussion. In the current study, teachers indicated that the role of the teacher in dialogic teaching is to control the dialogue and discussion and facilitate students' learning. Scott and Ametller (2007) argued that meaningful science learning and teaching should include both dialogic and authoritative discourse. Moreover, previous studies have emphasized that teachers play an important role in engaging students, facilitating the classroom dialogue, and co-constructing new understandings (Wells and Arauz, 2006; Gillies, 2013; Webb and Ing, 2019). Thus, it is important for teachers to ensure that all students are willing to participate and have an interest in the science lesson.

However, Lehesvuori et al. (2011) argued that the teacher's role in the dialogic approach should be more of a controller and director. In this way, a teacher can create an environment for meaningful learning. Alexander (2017, p.38) reported that one of the key principles of dialogic teaching is "collective: teachers and children address learning tasks together, whether as a group or as a class". Yet, teachers indicated that they tend to control the dialogue due to the challenges they encounter in their teaching practice, such as moving away from the topic during discussion and avoiding students' misbehaviour. Furthermore, it could be argued that teachers may not be aware of their role in dialogic teaching as more space is needed for students to exchange ideas, clarify thoughts, and express opinions freely, either with the teacher or with peers. Thus, training teachers in how to implement dialogic teaching is vital for them to perform their role in the teaching process effectively.

Additionally, teachers suggested that the students' role is to participate effectively, answer questions that are asked by teachers or students, express their ideas, and construct new knowledge. These roles are consistent with Alexander (2017, p.38), who stated that one of the five key principles of using the dialogic teaching approach is to create a 'supportive' environment, where "children articulate their ideas freely, without fear of embarrassment over 'wrong' answers; and they help each other to reach common understandings". Prior research suggested that the students' role in dialogue and discussion is to construct knowledge, interact with others and respect their ideas, think together, and share their scientific opinions (Scott et al., 2006; Mercer et al., 2009; Gillies, 2020). Thus, the student plays a major role in dialogic teaching and can contribute to science talk effectively.

7.3.2. Teachers' use of ICT

The results of this study indicated that teachers use a variety of ICT tools in science lessons. Although some expected ICT tools are not available in some schools, teachers use a range of hardware and software available in their school. Similar results, based on Saudi studies, found that primary science teachers differed in their use of ICT tools in science lessons depending on the availability of ICT in the classroom (Alsulaimani, 2010; Bingimlas, 2013; Alharthi, 2018). Other studies conducted in Saudi secondary schools referred to the widespread use of ICT in the teaching and learning process (Oyaid, 2009; Albugami, 2016). In this current study, the findings confirmed that teachers were content to use more ICT tools in all classrooms if these tools are made available, such as IWBs, iPads and access to the Internet.

Furthermore, from the interview data it was clear that some teachers use the iEN portal in their teaching activities. Although most teachers suffer from a lack of internet access, some of them use their own personal Internet to connect available devices and use the iEN portal. The iEN portal gives teachers and students access to many features, such as e-books, electronic lessons, viewing videos, and images. Despite the low use of the iEN among science teachers (Alharthi, 2018), it is likely that teachers' use of the iEN has increased during the COVID-19 pandemic. Therefore, teachers' use of the iEN portal, and other ICT tools, may become an integral part of their teaching practices in the future.

The interviewees mentioned that state schools are provided with an LRC where teachers can use a variety of ICT tools. These rooms are provided with IWBs and access to the Internet,

which may not be available in some classrooms. However, these rooms need to be booked in advance by teachers. Additionally, going to the LRC may waste lesson time. Thus, providing IWBs, access to the Internet, and other ICT tools is important to assist teachers in using technology effectively in the educational process. In his study, Alharbi (2018) argued that, although the LRCs were equipped, teachers find it difficult to use them because they need to be booked in advance.

In this regard, a recent study conducted by Alharbi (2018) to investigate the current state of ICT use in Saudi secondary schools found that there is a lack of ICT use in teaching practices due to the shortage of adequate ICT provision. This result is consistent with other studies conducted in different contexts (Alenezi, 2019; Obaydullah and Rahim, 2019; Bariu, 2020). Therefore, it can be argued that teachers' use of ICT in education has been negatively affected by a lack of ICT provision in classrooms. However, it is important for teachers to realise how ICT can be used effectively, rather than focusing on the number of ICT tools in the classroom, to obtain the advantages of using technology in teaching practices. Accordingly, Willis et al. (2019, p.72) stated that "purposeful implementation of ICT into the classroom is increased in teachers who believe quality, rather than quantity, of ICT implementation is important". Nevertheless, quantity and availability of ICT tools can assist teachers in achieving lesson objectives.

Having explained the implementation of dialogic teaching and teachers' use of ICT in primary science lessons, the next sub-section discusses the use of ICT to support dialogic teaching.

7.3.3. Using ICT to support dialogic teaching

The results of this current study indicated that teachers use ICT tools that are available in classrooms to initiate dialogue and increase interaction in science lessons. Teachers mentioned that they use ICT to provide opportunities for students to engage, discuss, and express their ideas, either with the teacher or with their peers. In their study, Mercer et al. (2019) confirmed that teachers in the UK use technology as an effective mediating tool to provide opportunities to create dialogic spaces. Similarly, Hennessy at al. (2018) found that teachers in the UK used the IWB to facilitate students' collaborative meaning-making and reasoning.

From the interviews, several teachers mentioned that, for example, they use the projector to

display video or pictures to students as a prompt for dialogue and discussion. This can be at the beginning of the lesson or during the lesson. It can be also used at the end of the lesson to enable students to extend the joint construction of knowledge and consolidate the information being taught. Prior research conducted in the UK found that teachers used the IWB, including its functions such as displaying video, pictures, and text, to stimulate students' reasoning and to enhance productive classroom dialogue (Deaney et al., 2009; Mercer et al., 2010).

The results from the interviews indicated that teachers are willing to make more use of ICT to support dialogue in science lessons in the future. However, teachers' usage of ICT to promote dialogic teaching may be negatively influenced by the unavailability of some ICT tools, such as IWBs and the Internet, in some classrooms. Such a lack technology would prevent teachers from using these important tools, meaning they are unable to promote greater interaction and participation between teachers and students in the same way. In this regard, Major et al. (2018, p.2014) stated that the challenges that face teachers in implementing dialogic teaching through mediating tools is related to "the support that teachers may need in integrating technology use into their classrooms". Thus, providing sufficient ICT tools to classrooms may increase teachers' use of technology and, in turn, enable and extend classroom dialogue. However, Higgins et al. (2007, p.217) argued that "good teaching remains good teaching with or without the technology". Thus, teachers should be aware that the dialogic teaching approach can be implemented with or without technology.

7.3.4. Using traditional teaching resources

The results of this study indicated that teachers still use traditional teaching resources in science lessons. Although the participants believed that the use of traditional teaching resources is less beneficial for students than ICT tools, they did refer to the use of types of traditional resources including textbooks, whiteboards, and materials and equipment in a science lab. Therefore, the use of these resources may also increase the use of traditional teacher-centred methods which often rely on lecturing, memorisation, and recitation techniques, where the teacher is the only source of knowledge in the learning process. In this study, most interviewees confirmed that they use dialogue and discussion when teaching science rather than direct instruction aimed at lecturing students. Teachers can be facilitators of learning and support student-centred learning that enables students to share in decision

making and increase their engagement and interaction. However, due to the large number of students in the classroom, teachers tend to use traditional resources to control students' behaviour. Previous studies have found that, with a large number of students, science teachers can find it difficult to provide opportunities for every student to participate (Chin, 2006; Alabdulkareem, 2017; Bansal, 2018; Ucak and Bag, 2018).

Additionally, the results of this research showed that teachers use a variety of ICT tools that are available in classrooms. However, teachers may be prompted to return to the use of traditional teaching resources and methods. One of the reasons for using traditional resources, as confirmed in previous studies, is the lack of ICT tools that are provided for teachers to teach science, such as access to the Internet, IWBs, and digital microscopes (Alsulaimani, 2010; Bingimlas, 2013; Alharthi 2018). Another reason is that a lack of skills and confidence in the use of ICT tools may lead teachers to prefer traditional teaching methods when teaching science (Alsulaimani, 2010). Finally, the teachers in this study mentioned that they need to follow the instructions of the MoE to complete the teaching of all lessons in their science books and fulfil the curriculum requirements for each semester. However, using ICT tools can often require more time. Consequently, teachers may focus more on traditional methods because they can be faster than using ICT to complete the curriculum (Alharbi, 2019).

Teachers can overcome these challenges and avoid using traditional teacher-centred methods only by combining the use of available ICT tools with traditional teaching methods and resources. This can help teachers to strike a balance between the use of technology and traditional methods of teaching science during the semester (Alsulaimani, 2010).

Having discussed the implementation of dialogic teaching, teachers' use of ICT, using ICT and dialogic teaching, and using traditional teaching resources, the challenges that hinder the implementation of dialogic teaching and ICT use are discussed in the following section.

7.4. Theme Three: challenges

The results of the current study are important to gain a better understanding of the challenges to the implementation of dialogic teaching and using ICT in primary science classrooms in Saudi Arabia. In this section, both challenges are discussed in the following two subsections. There may be an overlap between dialogic teaching challenges and ICT challenges, such as

issues related to the school or teachers. Thus, it is important to discuss each problem separately in terms of its cause, consequences, and how it can be addressed.

7.4.1. Challenges of dialogic teaching

In this study, teachers identified some challenges hindering their implementation of the dialogic teaching approach in science classrooms, including challenges related to: the teacher; students; the science curriculum; the number of students; the lack of time; and the challenges related to school.

From the interview data, the first challenge mentioned was the teachers themselves. The findings indicated that some teachers lack knowledge of how to use dialogic teaching appropriately. Therefore, they dominate the classroom dialogue. This finding is consistent with the results from other researchers (Almuntasheri, 2015; Alfayez and Alshammari, 2017), who found that teachers in Saudi Arabia, in general, lack questioning skills and educational dialogue practices in the classroom. This finding also reveals similarities with the results of recent studies conducted in other contexts, as teachers lack the knowledge and strategies for implementing dialogic teaching effectively (Ruthven et al., 2017; Ucak and Bag, 2018; Hajar and Hendayana, 2019).

Additionally, teachers may tend to use short question and answer from students and ask students to be silent until the teacher directs the question. Scott and Ametller (2007) asserted that teachers need to engage students in the dialogic approach and avoid questioning students on how well they know and understand some science. In this regard, Alshammari (2020) found that science teachers' skills in the use of dialogic inquiry approaches were improved after attending a professional development programme. Thus, training teachers is essential to improve teachers' skills for planning and employing effective dialogic teaching in their teaching practices. However, the quantitative data indicated that more than half of the participants in this study (60.3%) attended an inquiry-based learning course. This training session was organised for science teachers by the MoE in Saudi Arabia to support eliciting students' information and prior knowledge and encouraging students to talk.

The second challenge mentioned in the results of this study was that some students may inhibit the use of dialogue in science lessons. Teachers indicated that discipline problems with students during dialogic teaching might cause misbehaviour, or the teacher may be unable to

control the class. This finding shows similarity with the work of Lehesvuori et al. (2011); their study found that the question of discipline was one of the main factors that concerned teachers during teaching practice. The participants also pointed out other challenges related to the students, such as students' knowledge, culture, and skills of dialogue, and students being shy and introverted. Ucak and Bag (2018) argued that an inadequate linguistic background and students' unwillingness to participate and share their opinions causes difficulties for dialogic interactions. Therefore, it is important for teachers to try and address these challenges and help their students to overcome these difficulties by building a positive classroom climate. Furthermore, it was established that some students are lacking in dialogue skills due to the absence of a dialogue culture in school, home, and society. This finding is further supported by Alfayez and Alshammari (2017), who stated that teaching and learning activities do not support the culture of dialogue in the classroom. Thus, one interviewee suggested that students could be trained in using dialogue strategies to improve their dialogic skills.

The third challenge is related to the science curriculum. Lefstein (2010) referred to an over-crowded curriculum as one of the main reasons for challenges to the implementation of dialogue in classrooms. This outcome was confirmed by the qualitative data of this study, where the content of the science curriculum was one of the major challenges that inhibits teachers' implementation of dialogic teaching in Saudi schools.

Moreover, teachers referred to the number of science lessons as being insufficient to complete the science curriculum. Prior studies have asserted that a lack of time to cover the science curriculum, and accountability pressures on teachers, often force the teacher to transmit instructions and control dialogue and discussion (Chin, 2006; Bansal, 2018). Thus, a revision of the science curricula by the MoE, and an increase in the number of science lessons, will enable teachers to implement dialogic teaching more effectively and to achieve the objectives of the curriculum.

The fourth challenge, which was drawn from the quantitative data, was that most teachers perceived the number of students in the classroom as a hinderance to students' talk and discussion. This result was also supported by the interview data, where teachers referred to the number of students in the classroom as one of the major challenges for implementing dialogic teaching. From the background information of the quantitative data, more than a half

of the participants indicated that the number of students in a class was more than 30 students. Thus, it might be difficult for teachers to implement the dialogic approach with around 40 students in some classes. Dividing students into groups, as suggested by one of the interviewees, might be difficult as there are no teaching assistants in Saudi schools to help the teacher control the class. Furthermore, with a large number of students, teachers found it challenging to divide students into groups or conduct scientific activities that promote dialogue. This is because each student in the classroom in Saudi schools has his own table for individual learning. Therefore, teachers need more time to divide students into groups and rearrange their tables (Alnosiaan, 2019). Moreover, with the large number of students, teachers cannot listen to all students' opinions or provide opportunities for all students to discuss and share ideas. This is an important result since some previous studies found that large numbers of students in the class hinders the use of dialogue and discussion (e.g., Chin, 2006; Lefstein, 2010; Sedova et al., 2014; Bansal, 2018; Ucak and Bag, 2018).

The results of this study showed that a lack of time is one of the main difficulties for dialogic teaching and practice. The allocated time for lessons may not be enough for the dialogic approach in science lessons. Therefore, teachers may feel forced to use more authoritative approaches due to time restrictions. This finding is similar with the findings of previous studies where the question of time was considered an issue; teachers cannot spend time listening to every student and inviting students to engage and talk (Chin, 2006; Scott et al., 2006; Scott and Ametller, 2007; Bansal, 2018). However, Scott and Ametller (2007, p.5) claimed that "the key to dealing with this issue is to identify those parts of the curriculum where dialogic discourse becomes important, simply because the subject matter is demanding". Thus, teachers can spend time engaging students in discussing and sharing their opinions about those particular science subjects, in the main parts of science subjects, rather than discussing all information or knowledge. This method can help to address the problem of time and the complex depth of the science curriculum.

Finally, teachers demonstrated challenges related to the school that could hinder the implementation of dialogic teaching in the classroom. For instance, some schools in Saudi Arabia are rented schools, which differ from state schools regarding room spaces and facilities available. Some teachers indicated that, in general, rented schools have small classrooms, and the number of students is large. This is because the building was often built for housing

purposes and not for schooling. Therefore, it is difficult to implement the dialogic teaching approach, or divide students into groups, in this type of school.

Another issue related to the school reported by the participants of this study is the lack of resources, which may hinder teachers' use of dialogue. These resources can include technological tools, equipment in science labs, or even circular tables for group discussion activities. Major et al. (2018) found that insufficient resources may impact on the successful implementation of dialogic teaching. Although resources can enhance productive classroom dialogue, dialogic teaching can be implemented without these resources. However, at present, it is important for schools to be fully equipped and ready to implement teaching strategies.

7.4.2. Challenges of using ICT

The results indicated several challenges that may hinder the use of ICT in science lessons. These challenges were divided into two factors: external challenges and internal challenges. These are discussed in detail in the following sections.

7.4.2.1. External challenges

The result of this study shows three challenges relating to factors outside of the school: lack of ICT resources; lack of technical support and lack of technical training courses. These challenges are discussed in depth in the following paragraphs.

Firstly, teachers determined that a lack of sufficient ICT tools is the major issue that restricts them from using technology in the teaching process. They mentioned that classrooms and science labs lack adequate ICT tools. Although this problem has been widely identified and discussed in many studies since the MoE of Saudi Arabia adopted the use of technology in the teaching and learning process, it remains a major concern for teachers (Bingimlas, 2009; Oyaid, 2009; Almaliki, 2013; Almulhim, 2014; Alenezi, 2015; Alkahtani, 2017; Alharbi and Alotebi, 2019). The government of Saudi Arabia has invested heavily in the integration of ICT into education. However, there are still issues that cause disappointment among teachers, such as the poor provision of ICT in many schools (Albugami and Ahmed, 2015; Alenezi, 2019).

For example, the primary concern of teachers was a lack of access to the Internet; this is one of the main factors that hinders the effective use of available ICT tools. In the science

curriculum, there are some activities that require the Internet to present a lesson or to display video and pictures to students. Additionally, some teachers prefer using the official educational applications and channels, for instance the Madrasati platform and the iEN portal, to support their teaching practices. Teachers can also benefit from the educational content of these online tools, such as e-books, tests, and virtual lessons.

The second challenge demonstrated by this research was the lack of technical support and maintenance from the MoE. This issue is similar to the lack of ICT tools and is considered one of the most significant barriers preventing teachers from using ICT tools in science lessons (Bingimlas, 2009; Alsulaimani, 2010; Ahmad, 2014; Alenezi, 2015; Alharthi, 2018). Indeed, providing immediate technical support and maintenance is essential for teachers to effectively utilise technology and benefit from its outcomes. Conversely, the absence of or delays in technical support and maintenance hinders teachers from using ICT in their teaching activities (Lawrence and Tar, 2018).

It was mentioned that the maintenance services for, and technical support of, ICT are poor and insufficient. For example, if one of the ICT tools is broken, it takes a long time for it to be fixed and returned to the school. This may prevent teachers from successfully using ICT and achieving their goal of using technology in classrooms. In this regard, Becta (2004, p.16) reported that "if there is a lack of technical support available in a school, then it is likely that preventative technical maintenance will not be carried out regularly, resulting in a higher risk of technical breakdowns". As a result, teachers may stop using ICT tools due to continuous breakdowns and, instead, depend more on using traditional resources. Thus, this issue can be addressed by increasing the number of technical workers available to respond to requests promptly and provide repairs and technical support to teachers in their teaching process. Previous studies have found that technical workers and maintenance teams are limited in many schools, and this makes it impossible to deal with all requests concerning technical issues in a timely manner (Albugami, 2016; Alharbi 2019).

Finally, the results of this study referred to the lack of training courses as a barrier to using ICT tools in classrooms. From the background information of the quantitative data, it was surprising that half of the teachers had not attended ICT training courses. The probable reason of this issue, as mentioned in the interview data, is that there is lack of ICT training courses. Therefore, the lack of training courses may lead to poor ICT skills among teachers, particularly

in how to use modern technologies, such as smart boards and Augmented Reality. This result is in line with that of previous studies which found that an insufficient number of training courses hinders teachers from greater use of ICT in the classroom (Bingimlas, 2009; Almulhim, 2014; Albugami and Ahmed, 2015; Salinas et al., 2017; Alenezi, 2019; Alharbi and Alotebi, 2019).

However, other interviewees stated that there are training courses available, but teachers lack time to attend these courses. This might be because the training course times are inappropriate for teachers. It was pointed out that most of the training sessions are held during school time, in the morning, and outside of the school premises, which results in a low level of teacher attendance. This finding is consistent with Alnosiaan (2019), who argued that the training courses for Saudi teachers are often held outside the school; teachers, thus, need to leave their school to attend the courses. Therefore, it is important to consider the scheduling of courses that can be attended remotely, or to schedule courses in advance and announce them to the schools. This will allow teachers to make the necessary arrangements with their school to attend and benefit from these courses.

It is important to note that these external barriers may cause other problems inside schools. In the following section, the internal challenges are presented in detail.

7.4.2.2. Internal challenges

The results of this study showed three challenges that arise within schools. These challenges include issues related to schools, teachers, and students. Each of these challenges is discussed in depth below.

The first internal challenge that hinders teachers from using ICT is the type of school building, and the consequent lack of science labs. It was mentioned that the current buildings and infrastructure of some schools is not suitable to accommodate ICT tools. For instance, the classroom size in rented schools is small and there is insufficient space for certain ICT tools, such as IWBs. Similar findings were found in Alsulaimani's (2010) study; in rented school buildings the classrooms are too small to be suitable for ICT tools infrastructure. Albugami and Ahmed (2015) argued that rented schools are built for housing, not for schools or educational purposes, and so they suffer from a lack of infrastructure. In contrast, state schools are well built and have good infrastructure to accommodate ICT tools. Thus, it is

important for the MoE to consider whether school buildings meet the needs of teaching and learning with new technologies. Accordingly, in order to provide the same opportunities for all teachers and students, it is vital to include suitable school buildings and ICT infrastructure.

The second challenge that prevents teachers from using ICT is related to the impact on teachers of lack of resources. Although teachers, in general, have positive attitudes towards ICT, the lack of ICT resources in the classroom has affected teachers' use of available technologies. For instance, some Saudi schools have just one IWB in the LRC which needs to be booked by teachers in advance; therefore, teachers may feel less motivated to use this important tool. As a result, teachers may resort to employing traditional teaching styles, using pen and whiteboard, in a time when technology has become an integral part of the educational process. Ahmad (2014) found that failure to provide adequate ICT resources in classrooms causes a lack of ICT use among Malaysian science teachers. Therefore, greater efforts are required to provide adequate new technologies in classrooms to increase teachers' motivation, satisfaction, and interest in using them in their teaching activities.

Another challenge to the use of ICT in science classrooms is related to the individual teachers is a lack of ICT skills and knowledge. It was mentioned that some science teachers lack the skills and abilities to adapt their teaching to the use of technology in science lessons. This is probably due to a lack of ICT training courses provided by the MoE, which has resulted in some teachers having poor skills in the use of technology. Alenezi (2019) found that most teachers agreed that technical skills are important for successful utilisation of ICT tools in classrooms. The literature contains several studies conducted in Saudi schools that referred to a lack of knowledge and skills needed for the use of technology among teachers (Bingimlas, 2009; Almulhim, 2014; Albugami, 2016; Alharbi, 2019). However, some of the interviewees commented that many teachers have good skills because they have graduated from universities and are qualified to use technology. These teachers often bring their own laptops to use in the teaching process. From the background information of the questionnaire, it is evident that the vast majority of teachers have a Bachelor's degree, and some of them have a Master's degree.

Previous studies have identified that a lack of ICT skills among teachers leads to a lack of confidence in their ability to use technology (Becta 2004; Balanskat, 2006; Bingimlas, 2009; Almalki, 2017). Furthermore, Alenezi (2019) considered that this lack of confidence

contributes to ineffective use of ICT tools in Saudi classrooms. Teachers may feel hesitant and embarrassed to use ICT tools in front of students or their colleagues due to a lack of ICT competence. Therefore, it was suggested in Alsulaimani's (2010) study, that increasing ICT skills among teachers leads to an increase in their confidence in using ICT tools in the classroom.

However, Alharthi (2018) found that most science teachers develop their ICT skills through independent online learning and attending training courses. Accordingly, more effort is required from teachers to improve their ICT skills, either independently through online research, or by attending ICT training courses and workshops arranged by the MoE or other organisations. This may assist teachers in the use of ICT in their science lesson preparation and support them in their teaching and learning process.

Finally, the results of this study indicated that students can be a barrier to the use of ICT in the classroom. The data collected showed that students' age, thinking level, and affluence differ, and this might influence students' views towards using technology in education. For instance, presenting scientific content or showing a picture or video to students who study in grade six is different to those who study in grade one. Students in the same class may also differ in their thinking skills and scientific background. Therefore, teachers may require more effort and time to prepare their lessons, bearing in mind the difference in students' age and thinking skills. In this respect, Alharthi (2018) determined that the teacher can search Google to find scientific content that suits the students' age. This problem can be addressed by providing a variety of software and hardware in the classroom to support teachers in dealing with individual differences between students.

Another problem associated with students is that some have health issues that prevent them from benefiting from the use of ICT in the classroom. In this study, it was mentioned that some students have visual or hearing problems that need to be considered by teachers while using technology. Teachers can ask students who cannot see or listen well to sit at the front of the class to take advantage of using different technologies in the lesson. Additionally, the overuse of ICT may cause health issues among students. Evidence from the literature confirmed this result (Alsulaimani, 2010; Alharthi, 2018; Alharbi 2014; Albugami, 2016; Alharbi 2019).

The final concern regarding students is that there are ethical issues that may arise with students while using technology. For instance, when using YouTube in the classroom, students may see unsuitable advertising or videos that are inappropriate for their age or contrary to their culture and ethics. Additionally, teachers may access unwanted websites, games, or videos when using their own devices to learn. Thus, it is essential for teachers to consider the ethical issues that are associated with technology.

7.5. Summary

Chapter Seven has discussed the main findings of the quantitative and qualitative data and compared within the context of relevant literature. The discussion was divided into three themes: attitude, implementation, and challenges. Teachers expressed positive attitudes towards the implementation of dialogic teaching and the use of ICT in science lessons. The findings revealed how teachers implement dialogic teaching and the role of the teacher and students in classroom dialogue. This indicates the clear dominance of most teachers in dialogue and discussion activities. The advantages of dialogic teaching were one of the most important findings of this study.

Moreover, teachers' use of ICT was also discussed, which indicated a generally positive attitudes towards ICT, regardless of the negative issues related to it in the teaching and learning process. Most teachers use a variety of hardware and software that is available in their classrooms. Furthermore, the discussion demonstrated that teachers expressed positive attitudes towards using ICT and dialogic teaching in primary science classrooms. Teachers also use ICT to support students' dialogue and engagement in Saudi primary schools, which was consistent with previous studies conducted in Western countries.

Additionally, one of the most important findings of this research concerned understanding the challenges to the implementation of dialogic teaching and the challenges of using ICT in primary science lessons within the context of Saudi schools. Accordingly, a number of suggestions were presented and discussed that could improve the quality of the implementation of dialogic teaching and the use of ICT tools in Saudi schools. In Chapter Eight, the conclusion of this thesis, the implications of this study and recommendations are presented.

Chapter Eight: Conclusion

This chapter concludes the thesis by starting with a summary of the main findings obtained from the quantitative and qualitative data. The contributions of the study are discussed followed by the study's limitations. Next, the recommendations based on the findings and suggestions for future research are presented. Lastly, this thesis offers a personal reflection.

8.1. Summary of the study

The main purpose of this study is to investigate teachers' perceptions of using ICT and dialogic teaching in primary science classrooms in Saudi Arabia. As a result, the research focused on three aspects: the implementation of dialogic teaching; the use of ICT in teaching practices; and the use of ICT to support dialogic teaching. A mixed methods research approach was conducted in Riyadh city in Saudi Arabia to achieve the study's main aim and objectives. This research was conducted based on Alexander's (2004) dialogic teaching theoretical framework. The research instruments employed by this study include a questionnaire for the quantitative phase, followed by a semi-structured interview for the qualitative phase to investigate the phenomena in depth. These two research instruments were developed by the author to address the research questions.

During the next stage of the study, the researcher used explanatory sequential techniques to gather the quantitative and qualitative data, respectively. The data collected were analysed using the SPSS suite for the quantitative data and the NVivo software package for the qualitative data; these analyses included an interpretation of the quantitative findings followed by the qualitative findings. In order to analyse the quantitative data, a descriptive analysis was used, followed by inferential statistical tests, including: the Mann-Whitney test, Spearman's rank correlation, and a multiple regression analysis. Furthermore, a thematic analysis approach was used to analyse the qualitative data collected from participants. The findings drawn from both quantitative and qualitative phases were discussed and compared within the context of relevant literature.

It is important to note most findings of the quantitative were supported by the qualitative findings. Accordingly, the use of interviews in the qualitative phase gives great in-depth understanding and interpretation of using ICT and dialogic teaching from primary science

teachers' perspectives. For instance, the interviewees mentioned several advantages and challenges of implementing dialogic teaching and using ICT in primary science classrooms. Conversely, the limited sample size of the qualitative data is supported by the large sample from the quantitative data.

It was revealed that primary school science teachers, in general, have positive attitudes towards dialogic teaching. Teachers appeared to be aware of the importance and the advantages of talking and discussing ideas with their students and the role they play in facilitating students' learning. However, the results indicated that most teachers currently adopt a dominant role in dialogue and discussion activities. This may be a result of their tendency to use authoritative discourse to direct students' dialogue, rather than using the dialogic approach that provides more opportunities for students to talk and discuss ideas with their teacher or with their peers. Training teachers in how to implement an effective dialogic teaching approach is critical to improving their skills. Other issues that may affect the implementation of dialogic teaching were explored, including: the students' behaviour; an over-crowded science curriculum; the number of students in the classroom; the limited time available in each lesson; and the small size of classrooms in rented building schools in Saudi Arabia. These challenges may prompt teachers to resort to a traditional teaching style.

Regarding the use of ICT, teachers seemed to be interested in and to enjoy using ICT, and generally believed that ICT tools are important in supporting students' learning and attracting their attention. Teachers also indicated that ICT tools helped them to prepare lessons in advance. However, the findings revealed several challenges hindering the successful use of ICT in classrooms, such as a lack of ICT resources; a lack of ICT training; a lack of technical support; and various issues related to schools, teachers, and students. Although the MoE allocated a significant budget for the integration of ICT into education, teachers still face these major challenges which affect their teaching practices. This disparity must be given due consideration by the MoE.

One of this study's key findings is teachers' perceptions that, by supporting dialogic teaching with ICT tools, there was a consequent increase in student engagement. Further, the findings indicated that the use of ICT tools supports the interactivity between teachers and students, and between students themselves. Teachers reported that they use the available ICT tools to support dialogue and discussion in science lessons which, in turn, increases students'

understanding of science concepts. The results indicated that teachers are willing to make more use of ICT to facilitate dialogue in science lessons in the future. However, teachers' implementation of ICT to support dialogic teaching is negatively influenced by the unavailability of some vital ICT tools, such as IWBs and the internet in all classrooms and science labs. Therefore, ICT tools must be made available to facilitate the successful implementation of ICT tools to support dialogic teaching.

8.2. Contribution of the study

This study provides significant contribution in three aspects: the implementation of dialogic teaching; the use of ICT in teaching practices, and the use of ICT tools to support dialogic teaching in the primary science classroom in Saudi Arabia. This study presents new contributions about these three aspects from a different culture and context to the existing literature. As stated in the first chapter, this study is the first study that focused on the use of ICT tools to support dialogic teaching in a context of Saudi primary science classrooms. Most previous studies that investigated the use of technology to support dialogue were conducted in Western or non-Arab countries (e.g., Beauchamp and Kennewell, 2008; Hennessy, 2011; Major and Warwick, 2019; Mercer et al., 2019). It is hoped that this study will inspire the MoE to encourage teachers and develop their skills to use ICT to mediate dialogic teaching in all schools' levels in Saudi Arabia. This would help Saudi teachers to reduce traditional teaching methods and dominating the classroom dialogue to focus more on students' voices and roles within an interactive learning environment.

Another important contribution of this study is that a mixed methods research approach was conducted to obtain comprehensive perceptions of the dialogic teaching approach, the use of ICT, and using ICT to support dialogic teaching. In this study, questionnaires were used to collect the quantitative data followed by semi-structured interviews which used to collect the qualitative data to deeply understand the phenomena being investigated. Using both questionnaires and semi-structured interviews in this study may differ from most studies conducted in the area of using ICT to support dialogic teaching, which makes the findings of this study both original and unique.

The findings present highly detailed quantitative and qualitative data to understand teachers' attitudes, implementation and challenges of the perceived three aspects: the dialogic

teaching, the use of ICT, and using ICT to support dialogic teaching. In particular, the challenges mentioned by teachers may be considered as a more significant contribution because they highlighted most of the factors affecting teachers' teaching practices that needs to be addressed by the MoE working with teachers in Saudi Arabia. Also, the findings of this study provide insights into the significant roles of teachers and students in dialogic teaching and the perceived benefits of such an approach within the science classroom. Thus, this study is significant for primary science teachers.

8.3. Limitations

Although the aim and objectives of this study were achieved, the study has its limitations which should be explained to show a clear picture of the process of the study. The main aim of this study was to investigate teachers' perceptions of ICT and dialogic teaching in primary science classrooms in Saudi Arabia. The first limitation of this study, as mentioned in Chapter Three, is that all teachers who participated in this study are male. The reason for choosing male teachers is that Saudi culture and government rules prohibit males from entering female schools, which attended only by female staff and students because of gender segregation in schools.

The second limitation is related to the urban teacher sample. The participants of this study were primary teachers who teach science lessons in Riyadh. Other teachers who teach other subjects or teach in intermediate and secondary schools were not included in this study. Therefore, the findings of this study may not generalise to all primary schools in Saudi Arabia, but may inspire similar research in other parts of Saudi Arabia.

Third, an explanatory sequential mixed-methods design was used in this study which needs considerable time and effort. Questionnaires were sent and collected first, followed by interviews with primary science teachers. However, as mentioned in Chapter Three, the researcher planned to interview between 15 to 20 primary science teachers from the 37 participants who had volunteered to be interviewed. However, due to COVID-19 pandemic, the researcher was only able to interview 12 participants in March 2020 because the schools were then closed by the Saudi government. The researcher contacted the participants to conduct the rest of the interviews online, but they did not accept the request. This limitation may influence the findings of the study in terms of providing more information and to gain a

clearer understanding of the problem being investigated. However, using mixed methods research helped to obtain rich information about using ICT and dialogic teaching in science classrooms.

8.4. Recommendations

Based on the findings, discussion and conclusions of this study, several recommendations can be provided to the decision makers in the MoE, teachers and researchers in the field of using ICT to support dialogic teaching.

8.4.1. Recommendations for Ministry of Education

First, the MoE could pay more attention to the effective implementation of the dialogic teaching approach. This could be achieved by training teachers to develop their dialogic teaching skills. Such training could help change teachers' practices from the authoritative dialogue and dominating the classroom talk to successfully implementing the dialogic teaching approach that actively engage students in the learning process. In addition, some issues that hinder the implementation of dialogic teaching were raised in this study. These issues could be addressed by the MoE such as reducing the number of students in the class, revising dense curricula, excluding unimportant information and allocating more time for science lessons.

Another critical recommendation to the decision makers in the MoE is that technology can be an important mediating tool to support and increase the opportunities of dialogic teaching in the classroom. Therefore, providing important technologies such as IWBs and internet is required to help teachers to increase students' engagement and to develop their interaction within the lesson.

The final recommendation for the MoE is related to the availability of ICT resources. As presented in Chapter Seven, over the last two decades, studies have found that there is a lack of ICT resources in schools and a lack of technical support, both of which affect teachers' use of ICT tools in the teaching and learning process. Even though these issues have been raised by previous studies numerous times, not enough has been done to resolve the problem. Thus, it is vital to treat this issue as a failure and to review governmental strategy and policies regarding ICT to eliminate barriers to its use in the educational process. This would support

the equitable learning of younger generations, especially at the present time, where students may rely on using technology more in different aspects of their lives, including education. Also, this would help to achieve the policy goals of the Saudi vision 2030 for education.

8.4.2. Recommendations for teachers

In general, primary science teachers who participated in this study expressed positive attitudes towards the implementation of dialogic teaching, using ICT tools and using ICT to support dialogic teaching. However, the positive attitudes may not reflect some teachers' actual teaching practices. Therefore, some teachers may use traditional teaching methods where teachers deliver the content and transmit the knowledge without engaging students much in the learning process. Teachers are recommended, where they can, to provide more opportunities for students to talk, discuss ideas and clarify their opinions, either with their teacher or with their peers.

Another suggestion is that teachers have responsibilities to change their teaching practices to be consistent with their positive attitudes. As suggested by one of the interviewees, teachers are also required to pay more attention to developing their teaching skills by attending courses offered by the MoE, or free online courses such as teaching strategies and ICT pedagogy and ICT skills courses.

8.4.3. Recommendations for future research

Several recommendations can be suggested for more studies in the area of using ICT to support dialogic teaching. Firstly, in terms of the location of this study, this study investigated the perceptions of primary science teachers in Riyadh, which is the capital city of Saudi Arabia, where the situation is expected to be different from other schools across the country. Thus, more research might be undertaken in other cities and rural schools to compare the results with the findings of this study. Also, further research is needed to be conducted in Middle Eastern countries to compare the results with the existing literature from western countries.

Secondly, in terms of the participants, this study included only primary science teachers and excluded other teachers and school levels. However, future studies could be conducted to investigate teachers' perceptions and practices in other subjects such as Mathematics, or English teachers who teach in primary, intermediate or secondary schools. Furthermore,

including students in the future research would be insightful and useful as they considered the centre of the learning process. In addition, future studies could be conducted with female teachers to compare to investigate the difference between male and female teaching practices.

Thirdly, future research using observation approach is recommended to provide new evidence and to explore in depth teachers' performance of using ICT to support dialogic teaching. This approach allows researchers to observe teachers and students' behaviours during classroom interactions.

8.5. Personal reflections

My story of this study started from the first email that I received from my supervisor Sue Johnston-Wilder welcoming me to start my research journey and to set the date of our first face-to-face meeting in September 2018. This email was so important to me because my supervisor recommended reading two books: 'The Unwritten Rules of PhD Research' (Petre, 2010) and 'A Student's Guide to Methodology' (Clough and Nutbrown, 2012). Then, I started reading the first book as I was willing to understand more about the different rules and to read how to avoid problems. This book was useful and enjoyable and gave me a clear idea about the rules related to the research, the supervisor and the researcher. The second book was also important because it provided me with a general perception to understand more about methodology, methods and the tools needed to collect data. Now, I believe that these two books are important for researchers who are thinking about starting their postgraduate studies.

However, at the beginning of my study, I faced some challenges with academic language and academic skills because I studied my Bachelor and Master's degrees in Arabic. In the first year of my EdD programme I was required to study six modules. These six modules included four modules about foundation and advanced research methods, individual differences and critical study about education. Through studying these modules, my general academic language and skills were enormously improved. Also, extensive reading of literature while studying these modules helped me to expand my understanding and focus more on my interest in applying dialogic teaching and the use of ICT tools in the science classroom. During this time, I also attended a variety of courses offered by the University of Warwick or online to develop my

academic skills and learn more about software important to researchers. I had chosen courses that focused more on academic writing, developing critical argument and analysis, and software such as Qualtrics, SPSS and NVivo.

At the end of my first year, with the guidance of Sue Johnston-Wilder and valuable feedback from my second Supervisor Elisabeth Arweck, I was able to formulate my own research questions and develop questionnaire and interview tools to collect my data. This allowed me to start collecting my data at the beginning of my second year.

However, like many researchers, my second and third years were affected by the COVID-19 pandemic. I experienced many challenges in collecting my data, analysing the quantitative and qualitative data and also managing my time because most of the University's face-to-face facilities were closed for several months. Despite that, I worked hard to find solutions to issues I faced and to overcome these difficulties with the full support and guidance of my supervisor. At the end of this journey, I was able to finish analysing and reporting my data and writing up my thesis.

Finally, I am looking ahead to share the findings of this study with the MoE to pay more attention to applying the dialogic teaching approach in the classroom and addressing issues related to the ICT to help teachers increase the opportunities of dialogue and discussion. In addition, the different experiences and skills I obtained throughout this journey will support me to assist general Saudi teachers to understand more about dialogic teaching and ICT to be successfully used in their classroom.

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Appendix 1: The University of Warwick ethical approval

WARWICK
THE UNIVERSITY OF WARWICK

Application for Ethical Approval for Research Degrees

(PhD, EdD, MA by research)

Student number: 1894023

Student name: Alruways Alharbi

PhD ☐ EdD ☒ MA by research ☐

Project title:

Using ICT and dialogic teaching in the primary science classroom in Saudi Arabia

Supervisor: Sue Johnston-Wilder

Funding body (if relevant):

Please ensure you have read the Guidance for the Ethical Conduct of Research available in the handbook.

Methodology

Please outline the methodology, e.g. observation, individual interviews, focus groups, group testing etc.

I will use a questionnaire and interview to collect the data from participants.

Participants

Please specify all participants in the research including ages of children and young people where appropriate. Also specify if any participants are vulnerable e.g. children; as a result of learning disability.

I will send the questionnaires via email to primary science teachers, and interview science teachers in primary science schools in Riyadh in Saudi Arabia.

Respect for participants' rights and dignity

How will the fundamental rights and dignity of participants be respected, e.g. confidentiality, respect of cultural and religious values?

All participants will receive a consent form explaining the nature of the study. All communication will be delivered in the participant's native language (Arabic).

Privacy and confidentiality

How will confidentiality be assured? Please address all aspects of research including protection of data records, thesis, reports/papers that might arise from the study.

The participants will be asked to grant permission to use their responses for the study. The researcher will guarantee that no information that could identify any particular participant will be shown in the study. The participants will be assured that their identity will be anonymised. During all stages of this study, all the data will be stored in a virtual locked file and it will be kept 10 years from completion of EdD research.

Consent

How will prior informed consent be obtained from the following?

From participants:

All participants, science teachers, will receive informed consent form in order to explain the nature of the study. All participants will respond to agree whether to participate in this study. Also the informed consent form will explain the process of the study and the consequences. A participation sheet well be given to all participants explaining to them the aim of this study, and it will be solely for research propose, and also If any participant wants to stop at any time from the data process, they will be assured that they hold the right to do so, moreover, their participation data will be kept anonymised.

From others:

If prior informed consent is not to be obtained, give reason: Not applicable

Will participants be explicitly informed of the student's status? Yes

Competence

How will you ensure that all methods used are undertaken with the necessary competence?

I attended all sessions in Advanced Research Methods (ARM) courses and it developed my understanding of key methodological considerations. I also read Ethical guidelines for educational research (2011). Furthermore, the researcher's work will be supervised.

Protection of participants

How will participants' safety and well-being be safeguarded?

Participants will be informed of their right to withdraw; any risks will be explained; anonymity and confidentiality of data will be assured.

Child protection

Will a DBS check be needed? Yes ☐ No ☒ (If yes, please attach a copy.)

Addressing dilemmas

Even well planned research can produce ethical dilemmas. How will you address any ethical dilemmas that may arise in your research?

If an ethical dilemma arise from the planned research. This issue will be discussed with my supervisor and the advice would be heeded.

Misuse of research

How will you seek to ensure that the research and the evidence resulting from it are not misused?

All the research evidence is only used for my study. All the study stages and evidence will be monitored by my supervisor.

Support for research participants

What action is proposed if sensitive issues are raised or a participant becomes upset?

All participants have the right to withdraw. Any sensitive issues will be alerted to my research supervisor. All conduct will comply with the legal framework.

Management of your data

Who will have access to the data?

Only the researcher and his supervisor will have access to the data.

How and where will the data be stored?

The data will be conducted electronically. The researcher will use the software database platform (Qualtrics), which will provide me a single access by Warwick IT help services. Then, all the generated data will be secured in a personal computer protected by a password.

For how long will the data be kept?

The data will be kept 10 years from completion of EdD research.

Integrity

How will you ensure that your research and its reporting are honest, fair and respectful to others?

As mentioned above, I attended all sessions in Advanced Research Methods (ARM) courses. I also read Ethical guidelines for educational research (2018). Furthermore, the researcher's work will be supervised.

What agreement has been made for the attribution of authorship by yourself and your supervisor(s) of any reports or publications?
Yes, I will be the lead author in any publication and my supervisor will be a co-author if my supervisor has contributed more than comments.

Other issues

Please specify other issues not discussed above, if any, and how you will address them.

Signed:

Student: [redacted] Date: 13/06/2019

Supervisor: Sue Johnston-Wilder (by email) Date: 21st June 2019

Please submit this form to the Research Office (Donna Jay, Room C1.10)

Office use only

Action taken:

☐ Approved

Name: Michael Wyness

Signature: [redacted]

Date: 24.6.19

Stamped: Centre for Education Studies
University of Warwick
Coventry CV4 7AL

Notes of Action:

Appendix 2: MoE permission (English version)

Date: 18 AUG 2021 التاريخ: ١٤٤٣ / ١ / ٨

وزارة التعليم
Ministry of Education

Kingdom of Saudi Arabia
Ministry of Education
General Directorate of Education in Riyadh
280
Department of Planning and Development

Facilitation of a Researcher's Mission

Name	**ALRUWAYS ALHARBI**		
Academic Year	**2020**		
University	**University of Warwick-UK**		
Degree	**Doctor of Education**	**Community Sample**	**Science Teachers**
Research Title	**Using ICT and dialogic teaching in primary science classrooms in Saudi Arabia**		
Tools website	**https://cutt.us/wG83z**		

M/S Principal of the Primary School **Honorable**

Blessings, peace and mercy be upon you,,,

Based upon the decision of the Minster of Education No. 38717080 dated 08/02/2017 about authorization of education managers and in accordance with decision of General Director of the General Department of Education in Riyadh No. 38920793 and dated 21/03/2017 about authorization of Department of Planning and Development for facilitation of a Researcher's Mission and the above stated name and data requesting permission to conduct his research study and in view of the completion of the required documents ; we hope to facilitate his mission from the beginning of the second academic semester as of 19/01/2020 .

Noting that the research bears full responsibility for all aspects of the research. The public administration's permission does not mean its approval of the research problem or research and treating methods.

Best regards,,,

Director of Planning and Development Management
Saud Rashed Alabdullatif

K.S.A-Qassim - Buraydah - King Abdul A.Rd (Alkhobib) North ALBAIK
Next to AlJabr Laundry - Tel 0163242174 - Fax 0163246325
Unaizah office :ElDola s Street Near Al-Mosbah Company
Tel: 0163620701 - Fax: 0163640570
المملكة العربية السعودية- القصيم - بريدة - طريق الملك عبد العزيز (الخبيب)
شمال البيك بجوار مغسلة الجبر - ت ١٦٣٢٤٢١٧٤ - ف: ١٦٣٢٤٦٣٢٤٥
عنيزة - شارع الصليعة - بجوار شركة المصباح - ت ١٦٣٦٢٠٧١١ - ف: ١٦٣٦٤٠٥٧٠

Appendix 3: MoE permission (Arabic version)

المملكة العربية السعودية
وزارة التعليم
٢٨٠
الإدارة العامة للتعليم بمنطقة الرياض
إدارة التخطيط و التطوير

وزارة التعليم
Ministry of Education

الرقم/ ٣٩٨٩٥
التاريخ / ١٤٤١/٥/٢٣هـ
المرفقات / .....

تسهيل مهمة باحث

الاسم		السجل المدني
الرويس بن غلاب الحربي		١٠٤٥٧٠٧٦٨٢
العام الدراسي	الدرجة	الجامعة
١٤٤١ هـ	دكتوراه	وريك البريطانية
عنوان الدراسة: (استخدام تكنولوجيا المعلومات والإتصالات لتنفيذ استراتيجية التدريس الحواري في تدريس مادة العلوم بمدارس المرحلة الإبتدائية في المملكة العربية السعودية)		
عينة الدراسة :. معلمي مادة العلوم		
رابط الأداة : https://cutt.us/wG83z		

المكرم قائد المدرسة الإبتدائية وفقه الله

السلام عليكم ورحمة الله وبركاته ، وبعد:

إشارة إلى قرار معالي وزير التعليم رقم ٣٨٧١٧٠٨٠ وتاريخ ١٤٣٨/٥/١٢هـ بشأن تفويض الصلاحيات لمديري التعليم ، وبناءً على قرارسعادة مدير عام التعليم بمنطقة الرياض رقم ٣٨٩٢٠٧٩٣ وتاريخ ١٤٣٨/٦/٢٣هـ بشأن تفويض الصلاحية لإدارة التخطيط والتطوير لتسهيل مهمة الباحثين والباحثات ، وحيث تقدم إلينا الباحث (الموضحة بياناته أعلاه) بطلب إجراء دراسته، ونظراً لاكتمال الأوراق المطلوبة، نأمل تسهيل مهمته ، **بدءا من بداية الفصل الدراسي الثاني بتاريخ ١٤٤١/٥/٢٤هـ** .

مع ملاحظة أن الباحث يتحمل كامل المسؤولية المتعلقة بمختلف جوانب البحث ، ولا يعني سماح الإدارة العامة للتعليم موافقتها بالضرورة على مشكلة البحث أو على الطرق والأساليب المستخدمة في [redacted] ستها ومعالجتها.

[redacted] شاكرين لكم

[redacted]
سعود بن راشد آل عبداللطيف

Appendix 4: Questionnaire form

Background Information:

1. How many years have you been employed as a science teacher?

□ 1– 5 years □ 6– 10 years □ 11 – 15 years □ more than 15

2. Please choose the appropriate range for your age:

□ 20 – 30 □ 31 – 40 □ 41 – 50 □ more than 50

3. What is your highest qualification?

□ Diploma □ Bachelor □ Master □ PhD

4. What is the average number of students in a class?

□ Less than 20 □ 20-30 □ 31-40 □ more than 40

5. Have you attended any ICT training courses?

□ Yes □ No

6. Have you attended any training courses about enquiry-based learning?

□ Yes □ No

7. How often do you use the following teaching methods in your science classes?

No.	Science classroom activities	Very often	Often	Some-times	Hardly ever	Never
1.	Teacher-student talk					
2.	Student-student talk					
3.	Question and answer					
4.	Teacher-led whole class discussion					
5.	Small group discussions					
6.	Classroom computer					
7.	Watching a video/ Images					
8.	Interactive whiteboard					
9.	Data projector					
10.	The internet					
11.	Digital microscope					
12.	E-books					
13.	White/blackboard					
14.	Science displays					
15.	Science books					

8. In each row, please tick the answer that applies best to you:

No	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	I think that science talk is useful in the science classroom.					
2.	I think that science talk promotes student learning.					

3.	Science talk encourages student to understand the objectives of science lessons.					
4.	Science talk stimulates the development of reasoning skills.					
5.	Science talk challenges students to clarify, or re-state ideas.					
6.	Teacher-student talk develops students' problem solving and critical thinking.					
7.	Student-student talk develops students' problem solving and critical thinking.					
8.	I feel satisfied when students answer difficult questions.					
9.	I try to develop shared understanding of science.					
10.	Students often ask me when they need help in the classroom or with homework.					
11.	Students often ask their peers when they need help in the classroom or with homework.					
12.	Science talk encourages students to help each other.					
13.	Science talk support students to be more independent learners.					
14.	I think that science talk would leave less time for other activities.					
15.	Students prefer talking science with peers rather than in front of the class.					

16.	I think that science talk increases students' engagement.					
17.	I often use different methods to engage my students in science talk.					
18.	I encourage my students to participate and share ideas.					
19.	The number of students in the class hinders students' talk and discussion.					
20.	Using ICT tools increases science classroom interaction.					
21.	ICT tools support me to achieve teaching aims.					
22.	ICT tools improve students' understanding of science concepts.					
23.	Using ICT tools and science talk improves students' motivation to learn.					
24.	I use ICT tools to promote teacher-student talk about science subject.					
25.	I use ICT tools to promote student-student talk about science subject.					
26.	Using ICT tools and science talk supports students to express and reformulate ideas.					
27.	ICT tools provide opportunities for class discussion in the science classroom.					
28.	I find it challenging to talk and interact when using ICT tools with primary science students.					

29.	ICT tools provide opportunities for the explanation and exchange of ideas.					
30.	In the future I plan to make more use of ICT to support talk and discussion in science classrooms.					
31.	Other comments:…… ……..					
32.	This study requires interviews. Kindly, if you would like to volunteer for the interview, please write the appropriate contact details: ……					

Appendix 5: Informed consent form for questionnaire

Dear primary science teacher,

My name is Alruwyas Alharbi, I am an EdD student at the University of Warwick, UK. I am conducting research aiming to explore teachers' towards using ICT and dialogic teaching in primary science classrooms in Saudi Arabia. Dialogic teaching in this study means that the education that depends on dialogue, and the creation of the educational environment for this dialogue between the teacher and the students, as well as between the students themselves to achieve the science subject aims. Information and communication technology (ICT) in this study means that the hardware and software that science teachers use in teaching primary school students, such as the computer, data projector, the Internet, and others.

I am pleased to invite you to participate in this study by kindly answering the research questionnaire. The questionnaire contains three sections; The first section is about the personal information of the science teacher. While the second section relates to implementation of dialogic teaching activities and the use of ICT tools during the science lesson. The third section is to investigate teachers' perceptions towards the effect of dialogic teaching and the use of ICT on students' learning and interaction in science classrooms.

I appreciate you helping me with my research and would like to inform you that your participation is not compulsory, and you can withdraw at any time. I would also like to inform you that the collected data will be kept confidentially. Note that the collected data will be used only for the purpose of research and will only be seen by the researcher and the research supervisors and will be stored for 10 years after the end of the doctoral study according to the University of Warwick system.

Thank you for your participation

The researcher: Alruways Alharbi

Phone Number: [redacted]

Email: [redacted]

Appendix 6: Interview questions

1. Please tell me how you use talk or discussion as a part of teaching.
2. What do you think about the purpose of dialogue in the classroom?
3. Which do you prefer more in your classroom: discussion and dialogue, or direct instruction? Why? How often? Could you please give me an example?
4. What is the role of the teacher in dialogic teaching?
5. What is the role of the student in dialogic teaching?
6. Which do you prefer more: engagement with students in discussion, or encouraging students to engage with one other? Why? Could you please give me an example?
7. In your opinion, what are the advantages of engagement with students in discussion? What are the disadvantages?
8. In your opinion, what are the advantages of encouraging students to engage with one another? What are the disadvantages?
9. From your perspective, what are the features of dialogic teaching in teaching science? What are the drawbacks?
10. What software and hardware tools do you use in teaching science? Could you please describe an example?
11. To what extent do you think software and hardware tools support dialogue and discussion? Could you please give me an example?
12. What software and hardware tools do you use to support dialogue and discussion? Could you please give me an example?
13. What do you think are the challenges of using ICT tools? How might those challenges hinder classroom dialogue? Could you please give me an example?
14. What do you think about the future opportunities and challenges for ICT use to support science talk in the classroom?
15. Would you like to add anything else?

Appendix 7: Informed consent form for interviews

Dear primary science teacher,

My name is Alruwyas Alharbi, I am an EdD student at the University of Warwick, UK. I am conducting research aiming to explore teachers' perceptions towards using ICT and dialogic teaching in primary science classrooms in Saudi Arabia.

I appreciate your volunteer in this interview and would like to inform you that the interview will be audio-recorded with your permission. Your participation is not compulsory, and you can withdraw at any time. I would also like to inform you that the collected data will be kept confidentially. The collected data will be used only for the purpose of research and will only be seen by the researcher and the research supervisors and will be stored for 10 years after the end of the doctoral study according to the University of Warwick system.

Thank you for your participation

Teacher signature: .....

The researcher: Alruways Alharbi

Email: [redacted]

Phone Number: [redacted]