The Impact of online CPD programme compared to face-to-face CPD programme on science pedagogical practice in Saudi Arabia

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Submitted in accordance with the requirements for the degree of

Doctor of Philosophy

The University of Leeds

School of Education

September 2015

Declaration

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Suliman Binmohsen

Leeds (2015)

Dedication

This work is dedicated to my parents; my father who sadly passed away during the course of this study and my mother whose prayers have been a source of support for me. It is also dedicated to my wife, Amal, and my children, Abdullah, Yazied, Shahad and Yazan.

Acknowledgments

الْحَمْدُ لله رَبِ الْعَالَمِين

al-ḥamdu li-llāhi rabbi l-ʿālamīn

“Praise be to Allah, Lord of the Worlds”

This work would not have been possible without the expert, intelligent, careful, and patient comments, corrections and advice provided by prof. Ian Abrahams and Dr Matthew Homer, my supervisors. They have been tremendous mentors for me, in academia and in life. I would sincerely like to say a big thank you to each of them for being always there when in need throughout the journey of my study, continuously having faith in me through the hardships I have faced and for being dear friends.

I would like also to thank Prof. Robin Millar, a member of the Thesis Advisory Panel (TAP) at York University, for his advice and support when I was at York University. Also many thanks have to be given to all the reviewers and participants of ESREA 2015, 7th Saudi conference, and New Perspective in Science Education conference for their valuable feedback on the papers I have given based on this thesis.

I am extremely grateful to my amazing wife, Amal and my wonderful children, Abdullah, Yazied, Shahad, and Yazan, not only for their love and support, but also for their sacrifices and patience throughout my study journey.

I would like to express my gratitude to my father and my dear mother, for teaching me about life and bringing me up to be the person I am today. I appreciate all their support and prayers. I dedicate this work to them. A big thank also goes to all my dear brothers and sisters.

I would like to thank my dear friend Dr Khalid Altayyar for being a coffee-sharing, thought provoking, encouraging and believing companion while I was studying at York University, and also a big thank goes to my colleagues and friends Dr Mohammed Alzaghibi, Dr Mohammed Almoqbel, Dr Haya Alomran and Dr Ahmad Alamro for the experiences we shared and their support, encouragement and friendship. I would like

also to express my gratitude to my friends and colleagues at the School of Education for their support and companionship.

Also, I would like to thank the staff of the Ministry of Education, Ministry of Higher Education, Saudi Arabian embassy in England and Saudi Arabian Cultural Bureau for giving me the opportunity to undertake this study and for facilitating my task.

Finally I am grateful to Mr Abdullaziz Alsadan and Mr Abdulrahman Albasry who helped me in choosing the study sample and also a big thanks goes to all the science teachers in Saudi Arabia who volunteered to participate in this study.

Abstract

The purpose of this study is to compare the impact of an online Continuing Professional Development programme (CPD) to a face-to-face (f2f) CPD programme on changing science teachers' pedagogical practice in the classroom. The process of CPD programmes evaluation is guided by Guskey's 5 levels evaluation model, which is a helpful framework in gauging the impact of CPD programmes at five different levels. These level are: 1) Participants' reactions; 2) Participants' learning; 3) Organisational support and change; 4) Participants' use of new knowledge and skills and 5) Students' learning outcomes.

The study reports on the research undertaken using a sample of science teachers in Saudi Arabia. Twenty male science teachers from different schools in Saudi Arabia were selected to participate in this study. The sample was divided into two equal groups of 10 teachers: one group participated in the f2f programme (the control group) while the other participated in the online programme (the experimental group).

The study deployed a mixed methodology in order to maximize the robustness of findings by triangulating different forms of data. These methods were: (1) Classroom observations both before *and* after the programmes using the Flanders Interaction Analysis Category (FIAC) system of classroom observational analysis; (2) A questionnaire survey of all teacher participants, conducted *after* the programmes had been delivered; and (3) semi-structured interviews, also conducted *after* the programmes had been delivered. The data from each stage were coded and analysed and the key findings were captured.

The findings of the study suggest that the online CPD programme was *at least as effective* as, and in certain places more effective than, the f2f CPD programme. The overall satisfaction of the teachers was more positive towards the online CPD programme compared to the f2f CPD programme. The interview results indicate that the online CPD programme was slightly more effective than the f2f CPD programme in terms of the teachers' learning. In some cases the online programme had distinct advantages over the f2f programme, however in other areas the f2f CPD programme displayed its own advantages. Teachers from both groups felt that they could apply what they had learnt (e.g. the 5Es instructional model) effectively and confidently, although

there were often external factors that could affect its successful implementation, such as time constraints and class size issues. The study also finds that there was little, or no, impact from either of the CPD programmes on the sampled educational organisations. Although impact on student learning outcomes was not a focus for the study, the findings from the teacher interviews regarding the impact on student learning indicate that there was, to some degree, a more positive impact for students from online CPD programme.

The study findings will have implications for policy makers in general, and in Saudi Arabia specifically, and contribute to the existing literature on online CPD programmes. Policy makers in Saudi Arabia might consider increasing the opportunities available to teachers to be trained via online programmes and may put this expansion of opportunity at the top of its agenda with regard to teacher CPD programmes. Also Policy makers at the Ministry of Education could use the data and findings of this study to further investigate the implementation of an online CPD programme, especially for training teachers in changing traditional approaches to an active learning model. Policy makers might also investigate the potential that online CPD programmes have for rolling out CPD programme to a wider teacher audience, because the findings suggests that the flexibility of this mode of training and learning was valued by the teachers.

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List of Abbreviations

BERA	British Educational Research Association
BSCS	Biological Sciences Curriculum Study
CIC	Construction Industry Council
CIC	The Computer and Information Centre
CITC	Communications and Information Technology Commission
CPD	Continuing Professional Development
DfES	Department for Education and Skills
EU	European Union
f2f	Face-to-Face
FC	First Class
FIAC	Flanders Interaction Analysis Category system
GDP	Gross Domestic Product
GDTS	General Directorate of Training and Scholarship
GMC	General Medical Council
GTCE	General Teaching Council in England
GTCS	General Teaching Council in Scotland
GTCW	General Teaching Council in Wales

IBL	Inquiry-Based Learning
ICT	Information Communication Technology
iNACOL	International Association of K-12 Online Learning
IRC	Information Resource Centers
KFUP	King Fahd University of Petroleum
LMS	Learning Management System
MOODLE	Modular Object-Oriented Dynamic Learning Environment
MT	Machine Translator
NASDTEC	National Association of State Directors of Teacher Education and Certification
NCEL	The National Centre for e-leaning and Distance Learning
NCLB	No Child Left Behind
NISE	National Institute of Science Education
NMC	Nursing and Midwives Council
NSTA	National Science Teachers Association
PARN	Professional Associations Research Network
PCK	Pedagogical Content Knowledge
RCVS	Royal College of Veterinary Surgeons
S-TEAM	Science-Teacher Education Advanced Methods
SCIS	Science Curriculum Improvement Study model

SEN	Special Education Needs
SPSS	Statistical Package for the Social Sciences program
TA	Teaching Agency
TAP	Thesis Advisory Panel
TDA	Training and Development Agency for Schools
TIMSS	Trends in International Mathematics and Science Study
UK	United Kingdom
USA	United States of America
VLE	Virtual Learning Environment

Chapter 1. Introduction and Background

1.1 Introduction

The Saudi Arabian Government has reformed strategies for economic, social and educational development which are underpinned by using policies, where appropriate, which focus on improving human resources, as this is the single most important factor in the development of the country's intellectual infrastructure (Hassana and Woodcock, 2006). A core element of this is the introduction of a new curriculum for science and mathematics teaching, and the promotion of instructional models such as the '5Es' instructional model is also crucial (Bybee et al., 2006). Another key component of this approach concerns the continuing professional development (CPD) of teachers, enabling them to achieve better learning outcomes for their students by providing high quality training and skills development programmes. Saudi Arabia is faced with some logistical and organisational barriers geared towards effective CPD delivery – not least supply-side deficiencies in the provision of training, trainers and providers who do not achieve competitive standards (Al-Daud, 2004; Albahiri, 2010; Jalal and Ahmed, 1999), and a gender rights legislature which precludes women from participation in many CPD programmes (Al-Kahtani et al., 2006; Hamdan, 2005).

Online CPD programmes have been posited as a new, digital and innovative format of CPD provision. It is inferred that online programmes may be able to assist the Saudi Arabian Ministry of Education in enhancing teaching standards and learning outcomes while overcoming the barriers to implementation, which face-to-face (f2f) CPD programmes can encounter. These barriers include such factors as the geographical size of Saudi Arabia, the vast number of teachers working in various schools, high travel and event organisation costs for teachers, busy schedules and the fact that they must accommodate a wide range of teachers.

The subsequent sections give a clear insight of the background of the study (section 1.2), while section 1.3 highlights the researcher's personal motivation for conducting the study. Section 1.4 outlines the aims of the study. Section 1.5 describes the significance and the anticipated impact of the study and the final conclusive section (section 1.6) details the outline of the thesis.

1.2 Background

The Ministry of Education in Saudi Arabia is making considerable efforts to improve the education system of the country. Approximately 9 billion Saudi Riyals (SR) (£1.5 billion) has been allocated to the educational project of King Abdullah, namely *Tatweer*[1], which aims at improving the quality of public education (Al-shemary, 2007). The project is driven by a number of core strategic priorities which are concerned with improving the education curriculum and the educational environment for learners and practitioners. It also provides significant support for extra-curricular activities and the professional enhancement of teachers' skills profiles (Tatweer, 2012).

As a crucial policy component of King Abdullah's *Tatweer* Project, both primary (age range 6 -11 years) and high schools (age range 12-17) in Saudi Arabia have received a new curriculum of mathematics and science, which has been translated into the Arabic language and adopted by the Ministry of Education to suit the Saudi educational environment (Tatweer, 2012). This curriculum was designed by McGraw-Hill (2011), a specialist provider of educational materials, information and solutions for primary and secondary schools and professional learning and development markets, and is based on a variety of instructional strategies, including problem solving and inquiry-based learning; all of which are theoretically organised around the Biological Sciences Curriculum Study (BSCS) *5Es* instructional model. This model consists of 5 levels to the pedagogy process: *Engage, Explore, Explain, Elaborate, and Evaluate* (Bybee et al., 2006). These levels – each with their own precisely planned functional purpose in the overall student learning process – are combined to frame a syllabus and system of instruction that is especially applicable to the acquisition and understanding of scientific knowledge, approaches and skills. It has been suggested that the 5Es instructional model is an effective instructional model for enhancing the learning processes involved in understanding fundamental concepts, particularly in science (Bybee et al., 2006).

[1] *Tatweer* translates as 'development' in English.

However, these instructional strategies have presented a challenge for Saudi Arabian science teachers who often use 'chalk-and-talk' methods when explaining scientific phenomena, theory, empirics and concepts (Alabdelwahab, 2002; Algarfi, 2010; Ministry of Education, 2009). Teachers in Saudi Arabia may not be familiar with these approaches and therefore need appropriate, structured and systematised support to help them learn about, apply and generate good outcomes from these new strategies.

In order to improve teaching standards and facilitate this support via the use of policy measures, the Ministry of Education has recently developed a scheme aimed at sending 25,000 teachers (up to 5,000 per annum) across the world to countries including Great Britain, United States, Canada, Australia, New Zealand, Finland and Singapore, amongst others, to attend such training sessions (Majed, 2015). Although this is a useful initiative, it might be very expensive and looking for another approach in delivering CPD programmes, such as delivering them online, could potentially be a viable and cost effective alternative. Simultaneously, the Saudi government has also established a CPD programme with the aim of training teachers and keeping them up-to-date and informed on effective teaching practices and approaches, to help them understanding instruction and learning. This current CPD programme is traditional in nature and comprises mainly face-to-face (f2f) workshops and training days. There is evidence, however, to suggest that the CPD programmes provided to schools, and to science teachers in particular, are inadequate when it comes to fully informing and empowering teachers in science classrooms to implement these innovative strategies (Al-Daud, 2004; Albahiri, 2010; Jalal and Ahmed, 1999).

A recent study by Mansour et al. (2012) found that science teachers in Saudi Arabia believed they lacked even a basic knowledge of the pedagogical skills required for the effective application of newer approaches to teaching and learning. These teachers contended that they should have been provided with CPD training, which would have plugged this self-assessed skills gap. This perception of a lack of requisite and necessary training had led to a belief that they were professionally unable to teach science as it should be taught.

There are a number of possible reasons for these evident inadequacies in the teacher training system in Saudi Arabia. Firstly, Saudi Arabia does not have enough teacher trainers to meet demand (Almazroa, 2013) – there are a great number of teachers working in various schools, scattered throughout the geographically large country;

Saudi Arabia covers more than 830,000 square miles which is about 9 times bigger than United Kingdom (UK) and comprises in excess of 519325 teachers working in 31009 schools (Ministry of Education, 2014). This suggests that the proportionately small numbers of teacher training providers are logistically unable to meet the overall demand and give adequate support to all the teachers that require it. High travel and event organisation costs are another important factor preventing teachers from attending training centres (Alhajeri, 2004; Almazroa et al., 2015) even when training and skills enhancement are needed badly.

Secondly, the country's cultural context — whereby male-to-female face-to-face public communication is not permitted – is crucial in understanding the barriers to effective and universally accessible CPD provision in Saudi Arabia (Al-Kahtani et al., 2006; Hamdan, 2005). Furthermore, women are not allowed to travel outside of the home without an escort and it is well known that women are not allowed to drive vehicles in Saudi Arabia. All of these factors come together to form a social environment which limits the accessibility of training for approximately half the teachers; it also necessarily means that conventional f2f CPD programmes cannot realistically be targeted at women, leaving many teachers without access to training programmes. Although female trainers *are* available, it could be that there are simply not enough to meet the demand. A significant number of female teachers thus practice without adequate support or training (Bashatah, 2004).

A third issue concerns the quality and effectiveness of the trainers that exist in Saudi Arabia (Almazroa, 2013). The effectiveness of CPD programmes is entwined with the programme's relevance and delivery style, as well as the networking opportunities which are available to trainees (Chval et al., 2008). With partial evidence that teacher trainers – already inadequate in number – are failing to provide the highest standard of training, and with a gender rights system which is inhibitive, creating value added CPD programmes which drive genuine impact is a distinct challenge for the Saudi Arabian Government.

In light of this, there is a need to implement a proactive mode of providing training for teachers. Following the emergence of digital and online educational environments, both in the West and increasingly internationally including places such as Saudi Arabia (Cheong, 2001), it has been suggested that utilising advanced digital and web-based technologies for the purpose of delivering CPD programmes in Saudi Arabia would add

value to the current system and achieve greater impact on trainees and their teaching practice in the classroom (Al-Ghadyan, 2004; Albahiri, 2010). Interestingly, internet awareness and the use of social media in Saudi Arabia has tremendously increased in recent years, with research suggesting that the country has a more digital society than any other Arab country, with a minimum of 28 million people who use the internet for social media and mobile phone penetration exceeding 200% (That means there are at least two active phones per person) (Radcliffe, 2013). This might favour the integration of online education.

CPD programmes are a key strategic place wherein ICT-supported online learning has the potential to accrue benefits for all. Online learning is regarded generally as being beneficial - not only for learners but also for instructors - in terms of facilitating communication and learning at any time and in any place (Cantoni et al., 2004). Online CPD programmes could be used as an effective means for providing and accelerating high-quality professional development programmes made available to every teacher, wherever, whenever and however the teacher prefers (Ally, 2004; Cantoni et al., 2004; Cheong, 2001)

Online CPD programmes are distance learning activities which are offered to teachers and provided via the internet to address continuing professional development needs (Thomas, 2009). Online CPD programmes offer a number of distinct advantages when compared to f2f provision. Through online programmes teachers can participate in their training at times they find preferable and in a range of preferred locations (Chen et al., 2009). Online courses can overcome issues relating to greater workloads, due to trainees being unable to attend to their regular duties (Goldman, 2002). Online training and development can fit with teachers' busy schedules (Dede et al., 2009). When participating in online courses, it can also be easier for teachers to connect with a wider range of teachers across a broader range of subjects and learning stage areas (Russell et al., 2009a).

Therefore this study helps to initiate a vital and on-going process, which deepens our understanding of the benefits, and impact that online CPD programmes may have in the Saudi Arabian educational context. Some of the core barriers to the enhancement of CPD provision and the skills development of teachers in Saudi Arabia – not least those discussed above, including supply-side issues, the accessibility of conventional training for women teachers, and deficits in training providers own learning and skills – can

perhaps be overcome by the introduction of, and increase in, online forms of teacher CPD programmes. This study conducts a comparative impact evaluation of identical CPD programmes covering material on the 5Es instructional model – one online, the other f2f – to ascertain whether online formats of CPD programme can be a viable policy option when it is aimed at redressing these problems in Saudi Arabia. Only by building on what has previously been a weak evidence base, and by studying the impact that online CPD programmes can have on teaching and learning, can a concrete case be made for or against the dissemination, financing and promotion of online CPD programmes in Saudi Arabia.

1.3 Personal Motivation for the Study

The motivation for conducting this study came about as a result of my working experience and academic learning. Having worked in Saudi Arabia's Ministry of Education as a science teacher for the first ten years of my career at both primary and high school levels, and also as a teaching supervisor and trainer for about five years, I am very much aware of some of the issues surrounding CPD programmes.

In my experience, the programmes were often held in the evening at training centres which were located far away (at least one hour by car) from the homes of those attending them. It was often very difficult spending hours going to and from these centres. In addition to the time spent traveling to and from the CPD programmes, I had personal and family commitments which needed to be attended to, adding to the burden presented by the extra hours of work.

On the other hand, when the CPD programmes were held in the morning at educational training centres or in another school, a substitute teacher would be needed to cover for my classes in order that I may attend the programme. In Saudi Arabia, it is not easy to offer a substitute and in some cases head teachers are not able to facilitate teachers in attending professional development courses because of the difficulties in substituting teachers (Alhajeri, 2004; Almazroa et al., 2015), a problem which I found to be true from my own experience. Timperley et al. (2007) point out that teachers are, in many cases, unlikely to attend such professional development programmes unless they have the organisational conditions and support to do so. Furthermore, even though the substitute was sometimes provided, the problem was that my absence from school to attend the course delayed certain lessons and affected the implementation of the course timetable. This is in line with studies, which suggest that teacher absence can have a

substantial negative impact on student learning (Alhajeri, 2004; Miller et al., 2008). This is often because the substitute role, in many cases, is just to cover the session and it is not necessarily used to teach the students from their curriculum.

In addition, the CPD programmes are sometimes held in another city and therefore participants have to make travel arrangements, reserve accommodation and be paid overtime for their attendance, which the funder, in this case the Ministry of Education, had to reimburse. Sometimes the Ministry of Education do not pay, perhaps due to a lack of funds, and therefore participants have to pay the expenses themselves. The workload and financial cost factors are the most common reasons for non-participation in these courses (Hustler et al., 2003).

After becoming a teacher trainer, I noticed a lack in the number of teachers who were participating in such courses and the majority of attendees were from the nearby schools. I recognised that this was a result of the same problems which I experienced when I was a teacher.

When I moved to the UK to study for my Masters in ICT in Education, the course combined two methods of communication; the conventional f2f method and the Virtual Learning Environment (VLEs). Through these two channels of communication — whether f2f or virtual — we learnt collaboratively, which had a significant impact on my development. This was an entirely new experience for me. VLE refers to a software system which has been designed in order to facilitate teachers in the management of educational courses for their students, especially by helping teachers and learners with course administration (Stiles, 2007). Although the First Class (FC) system, which is a virtual learning environment, was mainly used throughout this course, other VLEs were also used, such as Blackboard. The main learning experience I gained can be summarised as follows:

For online classes, we used both First Class (FC) and Blackboard software. By using the FC learning tool, I found myself to be in what felt like a real learning environment; there was room for discussions, which is like a classroom seminar (synchronous environment), and there was also a virtual conference room (asynchronous environment) where we were able to post our tasks, reflections and ideas. There was also a virtual common room where we could participate in free discussions with peers about various topics.

Also by using Blackboard software, I had the opportunity to access the module-relevant materials at any time. The most interesting element of this was that we could post our comments and responses on a weekly basis. We could also accordingly add our own comments for the attention of our classmates. In fact, I found this practice very useful as it helped me to improve my critical thinking in terms of sharing and learning from others.

In my experiences, I could not imagine that, one-day, learners would be able to share their ideas synchronously in different geographic areas — even in totally different parts of the world — in such a way and as easily as this.

The experiences which I gained from my studies in the UK have seemingly offered potential solutions to the problems which I encountered and observed during my time working and teaching in Saudi Arabia. Therefore, I was inspired to transfer this experience to my own context by investigating and studying this potential benefit through comparing f2f with online CPD programmes in order to improve the standards and quality of teaching in science education in Saudi Arabia.

1.4 Aims of the Study

The overall aim of this study is to compare the effectiveness of the current Ministry of Education f2f CPD programme, which has been adopted following the introduction of a new National Curriculum based on the BSCS 5Es instructional model (Bybee et al., 2006), with the effectiveness of the *online* CPD programme consisting of the very same material.

Furthermore, to have a bigger picture of the effectiveness of the compared approaches, Guskey's 5 levels of impact evaluation (Guskey, 2002), is integrated into the research and in congruence with this framework, the study aims are:

(1) To measure the teachers' satisfaction with the content, process and outcomes of the CPD programmes, drawing comparison between f2f-trained and online trained teachers.
(2) To measure and evaluate the impact that the CPD programmes have on teachers' knowledge and learning, again comparing the data on the online group to the data on the f2f group;

(3) To identify any impact that the CPD programmes have on organisational support structures, culture and general activity at the organisational level (in the schools), comparing these organisational changes according to the two groups;

(4) To observe and record any impact that the CPD programmes has on teacher practice and approaches in the classroom – again, ensuring that any differences in impact between the online group and the f2f group are captured and interpreted.

It is should be noted here that although an evaluation of student learning (Guskey's level 5) is not the focus of this study, data on this was gathered from teachers' interview responses in order to triangulate the other findings.

Based on the above aims of the study, a literature review is carried out in the subsequent chapter (Chapter 3), which leads to the development of the research questions of the study.

1.5 The Significance of the Study

Saudi Arabian education is undergoing significant change through the Tatweer Project and the curricular reforms (Tatweer, 2012), and teachers in Saudi Arabia are in need of development and training to help them comply with and support these reforms (Mansour et al., 2012). Online CPD programmes have the potential to redress problems in Saudi Arabia (Albahiri, 2010) created by a distinct shortage in training resources (human and material) (Ministry of Education, 2009), a lack of quality in trainer standards (Al-Daud, 2004; Albahiri, 2010; Jalal and Ahmed, 1999) and a gender segregation system (Al-Kahtani et al., 2006; Hamdan, 2005) which does not easily enable female teachers to engage in conventional CPD programmes. Despite being a developing country (United Nations, 2014), Saudi Arabia has the digital infrastructure needed for online CPD programmes (Ministry of Communication and Information Technology, 2006) to be implemented and – like other developing states – an online CPD programme may be able to facilitate measurable improvements in teacher learning and student outcomes.

Nevertheless, based on the available literature, there is an on going debate in terms of the impact of the online education approach compared to traditional f2f approach (Driscoll et al., 2012). A wider scope of literature (discussed in details in chapter 3) on

online and f2f instructional classroom in general (Al- Qahtani and Higgins, 2013; Driscoll et al., 2012; Junaidu and AlGhamdi, 2004; Russell, 1999; Sitzmann et al., 2006; Tucker, 2001; York, 2008) as well as studies on online and f2f CPD programmes in particular (Adada and Styron Jr, 2008; Fisher et al., 2010; Fishman et al., 2013; Ginsburg et al., 2004; Hawkes and Romiszowski, 2001; Masters et al., 2010; McGraw et al., 2007; Peterson and Bond, 2004; Russell et al., 2009a; Ryan et al., 2007; Thomas, 2009) argue that online programmes can be as effective as traditional f2f programmes, while a number of studies comparing the impact of online and f2f programmes on classroom education in general (Al-Jarf, 2002; Albalawi, 2015; Logan et al., 2002; Summers et al., 2005; Urtel, 2008; Wilson and Allen, 2011) argue that the effectiveness of the online over the traditional f2f classroom are yet to be examined.

In addition, within the study context (Saudi Arabia), there are no comparative studies that evaluate the impact of online CPD programmes as compared to f2f CPD programmes particularly with regards to science teachers' pedagogical practice in the classroom. The available studies in online CPD programmes have only investigated participant aptitudes in general education (Albahiri, 2010) or in higher education (Al-Ghadyan, 2004; Alsadoon, 2009), or have investigated the effectiveness of participation in online discussion forums on teachers' performance and attitudes (Al-Jarf, 2006).

Furthermore, studies thus far have been concerned with teacher perceptions of the effectiveness of CPD programmes in general, or with the barriers and enablers that denote the impact that CPD programme can generally have. Goodall and Britain (2005) found in their study that most CPD programmes in schools are evaluated according to Guskey's lower levels (teacher satisfaction and learning and skills outcomes) and usually the data for these evaluations are collected via survey methods either on the day of training or immediately after the event.

Overall, studies in Saudi Arabia have hitherto investigated the opinions and aptitude of participants or reviewed the historical and policy drivers behind CPD programme in Saudi Arabia without (a) drawing proper and thorough comparisons between different formats of CPD programme delivery; or (b) using a systematic impact evaluation framework to ensure impact has been properly understood and interpreted.

This study therefore plugs the evident gaps in the literature by:

(1) Being the first comparative evaluation study the context of Saudi Arabia carried out on science teachers using the *higher* levels of assessment criteria of a systematic evaluation framework (Guskey's 5 levels) to assess the impact of both online and f2f CPD programmes which apply the 5Es instructional model.

(2) Being a timely study which has a practical impact and application as it provides a provisional but clear database for stakeholders in the *Tatweer* project and in the Ministry of Education in Saudi Arabia. This impact extends to the potential that online formats of CPD provision have to act as effective training media that can address some of the key deficiencies in the current f2f CPD programmes, as well as contributing to the academic body of literature; the study therefore has implications for policy and practice.

The data and findings of this study will be used by policy makers at the Ministry of Education and those involved in the *Tatweer* project in further investigating the implementation of an online CPD programme, especially for training teachers in different instructional models which are aimed at changing traditional approaches over to an active learning 5Es instructional model. This will also aid the planning and organisation of online CPD programme activities for science teachers in Saudi Arabia and other countries.

In addition, the findings of this study will add to the limited accumulative knowledge and research on CPD programme in general an online CPD programme in particular in Saudi Arabia and other large developing countries.

1.6 Thesis Outline

This thesis consists of six chapters, which are summarised in this section.

Chapter 1 (Introduction and Background), which is the present chapter, has introduced the historical and political backdrop behind this study. Within this chapter, the key background information of the study context is detailed. This goes further to highlight the stance of the Ministry of Education within the country and the drive to enhance the existing system. The state of current teaching standards is briefly mentioned and the challenges faced by the country in improving these standard are outlined. The chapter also introduces the current initiatives aimed at enhancing education standards within the country and the potential bottlenecks that may be encountered. The rationale behind the

study is also covered within the chapter to provide an insight into how important this research is, as well as its significance in relation to Saudi Arabia specifically and the literature in general.

Chapter 2 (Study context) presents the reader with an in-depth knowledge of the study context by detailing the history of the educational system within the country, efforts of the Ministry of Education to keep up with the fast paced development of the needs and challenges that the educational systems are currently facing, as well as the development of educational reform, in particular in relation to science curriculum. The chapter also demonstrates the models of science teaching within the study context, the need and the history of professional development and the available types of CPD delivery means.

Chapter 3 (Literature review) discusses issues related to CPD programmes in general and reviews studies that focus on the comparison of the impact of CPD programmes (both online and f2f) on teachers' pedagogical practice in particular. It begins by clarifying the concept of the CPD programme, highlighting the importance of CPD programmes on the teacher in the classroom, followed by an outline of the theoretical framework relating to the effectiveness of CPD programmes, the evaluation of CPD programmes and delivery methods. In this chapter, the meaning and definition of online learning/instruction is discussed and the principal issues relating to online learning is also highlighted with a brief account of the pros and cons associated with this mode of learning. A review of the impact of online learning compared to traditional f2f delivery in general then goes on to underline issues with regard to comparison studies on the impact of the online CPD programmes and f2f CPD programmes on teachers' pedagogical practice. The chapter concludes by presenting the emerging research questions.

Chapter 4 (Research methodology) explores methodological issues surrounding the research. It begins by providing justifications for the adopted research approach as well as the techniques for data collection and analysis. Within the chapter, two methods of CPD delivery programmes (f2f and online) covering same content are compared. The chapter also covers important information on the evaluation framework, research philosophy and the research design which has been applied to this research. Bearing in mind all the possible challenges and errors associated with sample selection for a research project such as this one, the approach, justification and description of the research sample population and selection of the sample from potential participants in the

study is clearly highlighted within the chapter which then concludes after demonstrating the quality and trustworthiness of data as well as the ethical considerations which must be incorporated into the work.

Chapter 5 (Analysis and discussion of the study findings) is divided and ordered into seven sections, five of which are according to Guskey's evaluation framework. The initial section gives a brief introduction to the chapter, after which the subsequent section presents and discusses the teachers' satisfaction towards content, context and procedure of both online and f2f CPD programmes (Guskey's level 1) which have been collected through a questionnaire. The third section presents and discussed findings with regard to teachers' learning (Guskey's level 2) as a result of participating in the CPD programmes based on the interview results. In the fourth section, key concerns about Guskey's level 3 are raised with reference to organisational change and support. The change in the teachers practice is presented in section five. This section is divided into two, with the first part analysing and discussing observational data which was obtained during observation, whilst the later part covers the data which was obtained via the interview approach. Section six within the chapter presents the impact of the CPD programmes on students' learning based on the teachers' point of view while the last section is a summary of the chapter.

Chapter 6 (Conclusion and Recommendation): This chapter summarizes the key findings of the work carried out. It further demonstrates the contribution of the study and offers the implications of the study for the Ministry of Education in Saudi Arabia (policy-makers), the CPD programmes providers, schools' administration and the teachers. The chapter is concluded with recommendations for further research, which explores ways to enhance the findings of this research and to expand the academic knowledge-base in order to benefit various stakeholders and policy makers.

Chapter 2. Study Context

2.1 Introduction

In order to further understand the context within which this research is taking place, it is useful to gain insight into the history of the Saudi Arabian educational system and discuss the current situation in detail. Therefore, in order to achieve this aim, this chapter provides both detailed and background information with regard to the study context. It goes further to provide the reader with an insight into the educational system within Saudi Arabia as well as the efforts of the Ministry of Education to keep up with the fast paced developments and challenges that educational systems are currently facing. The educational development initiatives and an introduction of the new science curriculum reforms are also discussed in the chapter, as are teachers' curriculum development and challenges. Finally, teacher professional development programmes in Saudi Arabia is also detailed in this chapter.

2.2 Background Information

It is essential to provide a brief description of the selected location for this study, which was carried out in Saudi Arabia. This country, also called the Kingdom of Saudi Arabia, is an independent Muslim Arab monarchy, which was first established in 1902 by King Abdullaziz bin Saud (Al-Sadan, 2000). Saudi Arabia is one of the largest countries in the continent of Asia and is geographically the largest country of the Arabian Peninsula. Saudi Arabia spans a land area of 2,150,000 sq. km (830,000 square miles) and the Peninsula is bordered by Jordan and Iraq on the north and northeast; Kuwait, Qatar, Bahrain, the United Arab Emirates and the Arabian Gulf on the east; Oman to the southeast; Yemen to the south; and the Red Sea on the west (United Nations Development Programme, 2014). With regard to population, the latest Saudi Arabian census estimates a total population of 29,994,272 (Central Department of Statistics & Information, 2012) who inhabit the thirteen administrative territories of the country, in which the centrally located Riyadh is the capital.

Saudi Arabia is considered to be the Holy land for millions of Muslims around the world and the government of Saudi Arabia applies Islamic holy law (Shari'ah) as a legal framework. Saudi citizens speak the Arabic language as their official language, whereas

English is widely used in the business sector.

Prior to the discovery of oil, Saudi Arabia was a poor country whose economy was sustained by farming, trading and pearl fishing. However, since the Second World War and the discovery of oil, the country has rapidly developed in oilfields and socio-economic infrastructures. Saudi Arabia currently holds the world's largest reserves of petroleum (16% of proven total) with an annual purchasing power of about US$ 174 billion and the share of the private sector economic activities reached 46% of GDP (Organisation of Petroleum-Exporting Countries, 2007). Increasingly Saudi Arabia's mineral riches are being developed as part of a large national development programme. Although the kingdom of Saudi Arabia is classed as a developing country, it is expected that the country will enjoy a position of higher socio-economic development in the future (United Nations Development Programme, 2014).

2.3 Education System in Saudi Arabia

The educational system in Saudi Arabia is relatively new. In 1925 the Director of Education was established to supervise the education department. The pioneering of formal education started in the 1930s and the first secondary schools were set up in 1951 (Ministry of Education, 2004). During this period, most of the teachers were not qualified; most of them could read and write but without any qualifications, having just completed their elementary schooling. The Ministry of Education was established in 1953 and handed the responsibility of policy-making, planning, budgeting curricula, resources and supervision of both public and private education (Ministry of Education, 2004). Currently, the Ministry of Education is responsible for the provision of free education for all students at any level. Table 2.1 illustrates the number of schools, teachers and students who are under the Ministry of Education's supervision (Ministry of Education, 2014).

Table 2.1: The number of schools, teachers and students in Saudi Arabia (Ministry of Education, 2014)

Education Level	Gender	Number of Schools	Number of Teachers	Number of Students
Pre-primary	Boys/Girls*	2779	20985	226977
Primary	Boys	6892	116830	1328418
	Girls	6940	130723	1295247
Total		13832	247553	2623665
Intermediate	Boys	4421	61624	644029
	Girls	4007	66028	605362
Total		8428	127652	1249391
Secondary	Boys	3072	57368	680134
	Girls	2898	65767	578454
Total		5970	123135	1258588
Total		**31009**	**519325**	**5358621**

*This level is mixed

It is essential to highlight that education in Saudi Arabia is centralized and performance driven, with the Ministry of Education having a top-down approach which is influenced by religious beliefs and traditional values (Ministry of Education, 2004). The educational system is gender-based, thus requiring boys and girls to be separated from one another, with same gendered teachers in all schools which are under the supervision of Ministry of Education (AlMunajjed, 1997). This, however, does not compromise the quality of teaching or education provided, as this is similar for both sexes with the exception of some special courses and subjects related to life skills or religion.

The education system in Saudi Arabia can be classified into a number of levels which include: pre-primary education (optional), primary education, intermediate education, secondary education and higher education; each level has a separated school building (Saudi Arabian Cultural Mission, 2006). Due to the cultural context of Saudi Arabia, boys and girls study separately and in different schools (Alotabi, 2014). These levels are briefly described below, to gain more insight into the overall education system of the country.

Pre-primary education level is targeted at children between the age of 3 and 5. Although

this is not a pre-requisite into the next level, it can serve as a preparatory activity prior to enrolling for the first grade of primary education.

Primary education: This level is compulsory it is regarded as the foundation of any education, and is specially designed for children who are age 6 to 11. This level of education requires six (6) years and is divided into two parts; lower (classes 1 - 3) and upper primary (classes 4 – 6). Education at this level is focused mainly on Islamic religion, the Arabic language, mathematics, history, geography and science. The academic year at this level consists of two semesters with each having a minimum of 15 weeks, while the daily schedule comprises of six 45 minutes sessions (Ministry of Education, 2004). Teachers carry out verbal teacher evaluations at this level rather than using examinations to assess the children.

Intermediate education: This level is for children aged 12 years and is scheduled to last for 3 years where students who have completed their primary education are encouraged to take part in further education. At this level, the academic calendar consists of two semesters each of which is about 15-weeks, plus a two week examination period. Passing the exam is important at this level as a certificate is issued as a recommendation for further studies at a secondary school level.

Secondary education: Upon successful completion of the intermediate stage, successful candidates aged 15 years are accepted for further studies. Students at this level are expected to spend 3 years in preparation for studies at the university level. The academic calendar at this level is two semesters, which last about 20 weeks each, with both semesters incorporating a two week examination period.

Higher education this is the highest education level within the system. This post-secondary education operates a similar system of education as the United States, however the patterns and approach at this level are in line with Islamic systems and customs.

In all the educational levels highlighted above, science education is deemed both important and compulsory (Mansour et al., 2014). For example, at the primary level science is delivered as general science, however, as students begin to progress into the intermediate level, although science is still presented as general science, it branches out into specific topics including physics, chemistry, biology, astronomy and geology. At this level, subject matter is divided into three broad disciplines, namely living things, matter and energy and the Earth and Universe. Higher up in the educational hierarchy, towards the secondary

school, science is delivered as separate disciplines where students at this grade study subjects including physics, chemistry and biology (Mansour et al., 2014).

Overall, all schools at all levels use the same instructional methods, textbooks curricula and assessment procedure (Ministry of Education, 2004). Although the Ministry of Education in Saudi Arabia is located in Riyadh (the capital city), several education directorates are strategically located around the country to supervise the educational process. Each of these education directorates is, however, further divided into several districts, depending on geographical size.

With regard to science teachers, the Schools of Education at Saudi Arabian universities are well acknowledged for the provision of a broad curriculum in education theories and approaches (Mansour et al., 2014). In addition, these Schools have departments which are specialised in pure subjects, including mathematics, physics, chemistry, biology, English and Arabic language and Islamic studies, and which requires each student to specialize within a selected department while combining other courses in education to aid general knowledge and delivery of specialized knowledge (Mansour et al., 2014).

The minimum requirement to engage in teaching at any level within the country is a 4-year bachelor's degree. This may be obtained through educational programmes in either a teachers college, or in a college of education (Sabah et al., 2014). Whilst the teachers college prepares teachers to deliver science and other disciplines at primary school level, the college of education prepares science teachers who teach only general science to students at intermediate level or those who are specialised in only one scientific discipline (biology, chemistry or physics) who deliver at secondary school level (Sabah et al., 2014).

2.4 The Education Development Initiative

The fundamental place of education in the world in which we live in today is seen as a key factor of financial and social development. This has led to the rapid demand for a higher quality education for both the public and private education systems in Saudi Arabia.

According to the Ministry of Education, catching up with the pace of modern life on the world stage requires a great deal of knowledge and skills (Ministry of Education, 2004). This acknowledgement has led to the government laying an emphasis on educational

reforms (enhancement of systems and approaches) as this avenue can furnish the Saudi students with the skills they need to face future challenges (Ministry of Education, 2004).

The efforts of the Saudi Arabia government to improve the educational system over the past 40 years are nevertheless widely acknowledged. There has been a large investment in educational infrastructure leading to an observable reduction in illiteracy in the country (The General Administration for Eradication of Illiteracy Programmes, 2008). The following table shows the decline in the illiteracy rate over the past years.

Table 2.2: Illiteracy rate in Saudi Arabia for years (1997 to 2007)*

Year	Illiteracy Rate	Males	Females
1997	22.40	12.03	32.81
1998	20.92	10.54	31.32
1999	19.47	9.10	29.85
2000	18.65	8.77	8.53
2001	17.76	8.41	27.10
2002	16.89	8.08	25.68
2003	16.03	7.77	24.27
2004	15.17	7.47	22.85
2005	14.03	7.90	20.90
2006	14.00	7.60	20.60
2007	13.70	7.30	20.20

*Adapted from The General Administration for Eradication of Illiteracy Programmes (2008)

However, a recent increase in birth rate in the country has amplified the challenge for meeting the higher educational quality standards required by the ever-increasing population.

Furthermore, although the traditional mode of teaching and skills acquisition in the Saudi educational system proved effective in the past, it is believed that it does not have facilities to deliver skills and specialization required to keep up with the current demands of a knowledge based economy (Ministry of Education, 2004). Al-Jarf (2005) also claimed that, in comparison to other educational systems, the Saudi Arabian educational system still needs more development in areas such as teachers' pedagogical approach, curricula contents, improving in-service teacher training programmes and integrating technology in the classrooms.

The Ministry of Education has established numerous initiatives aimed at developing the education system within the country, particularly with science and mathematics (Tatweer, 2012). The most recent of these reforms is the King Abdullah bin Abdulaziz Public Education Development Project (Tatweer) that was launched in 2007, with the primary

role of achieving comprehensive educational development in public schools within The Kingdom of Saudi Arabia (Tatweer, 2012). The Tatweer project, which principally means developed, particularly capitalizes on the weaknesses of the previous reforms and contains three main aspects: curriculum development, teacher requalification and school system reform (Tatweer, 2012).

The Tatweer project has embraced a dispersing scheme, granting more authorities to schools and the educational directorates, unlike the traditional centralized system. In addition, this reform lays more emphasis on learners' needs (Tatweer, 2012). The reform further emphasizes the need for improving students' proficiency in subjects, particularly mathematics and science, to prepare them for their future life, developing required and essentials skills for productive work and to meet the labour market's needs (Ministry of Education, 2004; Tatweer, 2012).

In regard to CPD programmes, Tatweer aims to use CPD programmes to improve professional development, improve teachers' levels of computer literacy whilst nurturing and enriching their learning through the incorporation of technology in education and preparing and supplying interactive training packages as resources which provide an abundance of knowledge which incorporate multimedia. It is hoped that this will help to provide effective and qualified trainers (Tatweer, 2012).

2.5 Science Curriculum Reform

Since the development of Saudi Arabian science education in the 1970s, no change has been made to the objectives, which are based on Islamic principles and values (Al-Mohaissin, 2002). Despite these unchanged objectives, the quality has not been impaired as these objectives and skills are ambitious, hoping to achieve a number of outcomes, including a sound approach in delivering science, enhancing Islamic values amongst students and developing a suitable interpretation of things and events (Al-Mohaissin, 2002). The objectives also include clarifying the lack of contradictions between religion and science as well as to mentally build the judgment sense of students. Teachers are also required a level of training pertaining to research through scientific experiments and to demonstrate honesty and integrity during the delivery of the curriculum (Al-Mohaissin, 2002).

In regard to the Saudi curricula, it is ready-made by the Ministry of Education. It contains

relevant materials which are delivered by all education regions and science teachers whilst using specified publications (Ministry of Education, 2004). Because of this, the curriculum may not be altered by teachers who are required to deliver it as it is. Nevertheless, concerns about the old elementary science curricula and locally developed textbooks have been raised. For example, teachers indicated that the contents were superficial and limited in regard to the exploration of exercises and experiments which can encourage students to do inquiry-based learning via observation, comparison and the employment of critical-thinking skills (Ministry of Education, 2004). Furthermore, it was highlighted that the old curriculum and textbooks were based on teacher-centred approaches and on pedagogies that principally encouraged memorization (Al-Aklobi, 2008; Alabdelwahab, 2002; Algarfi, 2010). This was furthermore coupled with pressures to keep up with the ever evolving trends in science education - particularly science education standards and scientific literacy (American Association for the Advancement of Science, 1993) - as well as the Saudi Arabian science students' low performance in the Trends in International Mathematics and Science Study (TIMSS) in TIMSS 2003 and TIMSS 2007 (Mullis et al., 2008).

In response to all of this, the Saudi Ministry of Education introduced a new science curriculum which is equipped with a new teaching approach (Tatweer, 2012). This was in collaboration with the Obeikan Research Development Company in 2008 (Obeikan Education, 2011; Tatweer, 2012) and is, to an extent, adapted from the translation of science textbooks manufactured by the American publishing company McGraw-Hill (Obeikan Education, 2011). In particular, extra emphasis is laid on student-centred learning and understanding concepts, in contrast to the previous curriculum which favoured memorization. This new curriculum provides tangible connections to students' life and experiences, and is based on the constructivist theory of learning with an emphasis on inquiry-based instruction, critical thinking and problem solving (Tatweer, 2012).

It is important to give an insight into this new curriculum to provide an in-depth understanding of the approach, techniques and anticipated impact. Therefore, the next section will provide information about this new curriculum, which is inquiry based.

2.5.1 Inquiry-Based Learning

There is no single definition for Inquiry-Based Learning (IBL) (Spronken-Smith, 2007), but it can essentially be described as "a pedagogy which best enables students to experience the processes of knowledge creation" (Spronken-Smith, 2007, p. 5). IBL involves 'the creation of a classroom where students are engaged in essentially open-ended,

student-centred, hands-on activities' (Colburn, 2000). The teacher introduces the task and facilitates the students' learning, while students pursue their own lines of inquiry. They look for evidence to support their ideas and take responsibility for analysing and drawing conclusions. Students can work individually or in groups, either in school or out of school activities (Kahn and O'Rourke, 2004). This approach was initiated when it became evident that the traditional didactic approaches that emphasize rote memorization were not effective in developing students as inquisitive, critical thinking and independent learners (Spronken-Smith, 2007). Such phenomenologist views which regard learners as passive recipients of knowledge have been called into question.

The inquiry learning approach is underpinned by the psychology of learning theories which state that learning is a mental activity and that learners have an active role in constructing new knowledge based on previous experience (Bransford, 2000). The constructivist approach of instruction encompasses these principles and is thought the most effective in delivering inquiry-based learning activities (Driver and Bell, 1986). Constructivism recognizes that children hold ideas of science which contradict scientific views and it is through inquiry and evidence that such misconceptions are challenged and dispelled (Boddy et al., 2003). Constructivism adopts a central approach between the teacher-centred instruction and the student-centred discovery method. The balance between the teacher's role and students' involvement depends on the content and the learning objectives of the task (McLoughlin, 2008). The premise is that students can learn and achieve specified goals when they are provided with minimal information and guidance.

There is substantial research suggesting that IBL develops students, including Special Education Needs (SEN) students, to become more creative and proactive in learning (Alberta Learning, 2004). Research also indicates that students who were involved in open-ended investigations demonstrated improved abilities in science literacy and research skills than students carrying traditional 'cook book' experiments (Brickman et al., 2009).

However, inquiry instruction may not be appropriate for students who are not cognitively able and who still require more guidance and support (Brickman et al., 2009). It has also been argued by Kirschner, Sweller and Clark (2006) that strong instructional guidance is more effective in the learning of novice and intermediate learners than the constructivist-based minimal guidance. They believe that learners need to acquire sufficient prior knowledge before they become able to learn independently.

Despite the success of the constructivist methods in promoting student learning, they are perceived complex and thus not applied by most school teachers (Boddy et al., 2003). Relatively easy to apply models of IBL have been suggested to propagate education based on constructivism. The most prominent models are the 3Es (Karplus and Thier, 1967), the 5Es (BSCS, 2006) and more recently the 7Es (Eisenkraft, 2003). The development of these models will be briefly described in the following section. However, adopting an inquiry-based learning is not a trivial enterprise. It requires a substantial investment in the training of teachers to apply these new instructional models and in developing the curriculum.

2.5.2 Models of Science Instruction

Models of instruction are developed to systematically guide teachers and students and draw their attention to the task in hand. Evidence from research suggests that consistent application of effective instructional models enhances students' learning of core concepts in science and in other disciplines (Donovan and Bransford, 2005). The history of development of instructional models goes back to the early 1900s when Herbart (1901) introduced the first systematic model of instruction as well as to the 1930s when Dewey (1910) published his seminal book "How We Think" (1910; 1933).

Herbart's model (1901) consisted of four consecutive steps: preparation, presentation, generalization and application. First the teacher explores students' knowledge and then introduces the topic for inquiry. Further explanation follows as required before students are asked to apply what they have learnt in other situations (Bybee et al., 2006).

Herbart's model (1901) was followed by Dewey's model (1910) which is based on the premise that learning is an active process that takes place through interaction and solving problems (Bybee et al., 2006). Dewey's model (1910) is composed of five phases (1) Sensing the problem, (2) identifying the problem, (3) formulating a hypotheses (4) testing the hypotheses and (5) making conclusions and generalizations (Bybee et al., 2006). These phases are characteristic of the scientific method that is taught at most schools. Based on Dewey's model, Heiss et al. (1950) developed the learning cycle, which is made up of the following stages: exploring, experience getting, organizing learning and application of the knowledge learnt.

In the late 60s Karplus then developed a learning cycle based on the Science Curriculum Improvement Study (SCIS) model (Karplus and Thier, 1967). Karplus' learning cycle consists of three phases: exploration, invention and discovery. Later the names of these phases were changed to exploration, explanation and elaboration (see Figure 2.1).

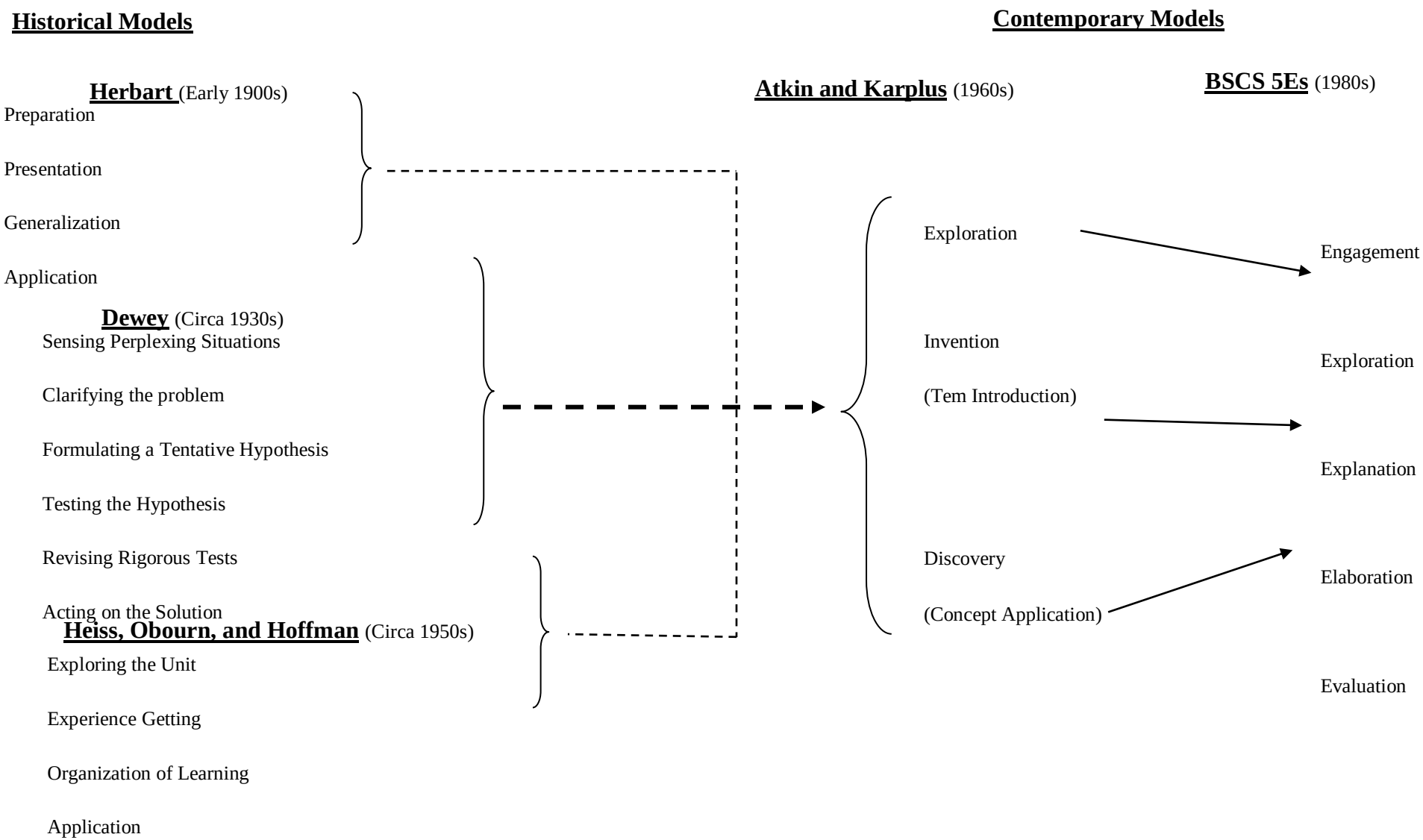


Figure 2.1: Development of Instructional Models (Bybee et al., 2006, p. 13).

2.5.2.1 The BSCS 5Es Instructional Model

The 5Es instructional model is used in this study and will be described briefly. This model is widely used around the world, and has recently been introduced in Saudi Arabia. The 5Es instructional model was developed by the Biology Science Curriculum Study (BSCS) in the late 1987 (BSCS, 2006) and it is a model that can be used to implement a constructivist approach of teaching and learning in the classroom (Boddy et al., 2003). Although the 5Es instructional model is relatively new, there is evidence that, compared to traditional teaching methods, it is effective in promoting students' understanding, achievement, learning and attitudes towards science. One of the early studies to establish the effectiveness of the 5Es instructional model over the traditional method of teaching was carried by Caprico (1994). In this comparative study, students were classified into two groups and had the same prerequisites and examinations to enable an accurate comparison. The findings demonstrated a better performance in students who engaged in the 5Es instructional model over the control group, demonstrating 13% higher marks.

Further evidence of this has been demonstrated by Bevenino et al. (1999) from which students were observed to develop independent frames of thought having engaged in the 5Es instructional model. This may also be buttressed by findings of Lord (1999) who further highlighted the benefits of this approach (5Es instructional model) over traditional methods (control group). In the study, engaging in the 5Es instructional model aided the understanding and interpretation of the participants. Furthermore, the added advantages of the 5Es instructional model observed in the study is also in agreement with Caprico (1994) who reported that the feedback received from students was mostly positive, which differs from the control group who submitted very little positive feedback.

For the successful integration of the 5Es instructional model, students and teachers are expected to follow the five phases of the 5Es instructional model, which are: Engagement, Exploration, Explanation, Elaboration and Evaluation, all of which will be briefly described below to demonstrate some of the respective roles of students and teachers (Bybee et al., 2006).

- **Engagement**

This is the first stage, which is aimed at engaging students in the learning task. During this phase, students engage in short activities and ask questions. These activities present students with new problems, for which they are required to proffer solutions. Such activities should make connections between past and present learning experiences and prepare students for new learning (Bybee et al., 2006). As a teacher, the primary role is to ask questions to capture students' interest and curiosity, and identify their prior understanding. These may be carried out by presenting a situation and detailing the instructional task including the observed outcomes (Bybee et al., 2006).

- **Exploration**

Following engagement in tasks, students are provided with reasonable time to explore their ideas and skills. During this phase, students use inquiry skills to explore and investigate concepts within given activities. They test hypotheses, experiment with alternatives and discuss and record observations. Overall, this is an important phase for both the student and the teacher as experiences that aid the integration of scientific skills are built (Bybee et al., 2006). During this phase, the role of teachers is similar to that of a coach as they are responsible for observing and listening to students to assess their understanding. They initiate activities and allow students to demonstrate their opinions and ideas. Most importantly, the role of the teacher encourages students to work together and ask probing questions to guide them (Bybee et al., 2006).

- **Explanation**

This is the act of delivering concepts, skills and processes in a comprehensive and clear manner. The importance of this phase is its provision of a common use of terms, which relates directly to the learning experiences acquired from the previous phases. During this phase, students focus their attention on a particular concept of the investigation. They use various resources to define and explain the concept. They listen and question other explanations. The role of the teacher is paramount at this phase and it is important that he/she uses the approach systematically. For example, it is expected that the initial part of this phase is based on the students' explanation and that it clearly links to the experiences demonstrated in the earlier phases of the instructional model. Therefore at this stage, the teacher asks students for evidence to support explanations and guides students towards a deeper conceptual understanding (Bybee et al., 2006).

- **Elaboration**

This phase of the instructional model aims to provide students with additional time and experiences, which contribute to the learning process. It is perceived that following the preceding phase, the elaboration phase engages students in further experiences that can enhance or collaborate the concept of skills. To aid effective delivery at this stage, interactions within students' group has also been identified to provide students with an avenue to express their understanding of the subject. Therefore, in this level students are provided with the opportunity to develop a deeper and broader understanding, and apply acquired knowledge in new situations. Teacher responsibility, on the other hand, is to extend students' conceptual understanding and encourage drawing conclusions using evidence. The teacher creates an environment conducive to interaction within groups and sharing of information (Bybee et al., 2006).

- **Evaluation**

This is the fifth and the final phase in which feedback is provided to students to rate their abilities and explanations. At this phase, students have the opportunity to put all the acquired skills into practice and demonstrate their understanding and ability to communicate solution. This may also take place in the form of an informal evaluation from the beginning of the instructional sequence. To assess their understanding and progress, students answer open-ended questions to demonstrate their understanding of concepts. The responsibility of teachers at this phase is to administer tests to evaluate each student's level of understanding. This is mostly achieved by asking a series of open-ended questions to evaluate students' progress. The teacher may also use summative evaluation methods at this juncture.

2.5.2.2 The 5Es Instructional Model Challenges and the Need for a CPD Programme

Despite all these efforts to develop the Saudi science curriculum, teachers' classroom practices still have not presented a noticeable change from a traditional teaching approach and the classrooms are still dominated by teachers talking (Almazroa, 2013).

In addition, the introduction of this new curriculum and moving from teacher-centred teaching approaches to more student-centred with inquiry-based instruction has raised concerns and challenges to the science teachers who primarily engage in the traditional

pedagogy. It should be noted that the quality of teacher's pedagogy has been identified as a main contributor to attain an in-depth understanding of science (Mansour et al., 2012). It is thought that this huge development needs to be accompanied by an intensive and effective systematic teacher professional development programme to help teachers develop pedagogical practice and an in depth knowledge of these teaching methods (Mansour et al., 2012).

Bearing in mind that Professional development programmes are an essential element for supporting the implementation of the new teaching approach, the CPD programme for science is widely recognized as a national priority (Obeikan Education, 2011). The efforts of the Ministry of Education is, however, acknowledged as teacher training programmes have developed tremendously as an integral part of the educational system in Saudi Arabia over the years. This development is in correspondence with the general development of the educational system in Saudi Arabia.

Overall it is inferred that more effort needs to be imputed into the delivery of these CPD programmes to principally enhance the delivery of the new curriculum. A number of factors also need to be put into consideration whilst developing the approach for delivery of CPD programmes. These include consideration of the study context which is populous and ever increasing, coupled with the consistent demand for science teachers at all grades within the country, thus putting pressure in the Ministry of Education who now accept candidates/teachers who hold a pure science degree such as geology, biology etc. irrespective of the lack of educational preparedness (Ministry of Education, 2004).

To understand the limitations and also gain an insight that will aid the proposal of solutions to the existing limitation, it is essential to understand the history of CPD programmes in the study context.

2.6 Teacher Professional Development Programme in Saudi Arabia

In the early 1950s, the Kingdom of Saudi Arabia pioneered the use of a teacher-training programme for teachers in the country. During the summer vacation of 1954 in particular, 1,025 teachers benefited from these courses which covered various subjects, as well as psychology and teaching methods (General Directorate of Training and Scholarship, 2002). During the initial years (1955 - 1973), the Ministry of Education was directly responsible for the delivery of these programmes thus limiting the number of teachers who could benefit from the approach. In addition, the duration for teachers

training delivery ranged between 6 months and three years as the programmes were aimed at upgrading teachers who were not skilled up to the standard requirement in their respective fields (General Directorate of Training and Scholarship, 2002).

In 1974, the Ministry of Education established the General Directorate of Training and Scholarship (GDTS), aimed at achieving professional development growth of educational incumbents, to rehabilitate national cadres in the disciplines needed by the Ministry of Education, and to develop methods and training systems in accordance with modern global trends (General Directorate of Training and Scholarship, 2011). During this period a shift of focus to science and mathematics curricula was reported alongside the need to enhance the teachers' knowledge and pedagogical practices. In light of this, Science and Mathematics Centres opened in 1974 to provide intensive pre-service teacher education at the middle-school level.

In the 1977 the need to enhance the organisation as well as control of the training process for teachers in the GDTS arose. Therefore, the Ministry of Civil Service responded with the approval of a guide to Educational Training and Scholarship that was developed by the Ministry of Education (General Directorate of Training and Scholarship, 2002). The guide also emphasized the fact that the Ministry of Education and its GDTS must provide teachers in all regions in Saudi Arabia with educational training programmes.

Despite all the additional strategies which were implemented to meet and provide teachers in all regions of Saudi Arabia with educational training, it was quickly realized that the reforms had their shortcomings as they were reported not to provide adequate focus on teachers' preparation coupled with less emphasis on important dimensions of teacher education. Hence, in the 1980s, the policies in the guide were reformatted by extension of the teachers training programmes to most regions. Although this provision proved effective, the rapid increase in teachers in the 13 regions led to the establishment of educational training centres to cope with the population (General Directorate of Training and Scholarship, 2002).

By 1997 a total of 45 education-training centres had been established with each region having their own (Ministry of Education, 2010). In this period, GDTS assumed the responsibility of managing and directing via the training centres which took ownership of the design and implementation aspects of the training programmes.

It is important to mention that over the years there has been rapid development in the educational system and teaching delivery in the country and this has simultaneously meant that the development of teachers' training programmes in the country had to develop in parallel in order to fulfil the needs which were raised as a result. The Tatweer project, as previously stated, stands as the most recent development and was launched in 2007 with the principal aim of achieving comprehensive educational development in public schools in Saudi Arabia (Tatweer, 2012). The programme initiates with the rehabilitation and training of teachers whilst adopting new policies, as it acknowledges their importance on all elements of the education system.

2.7 Types of Science Teacher Professional Development Programme in Saudi Arabia

In Saudi Arabia, there are generally two types of CPD approach offered by GDTS (General Directorate of Training and Scholarship, 2002). The first being the Educational training programmes approach, which is carried out over a period ranging between one day and six months in Educational Training Centres and the other in the form of Education Rehabilitation programmes which can extend up to four years.

1- Educational Training Centres:

These centres are distributed across the country providing training programmes, the duration of which can range from one day to six months. Most importantly, this approach may be delivered at four sites including educational training centres, teacher's college, local universities and the Institute of Public Administration. Under these four sites, which are distributed across the country, provision of CPD programmes are available in three forms, namely: Short-term CPD programmes, local CPD programmes and refresher CPD programmes. These can be understood as follows:

- Short-term CPD programme, which are designed by the GDTS and implemented by Educational Training Centres, last about two weeks or less. They aim at improving teachers in many aspect of teaching and learning areas, such as the formulation of behavioural objectives, the use of technology, the measurement and evaluation of student performance, teaching competences, educational communication and classroom management.
- Local CPD programmes are designed mainly for meeting the specific needs of a targeted population, which are most often teachers within a specific region. This

suggests that the programmes may not be applicable to all of the regions within the country, irrespective of their flexible implementation time, which may extend up to two weeks.

- Refresher CPD programmes, unlike the local CPD programmes, are usually relevant to most Educational Training Centres, which carry out the implementation, as suggested by the Ministry of Education. These CPD programmes are offered at the start of academic years and may be delivered over a period of three to five days.

2- Education Rehabilitation Programmes.

The education rehabilitation programmes, or in service training programmes, is more extensive compared to those offered by the Educational Training Centres. The duration of this CPD programme style lasts for longer periods, which could fall between six months and four years and are specifically aimed at three categories of teachers, each with their own programme; undergraduate programmes, post-graduate programmes and post graduate programmes in universities abroad.

- Undergraduate programmes: these are CPD programmes specifically designed for teachers' colleges or colleges of education in Saudi Arabia with the overall aim of rehabilitating teachers without educational qualifications by providing them with modules in subject matter, content teaching and learning. These programmes extend from a year to four years and a bachelor's degree is awarded following successful completion.
- Postgraduate programme in Saudi universities: these are specially offered to outstanding teachers to grant them the opportunity to complete their higher education, such as a post graduate diploma, Master's, or even a doctorate degree.
- Postgraduate programme in universities abroad: Similar to the above but specially packaged for postgraduate teachers abroad.

From the above, there is evidence that the need to enhance the Saudi educational system and facilitate professional development of teachers in Saudi Arabia is in the heart of the Saudi Ministry of Education, which is ever putting more effort toward curriculum development and increasing the professional development of teachers within the country. It is further gathered that educational systems require an intensive course of professional

learning to meet the intended standards, particularly in the aspects of science and mathematics education. A demonstration of this may be described via the integration of the new science education curricular and the placement of teachers' professional development as a national priority initiative to improve teachers' pedagogical practice and to help them to deal with this new curricular.

Although as part of the Tatweer project, science teachers were provided with teachers' professional development programme through teacher training teachers (Obeikan Education, 2011; Tatweer, 2012). It may be inferred that these CPD programmes which are offered to teachers simply fall short of the requirements of the new curriculum, as current attempts have not proven effective enough to create the needed impact on teacher's attitude and pedagogy (Almazroa, 2013; Almazroa et al., 2015; Mansour et al., 2013).

It is therefore suggested that an alternative approach, such as online CPD programmes, that might enhance the effectiveness of these teachers and enable them to efficiently deliver the new mathematics and science syllabuses that the Ministry of Education has put in place and which needs to be adopted.

However, before delving into the theoretical literature regarding CPD programmes, both f2f and online, it is essential to give the reader some brief information about the ICT and Internet infrastructure in Saudi Arabia to give the reader a better understanding about the technological context of the study. Therefore, the following section briefly discusses ICT and the Internet and their usage among individuals, institutions and the wider society.

2.8 ICT and Internet in Saudi Arabia

Although the Internet has been in existence since the 1990s in developed countries, the developing world (Roblyer M, 2006), in places such as Saudi Arabia, took much longer to introduce it (Internt. as, 2014). The Internet became an integral part of Saudi Arabia society and economy much later (Comunications and Information Technology Commision, 2009).

The Internet was used in the Saudi Arabia in 1994 when the educational and medications and researchers institutions has been allowed to use the internet for educational and researches purposes (Internt. as, 2014). Then it was officially made

available in 1997 by a ministerial decision and became available for public access in 1999 (Comunications and Information Technology Commision, 2009; Internt. as, 2014). The Internet is provided by the Communications and Information Technology Commission (CITC) which was established to regulate technology and communications services in Saudi Arabia with the goal of ensuring that the services were available to everybody, and that the quality of these services was of a high standard whilst been affordable for the masses.

In line with other countries, Saudi Arabia has realized the importance of the role and impact of the Internet and ICT on the development of individuals and societies (Ministry of Communication and Information Technology, 2006). Therefore, the Saudi government has paid more attention and put in more effort over the past few years in order to keep pace with the rapid growth and fast development of the ICT sector. In line with this vision, a comprehensive long-term plan for ICT has been prepared for approximately the next twenty years. The long-term vision of the government of Saudi Arabia for ICT is:

> the transformation into an information society and digital economy so as to increase productivity and provide communications and information technology (IT) services for all sectors of the society in all parts of the country and build a solid information industry that becomes a major source of income (Ministry of Communication and Information Technology, 2006, p. 4).

Despite the late start to the use of the Internet and ICT in Saudi Arabia compared to developing countries, including many of its neighbors, the increased reliance on the Internet and ICTs by the Saudi masses has led to it being one of the highest levels in comparison to other developing countries. Nevertheless it remains far below the rates of usage in developed countries (Al-Ghaith et al., 2010). The use of the Internet is spreading quickly in Saudi Arabia; the growth rate is approaching ten times that of the world as a whole in the same period. It has been noted that Internet penetration increase from 5% in 2001, growing rapidly up to the end of September 2009 where it reached 26.8%, representing a 3750% increase since 2000 (Comunications and Information Technology Commision, 2009). Saudi Arabia became the largest Internet user population in the Arab world by the end of 2014 having 19.6 million Internet users with 65.9% (Internt. as, 2014). This corresponds to 31% increase compared to 2007 and 11%

increase compared to 2008 (Comunications and Information Technology Commision, 2009). Figure 2.2 illustrates the number of Internet users in Saudi Arabia during the period from 2001- 2014.

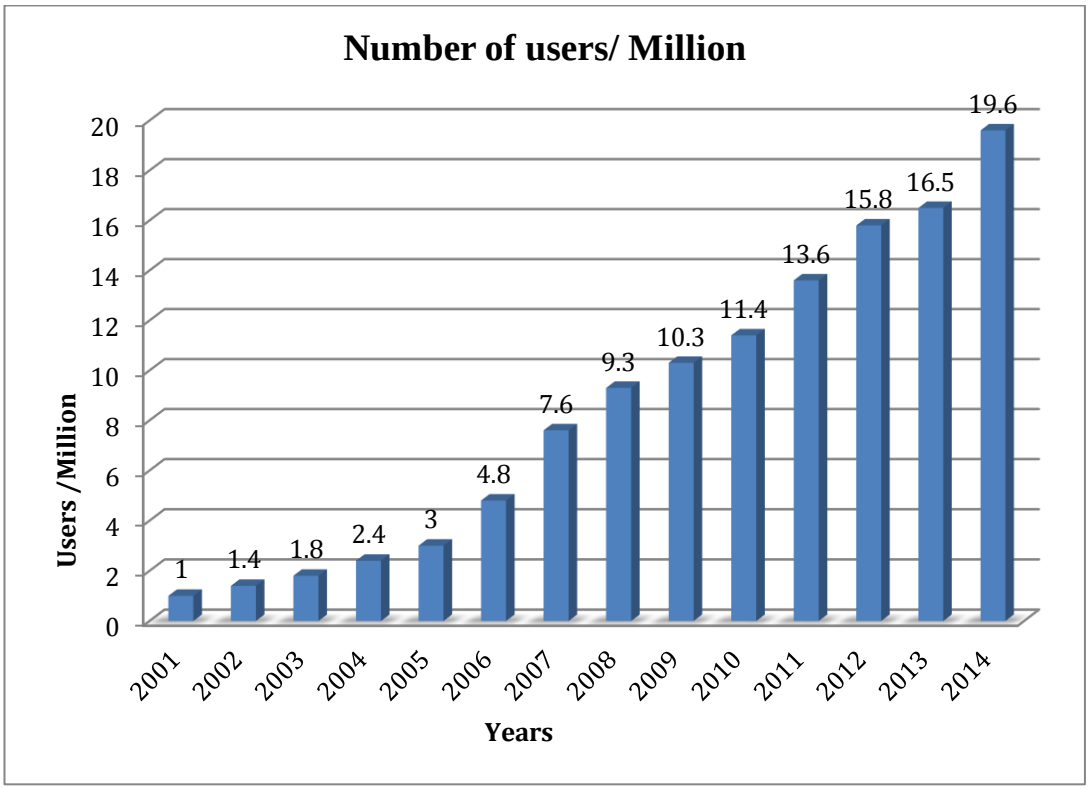


Figure 2.2: The number of Internet users in Saudi Arabia during the period 2001- 2014.

With regard to the services that are provided by CITC, modernization has taken place in line with technological developments. Between 2007 and 2008, dial-up was replaced with broadband connection. Three quarters now use a DSL/Broadband connection compared 47% in the previous drive (Comunications and Information Technology Commision, 2009). This is a result of service providers' campaigns which employed a more aggressive approach in communicating the benefits of broadband in comparison to slower dial-up connections. It is also a result of the dramatic reduction in cost of broadband which has been driven down due to fierce competition between service providers. However there are still areas which still have very low broadband penetration, like Al- Qaseem, Assir and Tabuk (Comunications and Information Technology Commision, 2009)

2.9 Internet usage in Saudi Arabia

The Internet is widely used throughout Saudi society by individuals, businesses, the government and institutions, including educational institutions such as schools, colleges and universities. The following section briefly describes individual's and educational institutions' usage.

2.9.1 Individual's usage

Steady progress has been made by citizens of Saudi Arabia in incorporating computers into their daily lives, which has come about because of the government's efforts coupled with the emergence of affordable computers. Usage has been for such activities as surfing the internet and storing documents as well as for entertainment purposes, such as playing games, watching movies, etc. (Comunications and Information Technology Commision, 2009). By 2009 laptops were preferred to desktops, with ownership of laptops reaching 76% compared to 66% who owned desktops. This is likely to be because of their ability to be used on the go. A third of nonusers express an interest in buying a computer (Comunications and Information Technology Commision, 2009).

As has already been demonstrated in Figure 2.2, there has been a significant and rapid increase in the availability and usage of the Internet in the country. This increase is mainly a result of the need for access to information, increased communication possibilities and the availability and low cost of broadband, which has made a significant impact as consumers have primarily moved away from dial up connection (Ministry of Communication and Information Technology, 2006). There is an overall satisfaction with Internet service providers. Most people are aware of ecommerce, but only few have utilized it, and most that have done it have done so for airlines reservations and tickets (Ministry of Communication and Information Technology, 2006).

Those who do not use the internet, have not done so because of a lack of knowledge about how to use it and/or because they cannot afford it, whilst some do not use it because their family do not permit them to do so (Ministry of Communication and Information Technology, 2006).

2.9.2 Educational institutions usage

The Internet is a medium which is crucial for enhancing education, by providing solutions to difficulties faced by teachers, researchers and trainers (Sait et al., 2002). Most educational institutions have at least one computer and laptops are increasingly being used by colleges and universities, which has not been demonstrated at other levels. Already by 2009, computer penetration in schools, colleges and universities was approaching 100%. Most educational establishments have moved away from dial-up connections and most have broadband, resulting in an increase in satisfaction, as broadband connections are much quicker. The government has set out to invest in its technology to improve performance, including the Ministry of Education. Saudis have found that the Internet is suitable for facilitating numerous aspects of education, including teaching, research and training (Sait et al., 2002).

The Ministry of Education has begun to provide all schools with advanced technology. The Computer and Information Centre (CIC) was established in the Ministry of Education in 1996, before the Internet was available in the country, to undertake the responsibility for planning and preparing schools to use computers and the Internet (Ministry of Education, 2012). In 2000, seventy Information Resource Centers (IRCs) were piloted in selected secondary schools and given all of the equipment required to promote the use of ICT, and information and instruction was made available through e-libraries, digital curricula, the Internet and e-learning (Ministry of Education, 2012). The goal of these centers is to foster learning and research skills as well as to teach students adequate thinking and problem solving skills. All schools have subsequently been given IRCs and, in 2003, computer skills became a compulsory part of Saudi education

In regard to the use of the Internet for teaching and training purposes, distance learning, e-schools, e-learning and online and digital curricula have all arisen as a result of the improved Internet resources (Albahiri, 2010). Distance learning has gathered popularity in Saudi Arabia which is likely to be a result of the dispersed nature of the student population (Albahiri, 2010). Therefore, distance learning could ensure the provision of a good quality education for the whole population. Many universities in Saudi Arabia have began distance learning courses, and King Abdul-Aziz University have set up special centers for the provision of distance learning, as have other institutions (Albahiri, 2010). King Abdul-Aziz University hopes to join other international universities that

provide a modern education by using Internet applications (King Abdulaziz University, 2009).

The institution which is responsible for creating research and development projects to advance a new generation of e-learning resources in Saudi Arabia is the National Centre for e-leaning and Distance Learning (NCEL, 2007). NCEL plans to expand the use of e-learning and its uses so that it becomes a significant asset to the Saudi educational system and to ensure that it is kept up to date (NCEL, 2007).

2.10 Summary of the Chapter

The aim of this chapter was to give the reader insight into the context of the study so that the research is firmly framed within it. It began by providing general information about Saudi Arabia from a political, cultural, religious and economic point of view. Also, the education system was discussed, looking at its history, infrastructure and the various levels of education. This was followed by looking at educational reform in Saudi in general, by focusing on the Tatweer project, and science education in particular, by discussing the curriculum and reforms made to it, specifically models of teaching science focusing on the 5Es instructional model and the challenges that face teachers who use this new approach. CPD programmes in Saudi Arabia were also discussed and the history of their development and challenges that they face was discussed. The types CPD programmes available to science teachers were described as well as the challenges of attendance and engagement faced by teachers. ICT and Internet infrastructure and usage were briefly highlighted generally and with specific reference to individual and educational usage.

The following chapter provides a review of the literature with regard to CPD programmes and gives a comparison of f2f and online approaches.

Chapter 3. Literature Review

3.1 Introduction

This chapter provides an in-depth review of the extant literature pertaining to the use of CPD programmes to enhance science teachers' pedagogical practice. There are two main sections in this chapter with each of these covering important aspects of the approach in relation to the research aims. In the first section (section 3.2), a brief overview of CPD programme is provided. This is supported by the possible approaches to the delivery of these programmes as well as the associated importance. Further into the section, the identification of features and qualities that can aid the creativity of a framework which will serve as a design guide to aid the development of CPD programmes are explored. To complement the identified features, possible learning approaches/activities that can be adopted to attain a successful CPD programme are investigated. The importance of evaluation of CPD programmes is also acknowledged in the chapter considering its relevance in delineating the impact of the programme. In particular, emphasis is laid on Guskey's 5 levels evaluation framework as it has been adopted for this study. The section ends with details of possible approaches for delivering CPD programmes, which are the online and f2f approach.

In the second main section (section 3.3), the online learning approach is stressed. This begins with the history of online and distant learning, which is then buoyed by the associated pros and cons of the online approach for CPD delivery. Further in the section, a comparison between the online and the traditional f2f approach is carried out to highlight similarities and differences. A review of the impacts of the online CPD programme compared to the f2f CPD programme on participants' reactions, participants' learning, organisational support and change, participants' practice and student learning is investigated within the section. This leads to the generation of the research questions followed by the concluding section (section 3.4).

3.2 Continuing Professional Development (CPD) Programme

Continuing Professional Development (CPD) programmes are an essential element of successful school development and reform and, thus, has attracted a growing amount of interest, both at a national and an international level (Day, 1999). In particular, the

incorporation of CPD programmes is acknowledged as a key element in improving teachers' teaching and learning in schools. To develop a significant understanding and application of this approach, this section gives an extensive deliberation below to shed light on its concepts, importance, application and methodology.

3.2.1 Concepts of CPD Programme

Continuing professional development (CPD) is a term which is becoming widely used in the education field in a similar context as in other medical, legal, engineering or financial professions (Jindal-Snape et al., 2009). The term CPD is often used interchangeably with lifelong learning (Jindal-Snape et al., 2009), although the concept of lifelong learning is much broader and can include all sorts of learning (Muijs and Lindsay, 2008).

Various definitions and purposes for CPD programmes have been given across different professions and associations. Most definitions emphasize the continuous acquisition of the required knowledge, skills and values relevant to the respective profession or association. Some of the definitions of the term *CPD programme* will be presented to throw more light on the meaning and purposes of CPD programmes.

According to Friedman and Woodhead (2008) the most commonly used definitions of CPD programme in the UK is that of the Construction Industry Council (CIC), which defines it as:

> The systematic maintenance, improvement and broadening of knowledge and skills, and the development of personal qualities necessary for execution of professional and technical duties throughout the individual's working life (Friedman and Woodhead, 2008, p. 1).

The CIC's definition has been adopted by many other organizations, like the Engineering Council UK, the International Pharmaceutical Federation (Netherlands), the Professional Associations Research Network (PARN) and the Royal College of Veterinary Surgeons (RCVS) (Engineering Council UK, 2012; International Pharmaceutial Federation, 2002; Professional Associations Research Network, 2012; RCVS, 2012). Within the UK education sector, CPD programme is of concern to two main establishments, the Department for Education and Skills (DfES), now known as

the Department for Education, and the Training and Development Agency for Schools (TDA), now the Teaching Agency (TA). The DfES defines CPD programme as: "any activity that increases the skills, knowledge or understanding of teachers, and their effectiveness in schools" (Bubb, 2004, p. 3).

Also, similar to the DfES definition, Day and Sachs (2005) defines the term of CPD as: "all the activities in which teachers engage during the course of a career which are designed to enhance their work"(p.3). Clearly, this definition focuses on teachers' learning and its impact on practice. Although the TA provides a definition of CPD programme, its definition asserts the development of the teacher as a 'reflective practitioner':

> CPD programme is a reflective activity designed to improve an individual's attributes, knowledge, understanding and skills (Training and Development Agency for Schools, 2008, p. 8).

A comparative study commissioned by the General Teaching Council in Wales (GTCW) has found that the structure of CPD programmes in education, both in the UK and internationally, is less developed compared to other professions. Suggestions have, therefore, been made that CPD programme must focus more on improving the generic skills and personal qualities of teachers (GTCW, 2002).

The above definitions and discussions reflect the importance of CPD programmes as an instrument for improving the quality of professional practice and services offered to users. Equally, as can be noted from the definitions set above, there are similarities in the sense that they all focus on enhancing the professional's knowledge, skills and practice.

This study uses the TA definition of CPD as it sufficiently covers the activities and needs of teachers to effectively apply the new science curriculum in Saudi Arabia, the CPD programme in this study focus on delivering activities to improve teachers' pedagogical practice in using inquiry-based learning methods. These activities can be delivered either via face-to-face or online.

3.2.2 The Importance of CPD Programmes

The world is changing rapidly as a result of technological innovations which have a profound effect on the way people are living their lives. Global competition has also

increased with the emergence of new products and new methods of work. These changes bring new challenges which require the development of new knowledge and skills to overcome them and therefore education is expected to respond to these changes and be modernized accordingly (Fullan and Hargreaves, 1992); CPD programmes are perceived as a tool to exactly achieve this (CPD Institute, 2009).

The benefits of well-planned CPD programmes are acknowledged by professionals and professional institutions and organisations (Muijs and Lindsay, 2008). Individuals, who are committed to CPD programmes, and who continually update their knowledge, are more likely to remain employed and progress in their careers (Friedman and Phillips, 2004). At the same time, professional institutions that encourage or oblige their members to participate in CPD programmes are better respected and gain the trust needed to sustain effective and lasting business relationships (Construction Industry Council, 2012; Friedman and Woodhead, 2008).

CPD programmes are not just applied to the training of teachers, and many other professions use them to improve industry standards. For example, within the UK, the health profession institutions like the General Medical Council (GMC) and the Nursing and Midwives Council (NMC) give CPD programmes special consideration as they promote competent personnel who provide quality patient care. As a result, CPD programmes are a pre-requisite for the promotion and progression of doctors and nurses (Nursing and Midwifery Council, 2008; The General Medical Council, 2012). In addition to improving professional effectiveness, CPD programmes motivate and bring satisfaction to practitioners (The General Medical Council, 2012). This is evidence of the effectiveness and success of the application of CPD programmes within general professional development.

Knowledge amongst the people of a nation is an important element of sustaining the wealth and prosperity of that nation, meaning that an educated population is of high value. Thus, governments all over the world make sure that their education is well funded and supported. There is compelling evidence to support the significance of continuing professional development in raising teacher quality and efficiency (Buchanan et al., 2006; McDonald, 2009), as well as sharing good practice between teachers (Muijs and Lindsay, 2008; Nicolaidou and Petridou, 2011). Friedman and Woodhead (2008) identified three purposes of undergoing CPD programmes:

1. Maintaining knowledge, skills and competence.
2. Improving and broadening knowledge and skills.
3. Developing personal qualities to execute professional and technical duties.

The ultimate purpose of teacher development is to enhance students' learning and achievement, and this can be attained by the development of all three of these aforementioned areas.

With regard to the management of education, CPD programmes provide opportunities for the development of leadership qualities and skills which are essential for improving the quality and standards of school practice (Hargreaves, 2000). Several leader and leadership development programmes have been introduced in many Western countries with noticeable benefits in professionalism and sustainable improvement in schools (Gerhard Huber, 2004; McLay and Brown, 2003; Spillane et al., 2004).

It has been suggested that CPD programmes have a widespread positive and high-quality impact for the whole of society, and do not only assist teachers and pupils only (Alexandrou et al., 2005; Dean, 1991).

Numerous studies have demonstrated the crucial role that professional development plays in enhancing teachers' classrooms practices. For example, Borko (2004), demonstrated the positive and noticeable impact of CPD programmes on teachers' practices, knowledge, collaboration and ability to deliver excellent teaching standards. Furthermore, CPD programmes are widely believed to be a cornerstone of educational reform. In this light, Boyd (2005) declares that professional development programmes are at the heart of the greater part of the advancements intended to enhance schools.

In the European Union (EU), as well as in other countries such as Turkey and Israel, there is concern about the low levels of students' interest and achievement in science (Stadler, 2010). Projects have therefore been funded, such as the EU's Science-Teacher Education Advanced Methods (S-TEAM). It addresses this problem by introducing changes in pedagogy and teachers' professional practice (Stadler, 2010). The project realised that teachers should be supported in appreciating inquiry-based teaching approaches and implementing them in the science classroom. As these types of project occur over the globe, it is important that networks of research in science exchange their national experiences and jointly develop models for effective CPD programmes (Stadler, 2010).

To realise the benefits of CPD programmes, educational authorities around the world are keen to develop training programmes and encourage teachers to participate in such programmes. In the UK, the General Teaching Council in England (GTCE) and the General Teaching Council in Scotland (GTCS) (GTCE, 2012; GTCS, 2012) provided CPD opportunities and encouraged teachers to participate in CPD activities.

The GTCE has, however, recently (on 31 March 2012) been abolished and its functions assumed by the Teaching Agency (TA). Equivalent bodies to the TA exist in countries all over the world. In the United States, for example, the National Association of State Directors of Teacher Education and Certification (NASDTEC) is responsible for matters related to the certification and development of professional standards (NASDTEC, 2012).

In Scotland, teachers are obligated to take part in at least 35 hours of CPD each year (Boyd, 2005). The report Teaching for the Profession for the 21st Century claims that, in Scotland, teachers will all have a yearly plan approved by her/his immediate manager and must keep a portfolio to record their participation to talk over with a member of the managerial staff (Scottish Executive Education Department, 2001).

Likewise, there is general agreement in the United States that teacher CPD programme is central to the accomplishment of successful educational reform (Vrasidas and Glass, 2004). Many researchers there viewed the 2002 No Child Left Behind (NCLB) Act to be a vital step in this regard (Cochran-Smith, 2005; Simpson et al., 2004). NCLB highlights factors such as the nature of student learning and, most importantly, how teaching practices can be improved.

Within Saudi Arabia's context, as discussed in Section 2.6, the General Directorate of Training and Scholarship (GDTS) is the responsible of providing CPD programmes (Alghamdi and Li, 2011). As in many countries, it is clear that CPD programmes have a key role to play in these initiatives. One of the central and most recent initiatives, which began in 2007, is the King Abdullah Project for Improvement of the Public Education. Teacher CPD is one of four programmes which are encompassed by the project (Tatweer, 2012). Alqahtani (2006) categorized teacher professional development to be one of the programmes that required the attention of educational leaders in order to assist efforts to improve education in Saudi Arabia.

3.2.3 Approaches to CPD Programmes

Two approaches to CPD programmes have been described in the literature: a mandatory (sanctions-based) approach and an optional (benefits-based) approach (Madden and Mitchell, 1993). The mandatory approach obliges members of a profession to undertake standard CPD activities which are deemed essential for their professional practice, with the threat that they will be somehow penalized or even lose their license to work. As an effective CPD programme is tailor-made to the teachers' individual needs and concerns, it is hard to see how a mandatory CPD programme can appropriately respect this aim. The other kind of CPD programme is therefore optional, which allows professionals to engage in activities they think are appropriate for their development needs. To encourage teachers to participate in professional development incentives, such as salary increases or credits for promotion may be offered (Desurmont et al., 2008). These two different approaches to CPD programmes have led to a debate as to which approach is more effective in achieving the set goals of CPD programmes (Collinson and Ono, 2001; Madden and Mitchell, 1993). Quantitative data on teachers' professional development is scarce both at national and international levels according to a report by the European Commission (European Commission, 2010). The report also states that although professional development is considered a duty for teachers in many European countries, participation in it is, in reality, optional. Some countries have set a minimum number of hours for teachers' participation in professional development (Australia, France, the Netherlands, Scotland, Sweden and some states of the United States, ranging from 15 to 104 hours a year. Other countries like England, Wales and Northern Ireland, Japan, and Korea have mandatory induction programmes for new teachers as a requirement for full certification (Desurmont et al., 2008).

The CPD programmes may be based on a training plan which is established to meet the educational priorities of central authorities, in terms of teacher competences and skills. Training plans may also be developed at school or local level as part of school development plans (Desurmont et al., 2008). For instance, in the USA, CPD programme is driven from the top and aimed at system-wide change, while in the UK CPD programme is usually initiated within schools, and aimed at more gradual change (Bennett et al., 2010).

3.2.4 Characteristics of Effective CPD Programmes for Teachers

There are certain features and characteristics, which are essential in the success of CPD programmes. Identifying such characteristics is of great significance to the creation of a framework that can be used to guide the design of effective development programmes, such as the CPD programme used in this study. There have been a number of attempts to define these fundamental characteristics, which will be briefly discussed below.

In the first of these attempts, Guskey (1994) produced a list of four characteristics to mark effective CPD programmes: a focus on the process of learning and the learners themselves, a focus on change for both the individual and the organization, minor changes which are nevertheless underpinned by a vision of the bigger picture, and procedurally embedded and ongoing professional development. It can be clearly seen that these characteristics focus on the importance of planning and implementation within clear goals, which should be based on learners' needs. Most training programmes are accompanied by assessment procedures for any improvement, taking place at the end of the programme (Guskey, 1994; Guskey, 2000).

However, Guskey (1994) argues that more effective training should include a follow-up observation, as final assessments can be limiting. Other characteristics, which have also been identified by the Training and Development Agency (TDA) to impact CPD, include the identification of the anticipated outcome, consideration of the participant's prior knowledge, provision of relevant CPD activities, modelling of effective teaching practices as well as impact evaluation (Training and Development Agency for Schools, 2007).

Furthermore, seven elements of a successful CPD programme were reported by Day (1999) from a study of UK INSET by Steadman et al. (1995). These were, inspiration (sharing visions), exposition (new content and ideas), discussion (and other activities to advance conceptual understanding), opportunities for cross-reference of standards (judging one's own position in relation to others), training in new skills, opportunities to experiment and coaching (from advisory teachers and/or colleagues).

Kelchtermans (2004) suggests that effective CPD depends greatly on the interaction between teachers and trainers. He pointed out that it was worth placing more emphasis

on the ‘reflective, thoughtful decisions and actions of professional development providers as they are doing their job’ (p. 232).

Loucks-Horsley et al. (1996) instead define seven principles of effective professional development, which could be applied to the science classroom. These principles, proposed by the National Institute of Science Education (NISE), are based around what were found to be the shared characteristics of effective training of science and mathematics classrooms, based on the experiences of teachers from both fields. These seven principles are as follows:

1. Effective CPD programmes have “clear, well-defined image of effective classroom learning and teaching”;(p. 3)
2. They give teachers the opportunity to increase their knowledge, improve their skills and expand their approach to teaching, to generate better learning for their students;
3. The instructional methods that they use for adults mirror those which will be used with their students;
4. They either construct or reinforce a community of learning for science and mathematics teachers;
5. They prepare and assist teachers who are inclined to work in positions of leadership;
6. They offer the teachers connections to other sections of the system;
7. They provide teachers with continuous assessment.

Of course, context is important and any realistic measures for effectiveness cannot be set without consideration to the context in which CPD programmes are undertaken (Loucks-Horsley et al., 1996). This means that the principles cannot be the only guide in creating a CPD programme.

Furthermore, Loucks-Horsley et al. (1998) argue that lengthy training sessions are expected to produce a chance for thorough discussion with regards to textbook contents as well as student understanding and misunderstanding of various scientific notions and teaching strategies –see also (Joyce and Showers, 2002; Kudenko et al., 2011). In other words, they believe that when CPD programmes are prolonged, they provide teachers with an opportunity to examine new strategies inside classrooms as well as to receive feedback on their performance. On the contrary, Abrahams et al. (2014) have found out

that some short-term and low-cost CPD programmes, such as the ones delivered in the context of Getting Practical Project, can be effective in terms of altering real teaching practice.

Furthermore, as Saylor and Kehrhahn (2003) suggested, an essential characteristic of a successful CPD programme is that they should be devised in such a way that motivates teachers to do their job well, as well as providing them with regular instruction over an extended period. It has also been argued that a CPD programme is especially effective when the programme is tailor-made and structured to meet the needs of the individuals as well as the development and needs of the organisation for reform (Garet et al., 2001). Loughran and Ingvarson (1993) point out that CPD programme providers should be able to recognise what science teachers need to know and be able to do. This requires a thorough analysis of the needs and requirements of the individuals undertaking the programme which can also be done through evaluation and assessment of the practise, after a CPD programme has taken place.

Some argue that teachers construct their own professional knowledge, meaning that their views in designing CPD programmes and activities should be taken into account (Armour and Yelling, 2004). Therefore, teachers' existing knowledge, beliefs and attitudes must also be considered if reform efforts are to succeed (Van Driel et al., 1998). CPD programmes must bridge the gap between theory and practice and, therefore, designers of CPD programmes need to work closely with teachers to address the needs of teachers and students (Klingner, 2004).

Similarly, within the Saudi context, Qablan et al. (2015) argue that giving science teachers the chance to design their own application of CPD programme is likely to provide them with considerable support and improve their pedagogical practice in the classroom. By doing so, teachers of each school can not only participate in the input during the implementation of CPD programme, but equally important, share their ideas in the programme concerning the individual needs in their teaching practice. Qablan et al. (2015) have also maintained that for the Saudi CPD programmes to succeed, providers may take into account making their programs as coherent as possible. This is due, according to Qablan et al. (2015), to the fact that several Saudi science teachers have reported a sort of lack of harmony between the various CPD programs that are

introduced to them. Such a lack of harmony disconnects teachers from what they have learnt and their classroom practice.

The ultimate aim of CPD programmes is to bring change into professional practice to improve students' learning and achievement, including attitudes and behaviour (Guskey, 1994; Klingner, 2004). Guskey (1994) suggests that care should be taken during implementation so that any new practice is introduced gradually to avoid mistakes and mitigate teachers' reluctance to change. Also, CPD programmes should be amenable to regular evaluation and intervention for improvement. Such interventions could be achieved by using a cyclic model for designing the CPD programmes (Lamberg, 2007). Standards for success should be clearly stated and any data for evaluation must be rigorously collected and analysed to see whether the goals and objectives of the CPD programme have been met (Guskey, 1994).

Garet et al. (2001) studied CPD programmes for a sample of science and mathematics teachers and came to the conclusion that an effective CPD programme is characterized by: (i) focus on content knowledge; (ii) opportunities for active and collaborative learning; and (iii) consistency with other learning activities. Their findings are commensurate with the findings of Berry and Loughran (2010) that emphasised the importance of Pedagogical Content Knowledge (PCK) for the effective professional development of science teachers. These conclusions are consistent with the ideas of Van Driel (2010) and Van Driel and Berry (2012) who argue that effective CPD programmes should provide opportunities for teachers to experiment with new teaching approaches and to reflect on their experiences, both individually and collaboratively.

Primary science teachers are expected to teach across all science subjects in addition to their specialised subjects. Effective CPD programmes should therefore take this into consideration and develop teachers' subject knowledge to the required level (Smithers and Robinson, 2008).

To demonstrate the awareness and necessity for effective professional development, the National Science Teachers Association (NSTA) in the USA has identified a consistent need for teachers (particularly standard six science teachers) to develop their knowledge and understanding of the ever evolving knowledge base of both the content and science pedagogy' (NSTA, 2012). It is inferred that with teacher empowerment, providers' views about CPD programmes would be challenged, leading to a

collaboration with teachers and partners to create and lead the path in individual professional development as opposed to them being a passive trainee who only digests what is being offered.

Alongside supporting teachers in areas of weakness, an effective CPD programme will help in developing their investigative skills and management of practical work, as many science teachers find that these areas are challenging (Abrahams and Millar, 2008).

In addition to the above characteristics, a successful CPD programme employs a range of learning activities as will be presented in the following section. These activities must be administratively facilitated by providing the required resources and removing any barriers, such as time and money, against their implementation.

3.2.5 CPD Programme Activities

Teachers are often expected to continue to develop and engage in activities to improve their knowledge and skills throughout their careers. CPD activities are effective if they are carried out through a personalized programme that addresses the development needs of each group of teachers (Institute for learning, 2011a). Activities could range from the formal to the informal, and be conducted individually or in groups. Another factor that may influence the activity is the nature of the system, which may be centralized or non-centralized (Stadler, 2010). In the non-centralized system, CPD activities are organized by the school to meet teachers' needs, however, countries like Saudi Arabia, who operate with a centralized educational system have their activities developed by the Ministry of Education and through specialized centres in each educational governorate.

The following is a list of some of the recommended CPD activities that teachers can engage in (Institute for Learning, 2011b).

1. Peer coaching and peer observations. This is a process whereby an expert in the field helps colleagues through a set of structured discussions and activities geared towards solving problems and improving performance, to improve their practical skills.
2. Subject learning including gaining further qualification. This is to keep up-to-date in their field of expertise and to improve knowledge on their subject, as well as to enhance their career prospects.
3. Work shadowing and mentoring new colleagues. This is where experienced members of staff assist other practitioners who need to acquire and improve their skills. An

individual with experience is appointed as a mentor to assist beginners or less experienced colleagues to adjust to the demands and complexities of their new job. This usually happens during the process of teaching in the classroom or during scheduled lesson-planning sessions.

4. Analyse student data and plan instruction to meet needs. This is where students' achievements are assessed and data is gathered in order to focus learning in a way that will help their academic improvement.
5. Team-teaching, self-assessment and reflection. This is where teachers' reflections about their own performances are shared and discussed for team and individual improvement.
6. Action research and sharing best practice. Similar to the previous point, it is a form of self-reflective analysis which is undertaken collectively by teachers in a social setting aimed at mutual improvement of their educational methods and increased understanding of the setting in which the practices are carried out.
7. Reading and reviewing books, websites or journal articles. This is a way in which teachers can increase their knowledge base and keep up-to-date with the latest research and theories.
8. Updating knowledge through subscribing to professional bodies, participating in conferences and workshops. This can help teachers to work on their self-confidence and improve their knowledge on certain topics related to their field, which entails a social element to encourage collective learning.
9. Networking with other subject specialists. This allows teachers of a diversity of subjects to discuss concepts, share skills, and problems that arise during professional development, which may then lead to better classroom practices.
10. Curriculum design, development and evaluation. This gives teachers an insight into the concerns of policy makers and includes them in the process of course design, allowing their experiences and expertise to be included in the process. .

Other activities that can also influence the efficiency of CPD delivery include: engaging in professional development meetings, attending internal and external courses and conducting action research and investigations (Training and Development Agency for Schools, 2007).

Teachers should be proactive in pursuing CPD activities with the purpose of making a difference in their practice and students' learning. Sound knowledge gained through CPD activities, coupled with a teacher's own inspirational implementation, may have a

powerful impact on teachers practice and students' learning and teachers should be able to collect evidence for such an impact (Bennett et al., 2010). Providers should be more explicit about the goals of their CPD programmes so that teachers can make the right choice according to their needs (Bennett et al., 2010).

3.2.6 CPD Programme Evaluation

Evaluation is the process of collecting and analysing data to determine the merits of any given programme (Guskey, 2002). Evaluation is therefore a means of ascertaining if the objectives of a programme have been met. Harris et al. (2006) recommend that evaluations of CPD programmes should serve both a formative and summative purpose. A formative evaluation is conducted at the start of a professional development programme and is concerned with modification and improvement of the programme (Harris et al., 2006). On the other hand, a summative evaluation is conducted at the end of the programme to determine its overall effectiveness (Harris et al., 2006). These two objectives can best be met by collecting data using a variety of approaches. For example, test scores could be used summatively while interviews and questionnaires can be utilized to guide formative evaluation (Scannell, 1996).

Impact evaluation of professional development provides an avenue to quantify the associated benefits of the professional development. As a complement, evaluation also aids the monitoring and evaluation of investments into and budget of the CPD programme. It is established that evaluation is a key component of professional development as it tends to improve teachers' knowledge and skills (Lowden, 2005).

Despite its significant importance, evaluation is rarely carried out in a systematic manner (Edmonds and Lee, 2002; Muijs and Lindsay, 2008) to determine the impact of a CPD programme on pedagogical practice, curriculum change, teacher-student relations and learning. As a result, CPD evaluations suffer from the following limitations, as described by Guskey (2000):

a) Most evaluations describe the activities performed, but do not measure their impact.

b) Evaluations usually focus on participants' satisfaction and neglect the more important parameters like improvement in knowledge or changes in practice.

c) Evaluations are usually performed at the end of a programme, while impact tends to takes time to show.

Edmonds and Lee (2002) found that, in England, most CPD programmes' evaluation took the form of a feedback form which are completed by teachers at the end of the programme by asking teachers questions regarding delivery, content and course objectives.

Moreover, most evaluations are discredited in terms of validity and reliability (Scott-Little et al., 2002) since the methods of collecting and analysing data are not rigorous enough. Bradley and Bradley (2011) argue that if evaluation is to give reliable and valid feedback, then the data should be analysed using more effective methods such as the Rasch methods. A major deficiency is that most current evaluations are not informed by a conceptual framework that guides the design and implementation of evaluation (Nicolaidou and Petridou, 2011). This is further supported by Scannell (1996), who argues that CPD programmes should be evaluated in a systematic and well-structured manner to find out if the objectives have been achieved.

In the Saudi context, as recommended by the GDTS, a proper evaluation and assessment should be carried out (General Directorate of Training and Scholarship, 2002). This may be in four forms, including: i) formative evaluation for diagnosing teacher needs, ii) construction evaluation which is applied in the development of objectives as well as the design of activities and modes of CPD programme delivery, iii) summative evaluation which is a post CPD programme evaluation to determine the continuity of a programme and, iv) follow up evaluation aimed at identifying the influence of programme on teachers' learning.

For a critical evaluation, the GDTS guideline suggests that CPD programmes should be evaluated from a combination of various aspects, such as content, activity, objective and ability to take into account teachers' need. In addition, the guidelines suggests a mode of evaluation during and after the programme to measure the impact on teachers, either via employing tests or observation performance. The use of questionnaires, interviews, tests and self-evaluations are also recommended by GDTS for the evaluation of CPD programmes, as they can assist in evaluating the trainees, trainers and CPD programmes in regard to their objectives, contents and activities.

3.2.6.1 CPD Programme Framework Evaluation

The above discussion highlights the importance of conducting CPD evaluation in a systematic manner and within a specified framework. In this context, Bredeson (2002) proposes that the design of any framework for CPD programme evaluation is guided by the following features:

> *Purpose:* The purpose of the evaluation should be clearly stated since each aspect of a CPD programme, including its design, delivery, context, content and outcomes, requires different types of data and methods.
>
> *Value:* This provides justification for carrying out the CPD programme evaluation.
>
> *Methods:* The methods for collecting, analysing and reporting professional development evaluation data will vary according to purpose and context.
>
> *Utility:* The ways in which evaluation data will be used to influence professional practice and policy decisions.

In a similar approach to Bredeson (2002), Coldwell and Simkins (2011) argue that in evaluating CPD programmes three key questions need to be answered: what should be the focus of evaluation?; how should these aspects be investigated?; and whose views should count in the evaluation?

A small number of conceptual frameworks have been developed for the evaluation of professional development. One of these frameworks is Stake's countenance model (Stake, 1967), which is based on using two countenances, description and judgment, to collect and analyse data through three phases:

1. Antecedents: the situation prior to and at the beginning of the CPD programme;
2. Transactions: what occurs during the programme;
3. Outcomes: the final product and impact of the programme.

From the analysis of the data, it can be discerned if the objectives of the CPD programme have been achieved or not. Any reasons for discrepancies can then be determined.

Kirkpatrick (1975) produced a framework for the evaluation of training programs in business and industry. This framework is composed of four sequential levels:

> *Reaction*: This level measures participants' perceptions to the development training.
>
> *Learning*: Which is assessing the amount of learning that has occurred due to a training programme.
>
> *Behaviour*: Which measures the extent to which participants have adopted the new ideas and practices learned in the training.
>
> *Results*: This evaluation measures the success of the development programme from the executives and managers' point of view.

Despite its popularity, Kirkpatrick's model has its limitations. It has been criticized by Bates (2004) for being incomplete and oversimplified and assumes causal linkages between levels of evaluation where there are none. However, this latter criticism seems to be unfounded because it is clear that a change in behaviour is evidence of learning and that a change in results is likely to be a result of a change in behaviour. It has also been suggested that the model also makes assumptions about the importance of the higher levels. Is, for example, the view of the manager or executive more important than how much the teachers have learned? The model has also received criticism for not giving consideration to organisational support and individuals' characteristics as influencing factors in effective evaluation (Bates, 2004). However, the model is still relevant to general educational settings, and has been adapted by Guskey (2000) for the purpose of evaluating teacher CPD programmes in schools.

3.2.6.2 Guskey's 5 Level CPD Programme Evaluation Framework

Guskey's model (Guskey, 2000) is comprehensive and consists of five hierarchical levels, which have been detailed below:

Level 1: Participants' reactions

The first level of evaluation addresses participants' reactions to the professional development experience. Information on participants' perceptions is typically collected

by questionnaires distributed at the end of an event. Three main types of questions can be answered using this approach: content questions (e.g. were the issues addressed relevant, was the material pitched at an appropriate level?), process questions (e.g. was the session leader well prepared, were the materials suitable?) and context questions (e.g. was the room the right size or temperature?). Information at this level is the most common, easiest to collect and can be useful in improving the design and delivery of effective professional development programmes. On the other hand, reliability of information by this method is questioned because participants' reactions may lack objectivity (Boverie et al., 1994).

Level 2: Participants' learning

This level measures participants' learning from the CPD programme. Various types of knowledge and skills can emanate from CPD programmes: cognitive, affective, attitudinal and practical skills (Knight, 2002). These variant types of acquired knowledge will require different methods of evaluation. Information for evaluation can be obtained from participants' presentations, reflections or portfolios.

Level 3: Organisational support and change.

This level evaluates the extent to which a CPD programme was endorsed and supported by an organisation. CPD programmes are unlikely to succeed in influencing change without organisational support (Knight, 2002; Muijs et al., 2004). Information about the organisational structure and conditions necessary for successful change therefore needs to be collected. However, this is rather difficult as it requires rigorous analysis of policies and records of the organisation in addition to conducting interviews and questionnaires (Guskey, 2002). Furthermore, a systematic study on the impact of CPD programmes by (Bennett et al., 2010), suggests that organisational change has no impact on participant's classroom practice. In addition, organisational support seems to be logically separate from the other four levels (Coldwell and Simkins, 2011). Of course this can affect the impact of CPD programmes on practice, but the extent to which it matters seems to depend on what the CPD programme is about and what its aims are.

Level 4: participants' use of new knowledge and skills.

This level evaluates whether participants are effectively applying the new knowledge and skills they have acquired in the programme. Evaluation of this level has to be

conducted after a reasonable length of time, allowing the participants to integrate the new knowledge and skills into their practice (Guskey, 2000). Information can be gathered by direct observations, questionnaires or interviews (Guskey, 2002). Despite the importance of this information, the follow-up required to collect the data is often not carried out satisfactorily.

Level 5: students' outcomes.

This level evaluates the impact of CPD programme on students' learning in terms of knowledge, skills and achievement. Correlation between the CPD programme and students' outcomes depends on the goals of the undertaken activity, as well as the effectiveness of CPD programme at the previous levels. It is unknown as to whether any definite link has yet been established between CPD programmes and improvement of student achievement (Wayne et al., 2008). Any other claim must largely be based on logical deduction rather than on research evidence (Guskey and Yoon, 2009) as students' learning is usually evaluated from exam results and records of achievement. It is also important to measure affective outcomes too, including the behaviour and attitudes towards the teachers' learning , as it is likely that if teachers do not notice a change in the results of the students then they will not be encouraged to continue their professional development (Guskey, 2002). Guskey (2002) suggests that when designing a CPD programme evaluation, one works backwards, starting with level 5, both in planning the CPD programme activity and in the evaluation. This practice emphasises the importance of student outcomes to the evaluation process. It also gives an indication that this model is cyclic rather than linear since each level influences the other. Further support to the cyclic nature of Guskey's model comes from the research by Rogers (2007) that indicates when teachers reflect on students' learning outcomes, they may adopt new ideas and strategies for improvement, leading to changes in the teachers' learning and attitudes. This learning process is ongoing and requires support to be sustained.

As Guskey's model is helpful in gauging the impact of CPD programmes at different levels and in various situations, Muijs and Lindsay (2008) adopted Guskey's model, but added a sixth level related to the cost-effectiveness of the CPD programme. It has been argued that costs analysis should be part of the planning process and, if the costs of a CPD programme outweigh the benefits, then the CPD programme should not be undertaken. However, for online CPD programmes the running cost is minimal which

means that there is no need to include this additional level. On the other hand, Nicolaidou and Petridou (2011) adapted Guskey's method for the evaluation of CPD programmes for leader and leadership development. They included Levels 1–4 and omitted Level 5. Level 1 (participants' reaction) was extended to include Stake's antecedent factors because of the influence of participants' expectations and level of motivation in determining the learning outcomes of the CPD programme. Level 5 was omitted mainly because students' learning outcomes were not part of the overall goals of the study, and was therefore unnecessary. Their method also applied rigorous techniques to analyse the evaluation data. They also stressed the importance of observing participants after the completion of the training to evaluate the extent of application of new knowledge. This follow up stage is often neglected because it takes time before any meaningful implementation of new knowledge can happen.

3.2.7 Methods of CPD Programme Delivery

CPD programmes can be delivered face-to-face (f2f), in an online environment (via the internet), or a combination of the two, termed "Hybrid" (Masters et al., 2010, p. 358). Each of these methods of CPD programme delivery has its advantages and disadvantages. The choice between these methods can sometimes be limited, simply by the circumstances within which it is being undertaken. However, the Hybrid approach is beyond the scope of this study; therefore emphasis is laid mainly on the f2f and the online approach of CPD programmes delivery.

The f2f method is the traditional way of delivering CPD programmes, in which the teacher and participants are in the same place and all learning aspects take place at the same time. The traditional f2f CPD programmes may be carried out in various forms, which include workshops, seminars, in service training, twilight or weekend study (Dalgarno and Colgan, 2007). This type of training course is usually provided over a short period, from a few hours to a few days (Cavalluzzo et al., 2005).

The use of the traditional f2f approach as a delivery method has associated advantages. Firstly it gives participants the opportunity to interact directly with each other and most importantly, the teacher. This avenue provides unquantifiable resources for participants as the presence of a teacher permits sharing of experiences and guidance on how to deal with challenging curriculums (Kubitskey et al., 2002). Participants in this CPD

approach can ask questions and get immediate responses and feedback from the teacher. Also, the teacher can see the participants and get indications from their behaviour if proper understanding has taken place.

Although the f2f approach for CPD delivery is more commonly embraced over its counterparts, its application may be limited depending on circumstances, therefore suggesting that the application for CPD programme delivery may not always be the perfect solution. For example, in service training may be held within the school premises in which the school authorities dedicate selected days in the academic calendar for these training sessions. This benefits the teachers as they can easily access the sessions, however, other training sessions, workshops or seminars may be scheduled in other locations away from the school. This may not be in line with the teachers' timetable, thus straining the school schedule as teachers have to be released from work and substitute teachers may be required during the teachers' absence or leading to a reschedule of the classes (Alhajeri, 2004).

Furthermore, a report published by the Web-based Education Commission (2000) suggests another key challenge which has been highlighted by teachers to be linked to the lack of *release time* i.e. the time outside the classroom to participate in these CPD programmes. Therefore it seems the most feasible way to integrate this trainings without interferences may be at weekends or as twilight packages (evening classes) (Abdal-Haqq, 1996). Although there may be a preference to weekends and twilight packages, it is worth mentioning that most providers of such training are traditionally, but not exclusively, colleges and universities. This means the teachers will be required to travel to the relevant college or university, which is often inconvenient (Forsyth, 2002).

Other obstacles of the traditional f2f approach is linked to the associated costs and disadvantages when teachers need to travel away from home to attend the CPD programmes, which may be in the form of time or finance (Broady-Ortmann, 2002; Piskurich, 2006). Some of the financial burdens that may be incurred include the costs of hiring a suitable venue for the programme and other concerns surround the possibility of having just a limited number of participants who can attend the programme, which undermines the benefits and cost-effectiveness of f2f delivery (Friedlander et al., 1997). Conclusively, the travel time and associated costs, coupled with the less flexible methods of training delivery, make traditional f2f CPD programmes limited in terms of reaching a wider audience within a flexible time frame and in a cost-effective way.

Having highlighted the pros and possible cons of the f2f approach, it is important to highlight the alternative to this approach as a result of the development of technology and the Internet. This relatively new approach termed *online* is, however, detailed below as a tool for CPD programme delivery.

3.3 Online Learning Approach

Unlike the traditional f2f CPD programmes, an alternative method also aimed at delivering CPD programme is online, or e-Learning as it is sometimes called, which is relatively new compared to the traditional f2f CPD programme (Lee et al., 2011). This method employs computer technologies to manage and enable learning via an electronic network. This delivery method of CPD programme is characterized by the separation of instructor and learners (Thorne and Payne, 2005). To develop an in-depth understanding of the online CPD approach, it is important to have background knowledge of how online learning has developed over the years.

3.3.1 Brief Account of Online and Distance Learning

The history of online learning spans across four generations (Moore and Kearsley, 2011). The first generation being between 1890s and 1950s where a hard copy of study materials was sent to students and all correspondence was received by mail. In this category, there was no immediate way for the instructor to communicate with students. Between the 1950s and 1960s, distant learning upgraded to a second generation where various technologies (television, video and radio) was put into place. This was seen as a *one way* communication system as students were not afforded the privilege of being able to ask questions of interest. The third generation, between 1970s and 1980s, saw the integration of satellite, telephones and cable digital networks to enhance learning over the second generation. According to Harasim (2000) this era pioneered online learning approaches, as it permitted the use of e-mails by academics, educators and scientific researchers for the exchange of academic information. The fourth generation is the current era (1990s to present) where more technology and a prosperous education system emerged. It has been reported that the most influential technology that emerged in this period and was used in the educational environment was the Internet (Alshehri, 2005; Bartley and Golek, 2004). In this Internet era, the majority of schools and

universities now use the Internet to provide online learning (Graham, 2004) as well as facilitate CPD programmes (Russell et al., 2009b).

3.3.2 Definition of Online and E-Learning

It is apparent from the literature review that there is an overlap between the various definitions and conceptualisations of 'online learning' and 'e-learning', however, the terms are not understood to be synonymous by researchers. Moore et al. (2011) indicates that some academics have nevertheless referred to both as having the same meaning. Because of this, there have been efforts made to determine conclusive definitions of e-learning and online learning respectively. The Department for Education suggests that e-learning is when "someone is learning in a way that uses information and communication technologies (ICTs)." (Department for Education, 2003, p. 4). Khan (2005, p. 3) defines e-learning as:

> An innovative approach for delivering a well-designed, learner-centred, interactive, and facilitated learning environment to anyone, anyplace, anytime by utilizing the attributes and resources of various digital technologies along with other forms of learning materials suited for open, flexible, and distributed learning environment.

Similarly others have defined e-learning as being an instruction which is either delivered on a computer by way of either a CD-ROM, the internet and/or an intranet (Clark and Mayer, 2011), or via electronic media, such as interactive television, virtual classrooms and video conferencing (Fresen and Boyd, 2005). Online learning has also been referred to as programmes which are delivered via the internet, without instructors and learners being connected at the same location (Richardson and Swan, 2003). Similarly, Carr- Chellman and Duchastel (2000) define online learning as including web-based learning instruction and delivery to achieve intended learning objectives. In contrast, however, 'distance learning' is also referred to as "an educational process in which someone removed in space and/or time from the learner conducts a significant proportion of the teaching" (Perraton, 1992, p. 7). Furthermore, Sinclair (2003) defines distance learning as being a method to deliver instruction by using e-learning, online learning and paper-based materials for both the learners and the instructors who are separated geographically. Therefore, distance learning includes the use of various educational media and can utilise both printed and online resources.

Therefore, there is indeed an overlap between the definitions of the terms e-learning and online learning, each of which carries different meanings for different people and, as

can be seen in the above discussion, there are similarities in the sense that they all include the use of technological means to assist the educational process; whether it be at a distance or face-to-face. Anderson (2005, p. 5) illustrates the connections between these learning methods, as shown in Figure1 below.

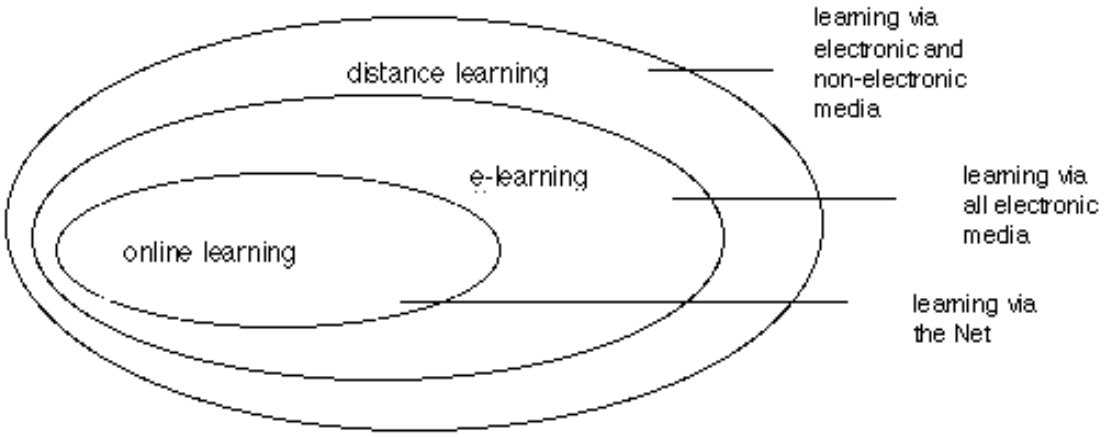


Figure 3.1: The relationship between online, e-learning and distance learning.

Based on the discussion so far, the following definition will be utilised for the purposes of this work, and in accordance with the International Association of K-12 Online Learning (iNACOL): online learning is an "education in which instruction and content are delivered primarily over the Internet" (iNACOL, 2011, p.7). This definition includes all types of formal education which can occur in a f2f environment by utilising technology (usually the internet) which facilitates students education whilst precluding the need for travelling to f2f centres (Henderson, 2003).

Online CPD programmes which facilitate an educational exchange between students and teachers who are unable to meet face to face, whatever the reason, can be described as a method which requires the use of the internet as a tool for delivering training, communication and collaborations (Rasmussen and Northrup, 2002).

Generally, there are two types of communication which can take place during online learning; Synchronous and Asynchronous. The following section will explore these two communication approaches in more detail in order to gain a deeper level of insight into them.

3.3.3 Synchronous and Asynchronous online communication approaches.

Synchronous and Asynchronous refers to communication approaches which take place between students and instructors. Synchronous specifically refers to a situation where both the students and the instructor are online at the same time (Inglis et al., 2002). Cole (2000) illustrates synchronous participation as being when "both or all participants are directly involved in the interaction simultaneously" (p. 59). Therefore, it is where learners and instructors can send and receive communications instantly, and take part in seminars which take place in chat rooms to discuss and share ideas (de Leng et al., 2009). Asynchronous, on the other hand, refers to a situation where instructors and their students do not need to be online simultaneously (Inglis et al., 2002). In this method of communication, all of the participants who are taking part can send and receive posts and comments, or in fact any information at a time that suits them.

Both the Synchronous and Asynchronous learning approaches have their own advantages and disadvantages. Synchronous allows and encourages more effective instant communication and follow-up for the learners in comparison to the asynchronous approach (Zhang and Nunamaker, 2003). In addition, it engages students in the process of learning and encourages them to become active members of the learning community (An and Frick, 2006). An additional advantage of utilising this type of online CPD programme to offer training to teachers is that makes asking and answering questions and receiving feedback easy.

The Asynchronous approach offers the benefit of flexibility because learners can take part in the learning process at anytime through the numerous tools which are available to them, such as via email, discussion boards and forums (Zhang and Nunamaker, 2003). Furthermore, in asynchronous interactions, the learners are at ease to engage in the classroom or online interactions and are much less likely to feel intimidated, because they can take part at a time which suits them and at the speed they feel comfortable with (Taylor, 2002). It has also been noted by a number of authors; Mann and Stewart (2000), Murray (2004) and Tates et al. (2009) that an asynchronous learning approach can remove much of the pressure associated with study, because the learner can engage in the materials at his/her own leisure and is not obligated by definite class times etc. This also allows for more time to reflect and engage in critical thinking and analysis because the learner has the liberty of taking more time to consider responses to questions and to absorb information as required. Unlike synchronous communication, learners have the

opportunity to take enough time to reflect on and comprehend new information and they can also edit and polish their contribution before posting them (Andrews and Haythornthwaite, 2007).

However, despite the benefits that these two approaches provide, there are certain limitations that both the Synchronous and Asynchronous platforms have been found to have. In the Synchronous method, if the discussion is interrupted by someone, for example, joining late - especially if the interruption is protracted - it can distract the other learners and make it difficult for them to remain engaged in the learning exchange (Rourke and Anderson, 2002). Moreover, expense can also be a major issue for providers, if the learners are paying for access time, as exceeding the time limit can be very costly (Taylor, 2002). Finally, differences in the time zone may be problematic, particularly if the course is provided for a global audience and instructors and learners are living in distant countries and, therefore, in different time zones, or are otherwise engaged in other commitments such as work or social obligations at those times (Taylor, 2002). Taylor (2002) pointed out that instructors and programme facilitators must take into account these time zone issues in preparing for lessons and their delivery when using the Synchronous approach to deliver course materials.

In the case of the Asynchronous method of teaching, the main limitation seems to be the delay in receiving responses to questions or issues raised by the participants (Andrews and Haythornthwaite, 2007; Cole, 2000; Hiltz et al., 2007). Indeed, it is a danger that questions could be met with a long delay before receiving their answer, and it is a possibility that it could be left unanswered altogether if there is no pressing urgency on the part of the person receiving the question to respond (Hiltz et al., 2007). This can be easily overcome by encouraging those involved to discuss, participate and engage with the questions and by setting deadlines for responses to be submitted (Zorfass et al., 1998). Similarly, the approach prohibits starting an immediate discussion which can be a useful part of the learning process because it allows the learners to explore ideas with each other and with the teacher.

Having discussed Synchronous and Asynchronous approaches, as well as their respective advantages and disadvantages, it is necessary to discuss the pros and cons of online CPD Programmes in order to better understand them and to add context to the overall discussion.

3.3.4 The Pros and Cons of Online CPD Programme

The integration of online CPD programmes provides a number of advantages over the use of the traditional f2f CPD programme. Some of these include its flexibility in relation to the time and location (Russell et al., 2009a). Learners can study in a time frame which suits them and can fit online study around their other commitments, such as family or work (Davis, 2007; Davis, 2009; Sun et al., 2008). This means that learning is accessible when and where it is needed as long as there is a computer and an access to the Internet (Chen et al., 2009).

The participants in online CPD programme also have the luxury of time, thereby enhancing the delivery of the courses as they have long-lasting access to the record of the text-based discussions and interactions from the online programme (Delfino and Persico, 2007). Thus, in-depth knowledge of content is favoured and critical thinking is promoted, which means deeper reflection in asynchronous communication (Delfino and Persico, 2007). Seok (2006) contends that online learning enables "self-directed learning, problem-solving skills, and higher thinking skills for the workforce at the sociocultural community level" (p. 49)

Goldman (2002) noted a number of advantages that online CPD programmes have, such as teachers having the ability to choose a number of aspects of their training, such as what they learn, when it will take place and where they would like to be trained. They can freely choose from a large range of activities the most suitable courses in regard to their schedule, skills and requirements. Of course, having access to the Internet is essential, however Smith et al. (2009) noted that one of the many advantages of using such training is that it gives the teacher the freedom to choose from a number of potential workshops and courses, rather than having to attend a CPD programme on a specific day and at a particular time.

In the Saudi context, according to a recent study by Qablan (2015), it was found that nearly 88% of teachers have improved through their participation in various CPD programmes particularly the more flexible online-based ones, such as teachers' website forums which offer them more freedom and time to share knowledge and teaching experiences than the traditional training programmes do. Such flexibility can also offer access to an unlimited number of participants without any social, cultural and religious

restrictions such as that of gender (Stewart, 2004), which is especially relevant to Saudi Arabia where male and female learners are usually segregated.

In addition to flexibility, online CPD programmes can provide teachers across schools and districts with a platform, which enables them to effectively communicate and interact with each other. This would allow participants to benefit from networking that would not have occurred otherwise. It is also essential to remember that this platform provides an avenue for widening participants' perspectives (Russell et al., 2009a).

Furthermore, utilizing online methods to deliver CPD programmes enables teachers who live away from urbanized centres to benefit from good quality training, which was previously only available to teachers who live in urban settings (Zabala and Collins, 2003). A result of that, interested parties may find online CPD programmes to be the best ways to increase the number of teachers working in rural areas, especially in developing countries such as Saudi Arabia.

Further advantages of online CPD programmes relate to its cost effectiveness; much less time and money is spent on participants' travelling for instance (Chen et al., 2009). Participants are also more likely to expect to pay lower fees for attending an online CPD programme than in traditional f2f CPD programmes (Kimbrough Kidwell et al., 2004). However, the initial costs of developing and delivering materials online are relatively high (Clarke, 2002), but this is not expected to be a challenge as these costs are a one-off expense after which the unlimited benefits of the online CPD programmes are subsequently realised.

Another advantage of online CPD programmes is that an online format can provide a more learner-centred environment where appropriate activities for professional development can be created (Huang, 2002; Piskurich, 2006). This allows participants to create learning communities for the exchange of knowledge and good practice, such as online forums and discussions (Stewart, 2004). These communities could help the training programmes to develop naturally, and due to their online format remain available for the next generation of teachers as well as the developers of the course.

There is evidence that online discussion approach can improve the quality of group discussions as their nature promotes reflection on the part of the learners (Casey and Vogt, 1994; Spitzer and Wedding, 1995). As the pace of the conversation is set by the

participants, they have as much time as they need to think about their contributions, as well as those of other members of the group (Lowry et al., 1994). They are therefore able to assess others' posts and plan responses to them (Ahern et al., 1992), whilst responsibility about what is written if ensured given that they are available to all members (Phillips and Santoro, 1989). Effective asynchronous online approach may be useful even when f2f discussion is possible.

Additionally, the educational nature of the discussion as well as certain interpersonal benefits of the chatroom, have been recognized. It is often easier to "speak up" in an online forum than in a classroom scenario, and shy people may feel at ease to participate in ways they might not otherwise feel able to (Lowry et al., 1994; Phillips and Santoro, 1989). A further advantage of online discussion is that the logistics are made easier by the technology itself. A record of any discussion is available and can be saved for future reference (Lowry et al., 1994), and copying and filing documents is easier for individuals to do (Phillips and Santoro, 1989).

A further advantage of online CPD programme, which is not offered by f2f CPD programme, is its suitability to people with physical disabilities or medical issues that might prevent them from attending traditional f2f CPD programmes. The ability to study from home, which is more likely to have suitable facilities and negate the need for travel, can open up the world of CPD programmes for those for whom the anxieties and practical difficulties associated with travel and inappropriate facilities prove too great an obstacle to overcome ordinarily.

However, online CPD programmes could suffer from several disadvantages. One of these is that learners must have access to a computer as well as a good enough connection to the Internet, which not all users can afford and sometimes, especially in developing countries, the infrastructure to fulfil this requirement does not exist. Learners must also be digitally literate and capable of using computer technologies and tools such as word processing, internet browsers and e-mail, in addition to managing and organizing files (Wojciechowski and Palmer, 2005). If it is required that teachers are trained prior to the delivery of online CPD programmes, considerations such as cost and time taken to implement schemes would need to be taken into account in this case.

It must also be emphasised that online learning requires a high level of motivation since it is essentially at the responsibility of the learner (Piskurich, 2006). This requires

learners to be capable of working on their own and managing time for their learning, as there will be no teacher present to encourage and motivate them. The feeling of isolation that some learners may experience because of a lack of interaction can also be detrimental to online learning (Brown and Green, 2003; Kimbrough Kidwell et al., 2004). Learners may also feel isolated and confused when faced with new training programmes thus making the process counter-productive. This may however be mitigated by providing an appropriate support network which encourages participants to subscribe to learning communities (Cavalluzzo et al., 2005; Schrum et al., 2005).

It is also possible that not all participants are suitable for online learning and therefore it is prudent that learners are diagnosed for suitability for online learning before they embark on an online programme (Yoder, 2002). This causes issues in terms of how learners could be assessed for their suitability, especially in a situation where an online programme is the only option.

However, there is unequivocal evidence on the increased use of online as an alternative platform for delivering CPD programmes (Donnelly and O'Rourke, 2007; Glogowska et al., 2011; Wilson and Stacey, 2004) as a result of its advantages over f2f training courses, the evidence on its impact on teachers and student learning and practice is far less conclusive. The subsequent sections will review literature of comparative studies, firstly carried out using a generic comparison between online and f2f approaches for teaching and learning (section 3.3.5), as well as the comparison between the online and f2f in terms of CPD programme delivery, with reference to the Guskey levels within the scope of this study (section 3.3.6).

3.3.5 Online Compared to Traditional f2f Delivery

The arguments on the impact of the online over the f2f can largely be divided into two categories (Driscoll et al., 2012). This begins with some empirical studies (Al- Qahtani and Higgins, 2013; Driscoll et al., 2012; Junaidu and AlGhamdi, 2004; Russell, 1999; Sitzmann et al., 2006; Tucker, 2001; York, 2008) who argue that the online learning approach can be as effective or better than the f2f in providing a learning experience, while others studies (Al-Jarf, 2002; Albalawi, 2015; Logan et al., 2002; Summers et al., 2005; Urtel, 2008; Wilson and Allen, 2011) argue otherwise; that the effectiveness of

the online classrooms over the traditional f2f classrooms are yet to be proven and that there is substantial basis for doubt.

One of the pioneer studies suggesting no significant difference in the two approaches was carried out by Russell (1999) from which *The No Significant Difference Phenomenon* was developed. From the study in which an extensive comparison was made between distance education classes and f2f classes, Russell (1999) argued that teaching could be effectively delivered in any classroom setting as long as both the students and the teachers are invested in the learning process. He further argued that the amount of learning that may be acquired in a course was more dependent on the pedagogical practices employed and not on the instrumental or technology engaged in. Although Russell's study has been identified as one of the most important pieces of supporting literature for online education, it has faced criticism and scrutiny in some of the literature for a number of reasons. For example, Bennett and Green (2001) identified that distance education led to instructors adopting a curriculum to suit technology rather than otherwise. This means that the approach might be limited as most times the technology is packaged to serve a purpose at the expense of the curriculum and/or instructional pedagogy.

Phipps and Merisotis (1999) also oppose *The No Significant Difference Phenomenon* in a critical and extensive review, a number of errors were identified which were overall classified into two: 1) lack of control for extraneous variables and 2) lack of reliable or valid instruments aimed at measuring students' outcome. It was further argued that other factors such as learning tasks, learner characteristics, student motivation and the instructor play a more significant role than technology for delivering learning.

Despite a number of criticisms on the studies of Russell on the efficacy of online over f2f in delivery of learning, more supportive studies have subsequently been carried out to strengthen the thesis. Johnson et al. (2000) carried out a study where learning outcomes and student satisfaction were used as criteria for evaluating efficacy between an online human development graduate course and in a traditional f2f course. From the study, no significant difference was observed when the learning outcome was evaluated. However, in terms of students' satisfaction, f2f learning proved more effective as the students demonstrated more positive perceptions about their instructor and course quality.

In an attempt to determine the efficiency of the online approach over the f2f education, Tucker (2001) examined students who were enrolled in a business communication class over a range of criteria including pre-test and post-test scores, homework grades, research paper grades, final exam scores, final course grades, learning styles and ages of distance education students. In this study, the instructor and the course requirements for both delivery approaches was the same to ensure consistency between the two formats. With regards to pre-test scores, homework grades, research paper grades and final course grades, the study proved no significant difference in the approach of delivery however, with regards to age, post-test and final exam scores, a considerable amount of difference was reported as these three categories favoured the delivery via the online approach. The findings of the study is in alignment with the general body of knowledge which suggests that online/distant education can be as effective as the traditional face to face education system. It is essential to mention that the study claims not to be conclusive and has identified other variables, which may have influenced the results some of centred on the students' preferred learning styles.

In a comparative study, Neuhauser (2002) assessed two parts of a course. The first was delivered online and asynchronously whilst the other was delivered face-to-face. He did this by observing gender, age, learning preferences and styles, media familiarity, effectiveness of tasks, course effectiveness, test grades and final grades. Both parts were taught by the same instructor and used the same materials. There were no significant differences in test scores, assignments, participation grades and final grades, but the online group's averages were slightly higher. 96% percent of the online students found the course to be as effective or more effective in terms of their learning than the face-to-face course. There was no significant difference between learning preferences, styles and grades in either group. The study clearly demonstrated that it is possible for equivalent learning activities to be effective in both online and face-to-face settings.

Al-Jarf (2002) carried out a study on two groups of freshman students enrolled in their first ESL writing course. This was with the aim of comparing the effectiveness of the online approach to the f2f approach. The study began with a pre-test where the writing abilities of both groups were initially evaluated, after which both groups were taken through the same material, assignments and assessments. After delivery of the programme, a post-test was carried out to compare writing abilities. Findings from the study showed the online group was more proficient as they made fewer errors and could

communicate more easily and fluently than the f2f group. It is thought that this is result is because of the luxury of time and the availability of web-based instruction which favours the online approach over the f2f.

Schoech and Helton (2002) conducted a study to compare the impact of a Master's course taught using Internet Chat-rooms text with a traditional f2f classroom based instruction on students learning and satisfaction. Both courses were taught by the same instructor and using the same syllabus. The study showed that students have gained more benefit from the Internet Chat-rooms than the traditional classrooms, though there were some concerns with technical issues.

Frey et al. (2003) conducted an evaluation of his students' perceptions regarding online courses by using questionnaires and a value rating checklist. The study found that learning style made no obvious difference in their perceptions. However, the students preferred online courses as they enjoyed access to their emails, marks, lecture notes as well as assignment guidelines and feedbacks. Interestingly, the elements which students reported as being the most useful were not always utilized the most widely by the faculty who were the subject of the study.

At King Fahd University of Petroleum (KFUP), Junaidu and AlGhamdi (2004) compared participant's learning using the online and the f2f teaching approach. Study was carried out on full-time undergraduate students of Computer Science and Computer Engineering BS programs from which the final exam grades obtained over five semester were analysed. From the study, it appears that the online approach proved more effective, thus agreeing with the first part of the argument, which states that the online learning approach can be as effective or better than the f2f in providing learning experience.

In another comparative study, York (2008) investigated the educational outcomes of students participating in a social work administration course. The instruction was received either with a f2f format or via online means and the criteria for evaluation were based on knowledge gained, course content and students satisfaction. The study indicated no difference between the approaches used for delivery when evaluated against the criteria. This therefore adds more data to support the existing school of thought that the online instruction achieves similar outcomes with the traditional f2f approach.

Irrespective of the level of study, the results of a number of studies have suggested that online courses work as well as the f2f courses. A study carried out by Kirtman (2009) on students enrolled for a Master degree programme to evaluate learning outcomes also proved that irrespective of the means of delivery (online and f2f) for the three courses delivered, learning outcomes were parallel.

Paechter and Maier (2010) investigated which learning course students experience as being favorable for learning; e-learning or face-to-face. They also assessed when students have a preference for either the online or face-to-face learning components. They investigated these questions by means of a research study using a sample of 2,196 students from 29 universities in Austria. The students were given questionnaires on their experiences of attending an e-learning course, how they perceived their achievements, and their preferences for the online or face-to-face components. The study found that students valued online learning for its ability to provide a coherent course structure, for assisting self-regulated learning and for disseminating information about the course and the topic of study. Face-to-face learning was preferred for communicating elements that necessitate that a shared understanding be derived or when personal relationships must be established. The study highlighted that when conceptual knowledge about the subject or skills regarding the application of a learner's knowledge must be acquired, students have a clear preference for face-to-face learning. Conversely, when self-regulated learning skills are needed, students preferred online learning.

Driscoll et al. (2012) carried out a quasi-experimental study to investigate student satisfaction and performance across online and f2f classroom settings. The evaluation study was carried out on 368 students who were enrolled in three online and three f2f sections of an introductory level sociology course. For the study, the instructor, course material and assessment for both delivery approaches was the same to ensure consistency between the formats. The findings from this study suggests that a significant difference may be obtained for online delivery in terms of students' performance. With regard to students' satisfaction, no significant difference was observed between the two settings. It may be inferred that with the integration of pedagogically sound practices into online courses, delivery may provide effectiveness which is equally as high as that obtained from a traditional f2f environment.

In Saudi Arabia, Al- Qahtani and Higgins (2013) carried out a study aimed at comparing students' learning under the three modes of teaching courses (e learning, blended learning and f2f learning) for the delivery of Islamic Culture course. For the study, two experimental groups and a control group totalling 50 students were randomly selected from at Umm Al-Qura University. Although the results of the study mostly favour the use of the blended approach, the study highlighted no significant difference between the online and the f2f approach, thus adding more strength to the existing school of thought.

A more recent study with a similar aim as the above was also carried out on second year English class of an intermediate female school in Tabuk city in Saudi Arabia (Albalawi, 2015). The study was carried out on 148 students on which a similar sampling approach was employed (two experimental and one control group) and the key evaluation criterion was student's academic achievement. Both groups in the study were tested prior to the experiment. The control group benefited from the traditional f2f approach while the experimental groups were taught using the blended and the online approach. While the obtained results from the study are in agreement with other studies in regards to *The No Significant Difference Phenomenon* claims between the online and the f2f approach, it however contradicts the findings from the study of Al- Qahtani and Higgins (2013) who identified the blended approach as a more significantly effective approach to the online and the f2f only approaches. This discord between the two studies may be attributed to the sample size which varies for both studies. Also, the subject and context may also have influenced the outcome of the study.

In contrast to the above studies which highlight the efficacy of the online approach over the traditional f2f, a second category of arguments exists. This category demonstrates numerous doubts and questions as to the efficacy of the online environment as an instructional medium over the traditional f2f approach, therefore suggesting that the f2f approaches may be a more effective means.

Harrington (1999) compared the grades of students who were taught in traditional classroom-based statistics courses with those who were taught using only software-based content. He found that students on the traditional course, whatever their undergraduate grade point average (CPA), as well as the students on the electronic course who had high CPAs earned higher grades, whereas, students using software-based content with low CPAs earned lower grades. This indicates that statistics can be

effectively taught using electronic methods if additional assistance is provided; otherwise a traditional course would be more likely to provide higher levels of achievement.

Summers et al. (2005) carried out a study which required evaluating classroom learning for an undergraduate statistics course using the two approaches (online and f2f). Outcomes were measured in terms of students' final grades and satisfaction with the course. With the integration of essential statistical analysis, including t-tests, obtained a result which demonstrated no significant difference in regards to final grades. However, when students' satisfaction was evaluated, students enrolled on the online study showed less satisfaction compared to the traditional f2f group which contradicts the notion that online could be as effective as the f2f group.

In agreement with the above study, the study of Wilson and Allen (2011) supports the notion that the f2f approach is a better approach compared to the online approach. In the study that was carried out on participants at one of the Historically Black Colleges and Universities (HBCUs), participants in the online study demonstrated a high withdrawal and failure rate, as well as difficulties in meeting the assigned deadlines. This poor performance of the online approach compared to the f2f approach suggests a better performance of the f2f approach.

Overall, from the literature discussed above, it can be seen that most studies tend to favour the online approach over the traditional f2f approach. Nevertheless, it may be inferred that the impact of the online and f2f is still under question and needs to be investigated, as these reasons are not enough to reach a conclusion as to which of the approaches yields the best results. It may be that the approach and context in which these delivery methods are used affects their impact.

In addition, the above review gives an insight to the overall benefits of the individual delivery method with the overall intention of identifying their strengths and flaws to gain insight into the wider use of the approach prior to streamlining them for delivery of CPD programmes, which is reviewed in the next section.

3.3.6 Impact of Online CPD Programmes Compared to f2f CPD Programmes

Similar to the previous section which looked at the impact of online delivery methods for imparting education in comparison to traditional f2f methods which take place in a classroom setting, the following section will look specifically at the impact of delivery of CPD programme. To date, a number of comparative studies (Fishman et al., 2013; Ginsburg et al., 2004; Hawkes and Romiszowski, 2001; Russell et al., 2009a; Ryan et al., 2007) have evaluated the impact and efficacy of online CPD programmes when compared with f2f CPD programmes, and from these studies there seems to be a claim that no significant difference may be achieved between the two methods for delivering CPD programmes.

One of the earliest works of this kind includes a study by Hawkes and Romiszowski (2001) who investigated an online programme aimed at enhancing participating teachers' capacity for developing problem-based learning curriculum. From the study, with regard to communication, online proved to be more effective with respect to reflective dialoguing whilst the f2f had the edge as a result of its more interactive dialog. Findings from this study align with a study of Harlen and Doubler (2004) who also identified the potential impacts of online CPD courses for building science understanding skills and inquiry.

Peterson and Bond (2004) compared teachers' pre-service learning of instructional planning in two pairs of asynchronous f2f and online courses which were in line with national teacher preparation standards. It was supported using interviews, which were conducted on a purposive sample; both groups significantly improved in their ability to plan technology-supported, problem-based learning as well as in their willingness to implement cutting edge educational methods. No significant differences between groups were detected in the post assessment results. F2f environments were shown to be more advantageous for learning instructional planning and for developing interpersonal skills for teaching in the data analysis, as well as for lower performing students, a facet which should be explored in future research.

Ginsburg et al. (2004) reviewed more than 40 well known online CPD sites for teachers of mathematics, looking for evidence of impact on teachers' practices and improvements in student outcomes following participation in an CPD programme. Their

findings reveal that, although the online sites focused on the potential advantages of online CPD programmes, there was no independent evidence to indicate that online CPD programmes are more effective than f2f CPD programmes was provided. McGraw et al. (2007) compared and examined the effectiveness of online and f2f discussion for pre-service and in-service mathematics teachers as a tool for professional development. In many ways, online interaction facilitates critical discussions and the sharing of best practice in mathematics teaching and learning. The study discussion was keenly focused on issues associated with the classroom implementation of tasks and characteristics, and the appropriateness of tasks for engaging students in thinking about mathematical concepts and processes.

Another continuing medical education comparative study by Ryan et al. (2007), reveals that online CPD programmes are equally as effective as f2f CPD programmes in preparing participants for their role as clinicians in pharmacotherapies and equipping them with requisite knowledge, skills and development of professional attitudes. Adada and Styron Jr (2008) carried out a study to investigate teachers' attitude towards the traditional f2f and the online approach for CPD delivery. From the study, it was inferred that despite the support teachers benefited from when using the traditional f2f approach, more technology was integrated into their instructions following the attendance of online professional training. Provided data from the study also demonstrates teachers' preference of the online method as a result of the interactivity and the convenience of the online approach.

A recent study by Russell et al. (2009a) aimed at comparing possible approaches used for effective delivery of CPD programmes on mathematics teachers' pedagogical beliefs, practices and understanding was carried out. The results obtained from the eight-week study, which required an equal amount of participants in both categories as well as the use of the same instructors, reading material and instructional activities, indicate that both the online and the f2f CPD programme approaches demonstrated a significant impact on teachers' mathematical understanding and pedagogical beliefs, as well as instructional practices. In addition, teachers who engaged in the online course demonstrated more satisfaction as they demonstrated their willingness to engage in more online courses in the near future, unlike the responses obtained from the teachers who participated in the f2f CPD programme.

Similarly, Thomas (2009) carried out a study on the perceptions of instructors and participants of online and f2f CPD programmes in regard to bringing change in knowledge, skills and professional practice, which shows positive responses by both groups. However, instructors and online participants with more years of teaching experience were found to have a more positive perception of the effectiveness of online CPD programme.

In agreement with the aforementioned studies, a randomized controlled trial aimed at examining teachers knowledge and satisfaction pertaining to the use of either a virtual or f2f workshop was carried out by Fisher et al. (2010). Following the results from the workshop, both groups demonstrated positive and substantial growth in knowledge signifying no difference between the approaches of delivery. With regards to satisfaction and impact on student learning, both groups also demonstrated similarities.

Also, Masters et al. (2010) conducted a study to assess how an online 7-week CPD programme impacted on the knowledge and instructional practices of fourth-grade English language arts (ELA) teachers. A control group who received no CPD were not prohibited from pursuing normal learning activities. The effects on their knowledge were determined using both pre- and post-tests, along with self-report of practice. Significant and positive effects were revealed of the online CPD programme in knowledge growth and practice from the pre-tests to post-tests, compared to the control group.

One of the most recent comparative studies carried out by Fishman et al. (2013) in the United States employed random selection of the sample to explore the differences in teachers' knowledge, beliefs, classroom practice and student learning in regard to CPD programmes. Overall findings from the study indicate no substantial difference between both approaches as they both exhibited substantial gains on the explored outcomes.

Having examined the literature to date, there is no comparative study to the researcher's knowledge that has compared the effectiveness or differences between the online and f2f delivery of CPD programmes within the Saudi context. Nevertheless, a few surveys have investigated the possible use of the online approach for CPD delivery in Saudi Arabia.

The first of these include the study by Al-Jarf (2006) who surveyed a dedicated online discussion forum for teachers in the Ministry of Education in Saudi Arabia. This was

with the aim of analysing the number of participants, discussion threads, trending topics, responses and their effect on teacher's attitudes. The survey demonstrated that it helped teachers exchange knowledge, information and experiences. However, the effect of participation and the application of strategies posted was inconclusive, as this would have required a pre and post measurement exercise to evaluate this.

Albahiri (2010) also carried out a study to investigate the willingness of Islamic education teachers in Saudi Arabia to use the Internet for the delivery of CPD programmes. In this study, aptitude, attitudes and barriers were of upmost importance. Findings from the study suggested that although all the teachers demonstrated a beginner competency level in using computer and the Internet for the CPD programmes, the male teachers had statistically significant higher results than the female teachers. Nevertheless, although both sexes of teachers demonstrated more positive attitudes, the female teachers seem to be more positive than the male. The survey further revealed possible barriers from the participants' view relating to the lack of reliable internet, incentives, technical support, teachers' English language proficiency and lack of willing to engage in the online CPD trainings.

From the above review, it may be inferred that despite the numerous benefits of online CPD programmes, as well as its advantages over the traditional f2f CPD programme, the effectiveness of this approach over and above f2f CPD programmes are still being debated by educational leaders. It is envisaged that to get a clear picture, more comparative studies between the two modes of CPD delivery need to be carried out. Furthermore, in the Saudi Arabian context, no comparative study has been carried out which evaluate the impact on science teachers of online CPD programmes in comparison to f2f CPD programmes, thus this present study is important because it aims to carry out a comparative study using Guskey's first four levels to compare the impact of the online CPD programme to a f2f CPD programme consisting of identical material. Four correlate research questions were generated:

RQ1: What are the perceptions of primary science teachers towards the f2f and online CPD programmes?

RQ2: To what extent do f2f and online CPD programmes impact on teachers' knowledge and skills regarding the 5Es instructional model?

RQ3: To what extent do f2f and online CPD programmes impact on the school and are organisational support structures improved by the programmes from the teachers' perspective?

RQ4: To what extent do f2f and online CPD programmes change science teachers' practice?

3.4 Summary of the Chapter

The chapter discussed the concept of continuing professional development with special focus on the professional development of science teachers. The rationale and characteristics of effective professional development were discussed in addition to the models and approaches of CPD evaluation. The main aim of any CPD programme should be to bring change into professional practice to improve students' learning and achievement as well attitudes and behaviour.

The discussion included comparisons between traditional f2f and online CPD programme delivery methods, exposing the advantages and disadvantages of each approach. It was indicated that online CPD programmes are making grounds at the expense of traditional f2f CPD programmes, mainly because they are more cost-effective, flexible and accessible. However, there is scarcity of systematic and structured research which evaluates the impact of CPD programmes, particularly online CPD programmes, and this was highlighted in the discussion.

In the next chapter, Chapter 4, the research methods and methodology used in this study will be presented.

Chapter 4. Research Methodology

4.1 Introduction

The main aim of this study is to undertake a *comparative evaluation study* of the impact of f2f and online CPD programmes on science teachers' pedagogical practice. This chapter explores the methodological issues surrounding the research. It explains the reasons for the research approach taken and the methods used for collecting and analysing the data. This introduction is followed by Section 4.2, which provides a comparative study, which explains the two groups of the study and gives an insight into the content and procedures of CPD programmes. These are delivered through two formats, which include the online and the f2f programmes. Whilst the content of both programmes are the same, more light is particularly shed on the procedures used to deliver the CPD programmes which are the subject of this study. The subsequent section (4.3) carefully maps out the evaluation framework used in this study by integrating Guskey (2000) for effective CPD programme evaluation, by critically analysing at five key levels: (1) Participants' reactions, (2) Participants' learning (3) Organisational support and change (4) Participants' use of new knowledge and skills, and (5) Students' learning outcomes. Research philosophy (section 4.4) gives an insight into the existing epistemologies, however it lays more emphasis on the pragmatic approach which is integrated into this study as a result of its liberality in choice from different concepts or a combination of concepts (mixed methods) to generate knowledge. Identifying the appropriate research design is of upmost importance to achieve a quality piece of research; therefore, section 4.5 gives detailed information about how the research design was developed. This includes the research procedure, which covers all aspects of the research, beginning with a pre-CPD programme observation conducted using Flanders' Interaction Analysis Category (FIAC) system (Flanders, 1966) to other aspects such as sample division, development of questionnaires, structuring of interviews and statistical/narrative analysis. Section 4.6 details the embedded data collection methods, including piloting the instruments. Bearing in mind all the possible challenges and errors associated with sample selection for a piece of research such as this, the approach, justification and description of the research sample population and the selection method of potential participants in the study is clearly highlighted in

section 4.7. To ensure quality and trustworthiness of the research a number of measures which were carried out are detailed in section 4.8. Ethical considerations are also incorporated in this study and are detailed in section 4.9, while the final section, 4.10, provides a summary of the chapter.

4.2 Comparative Study Approach

This study is a comparative *evaluation* aimed at examining the impact of the online CPD programme to the current Ministry of Education f2f CPD programme, which has been utilised in order to develop teachers' pedagogical practice in the light of the adoption of a new National Curriculum based on the use of the 5Es instructional model (Bybee et al., 2006). As such, this study contains two similar teacher groups that participated on the same CPD programmes, having exactly the same content, which was delivered through two formats; the f2f CPD programme and the online CPD programme, as detailed below.

4.2.1 F2F CPD Programme

The control group selected for the study attended the current Ministry of Education f2f CPD programme for science teachers. The course is specifically on teaching science with the content of the 5Es instructional model (Bybee et al., 2006) which is delivered by a Ministry of Education instructor in the same manner that it is currently delivered in Saudi Arabia. An educational trainer who possesses training experience in this field delivered the course that lasted for five hours, over four sessions as planned by the Ministry of Education. The training took place at the Al-Quwayiyah training centre and every topic was divided into a total of eight activities (Appendix 1 and Appendix 2).

In each session, the f2f CPD programme participants were divided into pairs or groups by the instructor and given activities to work and discuss with each other. At the end of the preliminary discussions, one speaker from the groups would then provide a summary of the collective answers to the questions discussed. After that, all the group answers were then discussed and compared with each other and a selected teacher summarised the discussion on the board. Ideal answers were then given to all the teachers at the end of each session.

4.2.2 Online CPD Programme

The experimental group was provided with an online CPD course, the content of which was designed by the researcher and then verified by Saudi Arabian Ministry of Education experts to ensure it was almost similar to the traditional f2f course. This section details the procedures taken to design the online CPD programme via the open source Learning Management System (LMS) as well as other measures taken to facilitate the effective operation and contribution of teachers.

4.2.2.1 Learning Management System, Moodle

The online CPD programme is designed and delivered by using the Modular Object-Oriented Dynamic Learning Environment (Moodle) (Appendix 3). Moodle is a free open source Learning Management System (LMS) developed by Martin Dougiamas (Antonenko et al., 2004) and used across North American and European Universities, and institutions such as The Open University in the United Kingdom (UK) and Mining Education Australia (Andrews and Daly, 2008; Jones and Conole, 2006). Moodle allows the user the liberty to edit the codes as deemed fit (Wheeler, 2005) and is integrated in this study, as it is easy to use and requires only basic ICT experience to deal with it. Furthermore, it provides flexibility in meeting the individual needs or the needs of the user community as well as universal accessibility, thus proving to contain numerous elements of constructivism, including social negotiation and knowledge building (Andrews and Daly, 2008). It also has many useful features that help the participants which are relevant to the research methods, such as providing facilities for a discussion group and opportunities for a survey (Dougiamas, 2004). In Saudi Arabia the Moodle platform is now being used by the Tatweer project (Tatweer, 2012) to deliver virtual classrooms, thus no additional expenses in terms of training costs need to be applied as part of the training delivery.

The Moodle platform is developed and uploaded on the internet after which the f2f course content material (5Es instructional model) was designed by the researcher and converted into an electronic format and sent to be checked/approved by three expert trainers from the Ministry of Education to verify that no misinterpretation of the contents exists (Appendix 4). This is then organised and uploaded into the Moodle platform. The webpage can be accessed at any time or place provided there is an Internet connection. (See the webpage link: http://cpd5es.org/moodle/.)

Subsequently, teachers selected for the online group were invited to participate in the online CPD programme, which lasted for about two weeks to allow for natural communication and discussion between teachers. The programme, which is designed in the light of the 5Es instructional model, is posted on the forum discussion on the programme's website where there was a daily asynchronous discussion (Appendix 5). This approach allowed the exchange of tasks, comments and information with each other at a convenient time and place and the participants and facilitators were not required to login simultaneously to take advantage of these benefits (An and Frick, 2006). Asynchronous discussion was used in this study as it is an emerging phenomenon and a popular online learning approach in Saudi Arabia (Al-Jarf, 2006). Also, asynchronous interaction between teachers provided 'a high level of satisfaction, particularly regarding flexibility of time and place for learning and the emphasis on interpersonal interaction' (Rovai, 2002, p.320). In addition, the time difference (time zone) between the study area (Saudi Arabia) and the researcher's current location (UK) also reinforced that asynchronous discussion was the appropriate approach.

After the activity was posted, the teachers were given two days to read, respond and discuss with each other. The nature of the activity was that every teacher had to reply to the question on the online forum discussion board and then an asynchronous discussion would commence between the teachers where they were given the opportunity to reflect on each other's replies. At the end of each discussion one of the group was appointed to provide a summary of the discussion. Then the theoretical material relating to this activity was uploaded on the website to be read and compared to the discussion that teachers provide. It must be noted here that the course facilitator did not interfere at all during the discussions and his role was limited to encouraging teachers to participate effectively and help them with any technical problems.

To facilitate the online programme, Salmon's five stage model was integrated to achieve online collaboration success (Salmon, 2004).

According to (Salmon, 2004), these five stages are: 1) Access and motivation, where learners need motivating to begin using and navigating the online system, and will likely require technical IT support, as well as a general overview of the system, instructions for how to log on, information about the tools they will likely use, and access to further assistance and support; 2) online socialisation, whereby learners recieve the chance to get to know one another, whilst becoming familiar with the

environment; 3) information exchange, whereby learners begin to engage with the content and share information with other learners; 4) knowledge construction, where active learning begins to occur because learners are, by now, familiar with course activities and where the teacher should assist this development and foster critical thinking; and 5) development, where the learner has become 'responsible' and has the ability to appraise the online process.

In light of the above, and to enhance communication between teachers, a WhatsApp Messenger group was created. This application is a cross-platform mobile messaging application, available through smartphones such as iPhone, BlackBerry and Android, and allows the free exchange of messages (Church and de Oliveira, 2013). The application offers users the flexibility to create a discussion group to exchange unlimited instant images, video, audio and text messages (Church and de Oliveira, 2013). The WhatsApp Messenger discussion group was used here to enhance socialisation between teachers and to solve any problems teachers may have, as they could send instant messages to the informal discussion group and any one in the group could respond. Also, it was used to update the teachers and encourage them to participate when an activity became available on the website. It should, however, be noted that although the Moodle platform has a similar chatting messenger, the WhatsApp was integrated for convenience as this was available on all teachers mobile phones unlike Moodle which is restricted to personal computers and laptops.

Through WhatsApp Messenger, teachers were provided with the necessary login information (username and password with a unique welcome page) and instructions on how to use the Moodle platform for necessary tasks such as attaching files, editing their personal profile and accessing numerous other features which allows for flexibility prior to the course.

4.3 Guskey's Evaluation Framework

Based on the literature review discussed in Chapter 3, and in-line with the aims of this study, Guskey's model of CPD evaluation was adopted. According to (Guskey, 2000), for an effective CPD programme evaluation to take place, measurable data should be collected and critically analysed at five key levels: (1) Participants' reactions, (2) Participants' learning (3) Organisational support and change (4) Participants' use of

new knowledge and skills, and (5) Students' learning outcomes. Guskey's evaluation framework is used here as it is considered to be helpful in evaluating the impact of teacher CPD programmes in schools at a number of different levels and situations (Davis et al., 2009; Kudenko et al., 2011; Muijs and Lindsay, 2008).

This evaluation study was conducted over all five levels. However, the emphasis is primarily on levels 1, 2 and 4 because the study focuses directly on the teachers (i.e. the participant). The study also chose to focus on those three levels as they were considered to be key indicators for the evaluation of teacher CPD programmes in Saudi Arabia (Tatweer, 2012).

With regards to level 3, evaluating organisational support and change is a more complicated and extensive approach than the proceeding levels, as this requires a range of activities before measurements can be made in a meaningful way because the process of gathering data may require analysing district or school records and examining the minutes from follow-up meetings. Other challenges of this level include the fact that any negative results obtained may not be attributed to poor training or inadequate learning, but as a result of the policies of the organisation which may challenge implementation efforts (Guskey, 2002). Nevertheless, this level was investigated through teachers' perspectives in order to give an indication of the nature of organisational support and change, thus three interview questions were given to the teachers.

In addition, Level 5 is not studied in detail as it is not possible to adequately measure the improvement, or otherwise, of students' learning and understanding within the relatively short time frame of the study. It is problematic to observe changes in the student outcome as a comprehensive analysis would require rigorous testing of the students and analysis of these results, and it is not expected that the results of the CPD programme would be immediately apparent in students' result. In addition Muijs and Lindsay (2008) argue that there are difficulties in identifying the students' improvement as a result of one specific CPD programme from other factors or programmes offered within the school.

Furthermore, in order to make a comparison between the two groups in this study, it is important to minimise the differences in the characteristics of the students in both groups. To do this, it is necessary for the majority of students to attend each lesson pre-

and post- CPD programmes and for the subject being taught to be the same. However, as this study was carried out across two academic years, there is little guarantee of the same students being present pre- and post-observation, as student movement over the duration of the study is expected and the teachers will be observed teaching a variety of subjects. Moreover, the students would have to sit for the same CPD tests (pre- and post), which would create a problem as students would have a familiarity with the examination and would be expected to do better. Aside from these reasons, the focus of the study is to observe changes in teachers' practice, and not students' results, as the link between the two is not necessarily causal or immediate. It is felt that data gathered at this level would be quantitatively weak. Nevertheless, as investigating all of Guskey's levels provides an avenue to triangulate research findings, the students' learning level data was gathered from teachers' opinions through interviews, which was qualitative, so we were able to get an indication of how the students reacted to the CPD training.

To effectively identify the appropriate methodology required for this study, the next section provides a concise exploration of research philosophy.

4.4 Research Philosophy

Exploring research philosophy is a necessary step has it possess unquantifiable benefits particularly when determining/evaluating the research methodology. It gives an insight into what research designs to adopt, the required evidence and ways of interpreting them and how the evidence answers the research question. In addition, exploring research philosophy can help highlight the limitations of particular approaches and afford the researcher creative insight in selection of methods (Easterby-Smith et al., 2012).

Philosophical assumptions are referred to as research paradigms, which are "a set of assumptions about the nature of reality, knowledge and the goals and aims of the research process" (Maione, 1997, p.2). It is worth pointing out that every researcher has a mental structure as well as assumptions which act as a guideline in his/her research. In social science research there are three fundamental elements, which include ontology, epistemology and methodology. Whilst ontology relates to the philosophical study concerned with the nature of reality and what exists (Creswell, 2003), epistemology is concerned with phenomena that can be made known to the researcher i.e. the nature of

knowledge and what can be perceived as knowledge (Walker and Evers, 1988). Although the concept of epistemology is clearly distinct from ontology, these two concepts are clearly related as they together describe how researchers know something as well as the nature of what is known (Smith, 2010). Methodology, which is the third fundamental element, has been referred to as "the approach or paradigm that underpins the research" (Blaxter et al., 2010, p.59).

Every researcher has a point of view in understanding the world and it has been highlighted as the main subject making one research method different from another. These views are, however, centred on different research paradigms, which are the positivist, interpretivist (Bryman, 2004) and pragmatic paradigms (Greene, 2007). Paradigm, which may be defined as "the basic belief system or world view that guides the investigation" (Guba and Lincoln, 1994, p.105).

The present research adopted pragmatism as a paradigm to underpin the research process and data analysis, since the study evaluates CPD programmes from different perspectives. Pragmatism is an alternative approach to positivist (Crowther and Lancaster, 2008) and interpretivist epistemology (Bryman, 2004). This approach offers superb promise for researchers and social scientists as it argues that different worlds can be merged to seek a deeper understanding of complex situations and experience through the examination and comparison of data (Greene, 2007).

The traditional positivists and interpretivists are of the school of thought who have expressed their belief that studies need to integrate either a qualitative or quantitative approach and that both epistemologies cannot be combined in a single study as a result of their identified differences in their ontological and epistemological conceptions (Teddlie and Tashakkori, 2009). The pragmatic paradigm nevertheless acknowledges the differences held by both worldviews, yet maintains that this should not be a limiting factor for researchers, thus embracing the possible combination of both approaches to achieve research objectives (Greene, 2007) as no single point of view can clearly depict the entire picture and that there may be multiple realities.

In light of the above, more recent studies have reported that research may be viewed from an integrated point of view whereby the research questions inform the choice of methodological approaches (Leech et al., 2010). In clear terms, pragmatism may be described as an approach to research that combines both qualitative and quantitative

methods (mixed methods) to achieve a given research objective (Onwuegbuzie and Leech, 2005).

Pragmatism encourages liberality in choice from different conceptions or a combination of conceptions (mixed methods) to generate knowledge. The paradigm holds that truth and reality is relative and constructed, knowledge and activities are constructed within several contexts such as social, historical, political or economic, and that the approach is interested in all approaches which have the potential to solve a particular problem (Creswell, 2003).

The suitability of the pragmatic approach over the individual use of the positivist or the interpretivist epistemology has helped to underpin the research process and data analysis in this study, since the study evaluates the impact of CPD programmes from different perspectives. In light of this, the focus is channelled towards evaluating teachers' reactions, learning and practices in the classroom, as well as the change in the school culture and support whilst integrating Guskey's 5 levels.

Aligning with researchers Johnson and Christensen (2012), Greene (2007), and Onwuegbuzie and Leech (2005) regarding the importance of mixing both the qualitative and quantitative methods in one single research to answer research questions of this nature, this study will apply a mixed method approach as detailed in the next section.

4.5 Research Design

Research design is the overall process and strategy through which research is undertaken to integrate the different research elements in a scientific and coherent way in order to ensure the success of addressing the research problem (Lankshear and Knobel, 2004). Research design and selection of its methods in any study is influenced by many factors, such as the nature, objectives, context, number and type of people participating in the study, as well as the amount of time and money available for the research (Creswell and Clark, 2007; Robson, 2003). Phenomenon can be measured in two broad ways: qualitatively or quantitatively (Ritchie and Lewis, 2003). The quantitative method aims to objectively measure a phenomenon, and is based on positivism: the idea that scientific theory should aim to discover universal laws. Qualitative methods are anti-positivist as they aim to understand social life and meaning, which is in its nature subjective and thus not governed by universal laws (Schurink,

1998). There is much debate within the social sciences as to which is the most effective method and proponents of each argue that one is superior to the other (Krantz, 1995; Shadish, 1995). This study however leans towards capitalizing on the individual strengths of the two approaches and combining them to achieve the research aims and scope of the study, as mentioned earlier, using an integrated approach (mixed methods), which is discussed below.

4.5.1 Mixed Methods

Mixed method is identified as the third research paradigm and research which employs this paradigm have been defined by Johnson, Onwuegbuzie, and Turner (2007) as a integrating both qualitative and quantitative approaches for data collection, analysis and inference techniques to enable a clear understanding about the research topic. Mixed methods is closely related to the pragmatic paradigm and is seen as an effective method of analysis, as it is not restricted to a single conceptual or epistemology (Johnson and Onwuegbuzie, 2004). A series of benefits may be associated with the integration of this approach in a research case study and some of the associated benefits may include its ability to move past the 'paradigm war', and allow for a rational alternative that can move past the negatives and positives of each side (Phillips, 1981). Furthermore, the mixed methods approach can complement, harmonize and collect information from diverse communities and allow a researcher to successfully carry out a study using a sequential or concurrent style (Creswell, 2003).

While the mixed methods approach combines qualitative and quantitative approaches to understand complex issues and make research findings satisfactory for varying audiences, integrating findings of data may be contradictory (Mason, 2006). However, the benefit of this approach extends to the opportunity for creating multi-dimensional accounts of event in a study (Li et al., 2000).

A mixed method approach should follow a fundamental principle of mixed research, as defined by Johnson and Turner (2003). This principle states that research should collect data using multiple strategies in a way which uses the strengths of the different methods and approaches and which avoids overlapping weaknesses. If the researcher defines the strengths and weaknesses of the different methods used, the analysis can be considerably more effective than using a single method. The effectiveness of the mixed approach method within CPD research programmes has been identified in a number of

studies (Goodall and Britain, 2005; Muijs and Lindsay, 2008; Smith and Freeman, 2002) where studies were guided by Guskey's levels and aimed at providing a rich empirical basis using a number of data collection strategies, including survey and field work investigations. This, coupled with more recent studies such as the findings of Grammatikopoulos et al. (2008), confirms the possibility of the mixed method approach in increasing the validity of the evaluation procedure as it utilizes multiple approaches to successfully measure complex educational evaluation procedures.

Therefore, it can be inferred that a combination of both qualitative and quantitative approaches (mixed method approach) are deemed fit for achieving the overall aim of this study and that some levels require a differentiated and suitable approach (either quantitative or qualitative) compared to other levels. Table 4.1 below gives a breakdown of the research questions and the methods of data collection applied to the study. As discussed in chapter 3 (Literature review), these questions are aligned with the first four levels of Guskey's evaluation framework.

Table 4.1: Research aims, Questions, and Methods of Data Collection

Research questions	**Data instrument**
What are the perceptions of primary science teachers towards f2f and online CPD programme?	Questionnaire
To what extent do f2f and online CPD programmes impact teachers' knowledge and skills in terms of the 5Es instructional model?	Interview
To what extent do f2f and online CPD programmes impact on the organisation and the organisational support that this programme has gained from the teachers' perspective?	Interview
To what extent do f2f and online CPD programmes change science teacher practice in the classroom?	Observation (Flanders) Interview

A descriptive outline of the study procedure is provided in the subsequent subsection (section 4.5.2) to provide more insight into the step-by-step approach which was required to achieve the research aims of this study.

4.5.2 The Study Procedure

To achieve the overall aims of this study, the necessity to draw out a well-detailed plan of the required steps was identified. This helped the researcher to work through the comparative evaluation study in a logical sequence, as well as to ensure no vital step or information was omitted during the course of the study. This will also provide a platform for other researchers as well as ensure the reproducibility or transferability of the study. Therefore, prior to conducting the study, a plan outlined with the research was then drawn accordingly. This section gives insight into the steps taken to achieve the research objectives. These were embedded into the study's procedure, and have therefore been highlighted below:

1. The initial procedure integrated a pre-CPD programme observation which was conducted using the FIAC system (Flanders, 1966) for the entire study sample and was repeated 3 times for each individual. This was aimed at gathering the necessary data regarding the nature of primary science classroom interaction in Saudi Arabia before establishing the CPD programme so that a comparison could be made both pre- and post- CPD programme.
2. The entire sample was then divided into two equal groups; those who would take part in the f2f CPD programme, which is the control group, and those who would participate in the online CPD programme, which is the experimental group. The control group (f2f group) attended the current Ministry of Education science teachers CPD course (see section 4.2.1) and the experimental group (online group) was provided with an online CPD course (see section 4.2.2), the content of which was identical to the traditional f2f CPD course.
3. Questionnaires were distributed immediately at the end of both programmes to collect *teachers' initial reactions* to the CPD programmes (Guskey's level 1) and to make a comparison evaluation between traditional f2f and online

CPD programmes in terms of the programmes' content, procedure and context. The amount of time between the participants' experience and their reaction to the experience was kept to a minimum to ensure accuracy of the reactions. As suggested by Guskey (2000), a questionnaire was used at this level and the evaluation was kept anonymous in order to encourage honest feedback and allow an in-depth comparison (see section 4.6.1).

4. After about one month all online CPD programme' participants were post observed while only 8 teachers of f2f CPD programme' participants were post observed. As with the pre-CPD programme observations, each teacher in the two groups were also post observed 3 times in the class, using the FIAC system (Flanders, 1966). Two teachers from the f2f group were not post-observed; one due to the closure of his school and the other due to illness.
5. Following this, semi-structured interviews were conducted with 18 teachers in order to gather in-depth data on the impact of the CPD programmes on teacher learning (Guskey's level 2), organisation change and support (Guskey's level 3), teachers' practice in classroom (Guskey's level 4) and students' learning (Guskey's level 5) (see section 4.6.2).
6. Finally, the data collected from the questionnaire, observations and interviews were analysed using a combination of the statistical and narrative techniques. The four steps of data analysis including data reduction, transformation, comparison and integration were used (Li et al., 2000). This procedure is presented in a schematic form in Figure 4.1.

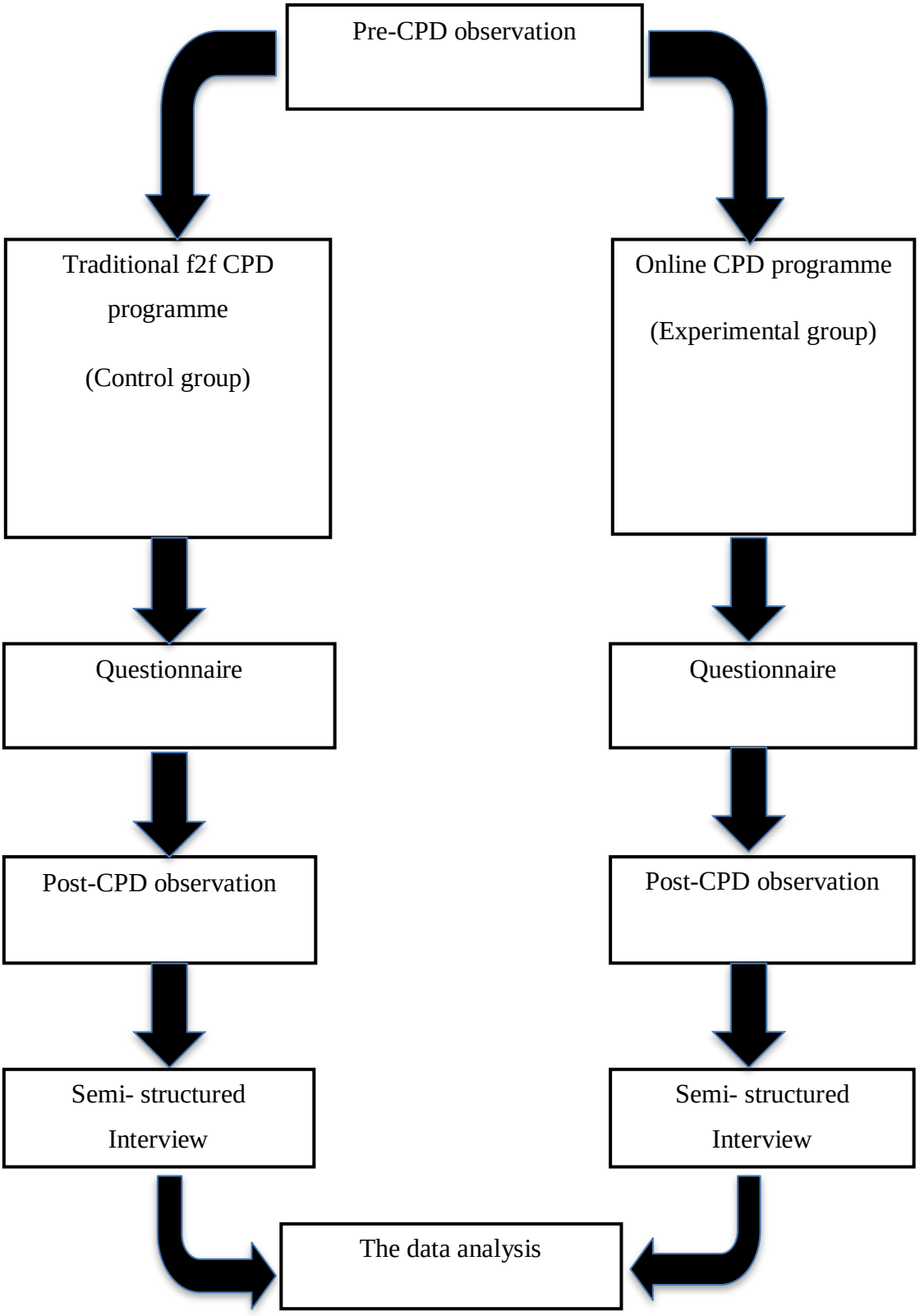


Figure 4.1: The study procedure

4.6 Data Collection Methods

The data collection method is principally related to the various techniques of data collection, such as questionnaires, interviews and observations (Blaxter et al., 2010). As discussed in section 4.5.1, this study used a mixed methods approach, a questionnaire and the FIAC system (Flanders, 1966) to collect quantitative data, and semi-structured interviews were used to collect the qualitative data. Each method was developed and designed based on the needs of the study. These methods are explained in more detail during the following sections.

4.6.1 Questionnaire

In social science research, the use of questionnaires is widely adopted and its use as a quantitative research method has increased (Rea and Parker, 2012). A questionnaire is a research tool used, in most cases, to investigate opinions, perceptions and attitudes (Black, 1999; Rea and Parker, 2012). This instrument works by collating survey information to generate data in the absence of the researcher (Cohen et al., 2007).

Following Guskey (2000), it was decided to use questionnaires with closed questions at the end of both CPD programmes to gather information on the teachers' reaction towards CPD programmes (Guskey's level 1) which were linked with research question 1. This was to conduct a comparison evaluation between traditional f2f and online CPD programmes in terms of the programmes' content, procedure and context. The questionnaires were administrated immediately at the end of CPD programmes to ensure accuracy of the reactions, which were necessarily immediate. Furthermore, questionnaires allow respondents to remain anonymous in order to encourage honest feedback (Cohen et al., 2007; De Vaus, 2001; Guskey, 2000). This is particularly relevant to the Saudi socio-cultural context, as giving negative responses is unlikely to occur due to politeness and a need to maintain relationships with the trainer or interviewer. Also, as the research is a comparative study, the structured questionnaire enables in-depth comparisons to be made across groups in the sample, as well as generation of responses amenable to statistical treatments and analysis (Cohen et al., 2007).

Depending on the intended purpose, questionnaires may be developed in three forms, which include the structured, semi structured and unstructured (Cohen et al., 2007).

While these three types have associated advantages and disadvantages, this research has adopted the structured questionnaire approach, which is followed by two open-ended questions, allowing for additional information. The use of structured questionnaires was deemed fit as a result of its added advantages which enable the researcher to observe patterns and allow for comparison within the study (Cohen et al., 2007).

4.6.1.1 Questionnaire Design

Based on the first research question and using the Guskey's level 1, the purpose being to collect evidence regarding the extent to which teachers are satisfied with CPD programmes, questionnaires were designed and developed. According to Guskey (2000), the questionnaire approach may be used to answer three main questions regarding content, procedure and context, as these address the fundamentals of professional development which are capable of enhancing CPD programmes. Therefore, to prompt teachers to provide feedback on content, procedure and context of both CPD programmes, the questionnaire was categorised into three main sections, composed of 24 statements in total, which are followed by two open-ended questions to allow for more extended responses. Statements were chosen from previous studies (Guskey, 2000; Mullins et al., 2010) and modified to meet the study aims. The responses to the statements are indicated by the teachers using a Likert scale (Likert, 1932). The Likert Scale is one of the most common scales used in social research, and enabled the teachers to express their level of satisfaction on a five point scale in which 1 is very dissatisfied and 5 is very satisfied. The scores were calculated to find the total score for each statement, with a higher score indicating a higher positive satisfaction. This scale is used for both f2f and online CPD programmes (Table 4.2)

Table 4.2: The Likert scale used in the questionnaire

Very dissatisfied	Dissatisfied	Unsure	Satisfied	Very Satisfied
1	2	3	4	5

As there are two types of CPD programme, online and f2f, the questionnaires for each programme was largely similar, except for a few minor differences in section three, CPD programme context.

Section 1: CPD Programme content.

This section contained eight statements which aimed to investigate teachers' satisfaction toward the relevance, utility, clarity, value, difficulty and importance of the CPD programmes' content. All teachers, that is both the f2f and online programmes' participants, were given the same questions.

Section 2: CPD Programme Procedure

This section contained seven statements aiming to investigate teachers' reaction towards the process of establishing the CPD programme. This included the quality of the instruction, activities and materials. Both f2f and online participants were given the same questions.

Section 3: CPD Programme Context

This section contained nine statements aiming to measure the satisfaction of the teachers toward CPD programme context, including the appropriateness of the setting, facilities, and accommodation of the CPD programmes. Since the online and the f2f approach works in different settings, the statements for f2f and online CPD programmes' participants differed in some respects, thus, this section of the questionnaire was divided into two sets with the first set designed to measure the level of satisfaction with the common features of online and f2f CPD programmes while the second set of statements provided the views of teachers about the distinctive features of both programmes separately.

The last two questions on the questionnaire were open-ended questions. The first was to gather comments on individual thoughts in regard to which parts of the programme they found interesting, whilst the other question was to collect any additional information the teachers might have had. The advantage of adding these types of questions is that teachers have the flexibility and freedom to express their thoughts and have the opportunity to add further information that they may not have been able to express in answering the closed questions (Cohen et al., 2007).

After the questionnaire was developed, and prior to piloting, it was reviewed by two Specialties in CPD programmes in Saudi Arabia who provided useful comments and

suggestions, such as changing the structure, building themes in sections and changing the Likert scale from three to five rating points.

The initial version of the questionnaire was piloted on 5 volunteer teachers who teach at a private Saudi financed school in a Northern Industrial city in the UK. This school was chosen for piloting the questionnaire for a number of reasons. First, it was considered to be relatively easy to access teachers, all of whom are from Saudi Arabia, without having to return to Saudi Arabia itself. Another reason of choosing this school was that the city was relatively near to where the researcher lives and so was easy to visit.

Feedback included valuable suggestions, such as the statement that *"All further training was clearly explained"* had to be removed as it was deemed unnecessary, and the statement *"Explanation of the course aims and objectives"* was changed to *"The aims of the programme were clear".* Furthermore, by piloting the questionnaire the researcher estimated the average time it takes to complete the questionnaire, which was about five minutes. As a result of the comments and suggestions, the final questionnaire was developed (See Appendix 6 and Appendix 7) all of which were implemented prior to the study.

4.6.1.2 Translation of Questionnaire into Arabic

Due to the fact that language of the target research sample is Arabic, the questionnaire was translated from English into Arabic by the researcher. It was important that the translation of the questionnaire was correct and clear in order to ensure the validity and reliability of the questionnaire (Behling and Law, 2000). Therefore, both the Arabic and English versions of the questionnaire were sent to a PhD student at Leeds University who is a specialist in translation for verification. The feedback obtained confirms the translated questionnaire was accurate (see Appendix 8 and Appendix 9)

4.6.1.3 Questionnaire Administration

As the two CPD programmes were administered using different methods, the questionnaire was also distributed using two different methods.

With regard to the f2f CPD programme, questionnaires were handed out in person to the teachers immediately after completion of the programme. Teachers were given 20 minutes to complete the questionnaire. Questionnaires were handed in on completion. Being aware of the possible limitations which may be encountered with the use of

questionnaires, such as the inability to explain questions to participants and also the lack of guarantee that the questionnaires are answered by the right person (Sarantakos, 2005), this study however overcame these challenges, guaranteeing a high response rate, as respondents completed the questionnaire under supervision there and then and assistance was administered when required.

The online CPD programme questionnaire was made available on the interactive website and was to be answered online. Online was seen to be the easiest way to distribute, collect and analyse the questionnaire data as each of these steps could be done at any time and any place, and was particularly useful with the researcher being in the UK and teachers in Saudi Arabia. Surveys, and research into them, have benefitted largely from the Internet as the geographical reach is a huge benefit (Berg, 2007). The questionnaire was uploaded to the website Moodle, the website used for the delivery of the CPD programme which contains a feature to create surveys, and can be found at the link: http://cpd5es.org/moodle/ (Appendix 10). The link was posted on the website at the end of the course and teachers were sent a notification text message, through WhatsApp messenger (See section 4.2.2), to inform them of this and to encourage them to respond. Unlike the f2f questionnaire, response was not guaranteed, and follow-up contact with the teachers was required. These messages were sent to those teachers who had not completed the online questionnaire via the WhatsApp messenger until all teachers had responded.

Both f2f and online questionnaires had a cover letter that explained the aim of the survey, provided contact details for any enquiries and had an assurance of confidentiality. A copy can be found in Appendix 11.

4.6.1.4 Questionnaire Data Analyses

The questionnaire data was coded and analysed using the Statistical Package for the Social Sciences program (SPSS), version 19. Simple descriptive techniques including means, median and standard deviation were calculated to describe the sample perception towards the respective CPD programmes.

Since the sample size of this study is less than 30, the data cannot be considered to be normally distributed as suggested by Carver and Nash (2011), thus an independent sample t-test as well as Mann-Whitney U test were carried out for content, procedures

and context of the programme separately to determine whether there was a significant difference between online and f2f CPD programmes.

4.6.2 Interviews

Interviews are structured conversations conducted by a researcher to capture the views and experiences of the interviewee on a specific subject (Kvale, 1996). They are regarded as being powerful and flexible tools concerned with gathering an in-depth, detailed and broad range of information on a given issue, especially in regard to people's experiences, opinions, aspirations and feelings (May, 2011).

In this study, a semi-structured interview was used for gathering data related to the impact of the CPD programmes on the following Guskey's levels:

1. Guskey's level 2 *(Participants' learning)*: This is linked to research question 2 and which aimed to gather evidence regarding changes in teachers' knowledge and skills that can be attributed to their professional development. To explore this level, a semi-structured qualitative interview was conducted (one month) following the CPD programmes to allow reasonable time to assess the knowledge retention of the teacher and to gather rich data.
2. Guskey's level 3 *(organisation change and support*): This is linked to research question 3, which aimed to *compare* the impact of both CPD programmes and the extent to which the programmes brought about change in the organisation and organisational support amongst teachers from the teacher's point of view.
3. Guskey's level 4: (*Participants' use of new knowledge)*: This is linked to research question 4, which relates to the teachers' implementation of what they have learnt through the professional development. Although this level was evaluated by the FIAC system (see section 4.6.3), using the interview will allow insights from the perspective of the teacher that would not be available from observation alone. The FIAC system as a type of observation tool has its limitations. Firstly, it is a structured method of recording data and collects only verbal interaction. Secondly, only a relatively small sample of teacher practice can be observed, so an interview will provide insight into teachers' views of their classroom practice that occur outside of the observation (which of course is most of their practice). Therefore, an accompanying interview will give a wider view than the classroom observation alone could have provided.

In general the reasons for using the interview in this study as a method of collecting qualitative data was because: 1) it provides in-depth information which can be used in a comparative analysis so that different types of evaluation can be made, 2) such an approach can provide deeper insights in general, and help to generate corroborated evidence that increases the confidence in the reliability and validity of the data and findings (Johnson et al., 2007; Robson, 2003).

Interviews are usually conducted by direct f2f interaction and most commonly can be classified into three main types, based on the type of questions: structured, semi-structured and unstructured (Bryman, 2012; Harvey, 1998). The structured interview is generally more closed, questions are asked to various groups. This is merited by making the interview more focused, but is not easily adaptable. This type of interview is characterised by being a closed situation (Cohen et al., 2007). In contrast to this, the unstructured interview is characterised by being an open situation having many, unordered open-ended questions and has the advantage of being quick and adaptable, but requires more time to analyse the responses. The semi-structured interview, on the other hand, can be a list of questions that are prepared in advance, with all these questions not necessarily having to be asked. Some questions might be changed or deleted based on participants answers and the interviewer is able to create new questions during the interview process (Bryman, 2012). The wording of questions is more flexible and the level of language can be adjusted.

Semi-structured interviews were used in this study as it proved to be the most appropriate method for this analysis. This was because flexibility was very important because each section of the interview follows each of Guskey's levels and it was necessary to ensure that each level was covered and answered in appropriate detail. The interview was divided in this way to ensure that the teachers had understood the programme material. In a semi-structured interview, the researcher can ask more questions if clarification or further detail is needed. In addition, interviewees tend to anticipate questions (Hitcock and Hughes, 1995). This can lead to participants' under- or over- answering questions, and areas being avoided or missed out. To avoid this, in the semi-structured interview, the researcher is able to change the order of the questions and add new questions as they see fit. Related to this, the interview must be well planned to address the research questions and at the end its results must be verified for

validity (Kvale, 1996). The researcher must keep their aims in mind during the interview process.

4.6.2.1 Interview Design

As the purpose of the interview was to gather data related to the impact of the CPD programmes on; 1) teachers learning 2) using of new knowledge 3) organisational support and change, and 4) students learning, the interview questions were designed to investigate these four aims which developed around Guskey's 5 level framework.

In this study, the interview has the aim of gathering data related to the impact of the CPD programme in changing teachers' behaviour with regards to the 5Es instructional model and in respect to teachers' learning, use of new knowledge, organizational support and change and student learning. As a result, the interview was divided into four sections, following four of the five levels. The interview was then comprised of fifteen questions (Appendix 12).

Section 1: This section contained five questions that aimed to gather evidence regarding changes in teachers' knowledge and skills, aligned with Guskey's level 2: participants' learning.

Section 2: This section contained three questions aiming to gather information regarding Guskey's level 3: evaluating the CPD programme in organisational support and change. Based on Guskey's level 3, this section contains questions that investigate the impact of the CPD programme on school support from the point of view of the teachers.

Section 3: This section contained three questions related to Guskey's Level 4 which aimed to gather information related to the CPD programme's impact on changing the teachers' use of new knowledge regarding 5Es instructional model. It is must be also indicated here that this level is also evaluated by observation using FIAC system, (see section 4.6.3).

Section 4: This section contained three questions aligned with Guskey's level 5, which aims to gather information related to the impact of the CPD programme on changing students learning outcome. Although this is not within the scope of the study as discussed earlier, it was nevertheless attempted from a teachers' point of view to get an indication of how the students have reacted to the CPD training.

Open-ended questions were included at the end of the interview questions in order to give the teachers opportunity to add their thoughts if they had any.

To ensure validity, the interview instrument in this study was piloted and two steps were also followed. First, after reviewing the interview questions with the researcher's supervisor during several meetings, three copies of the interview questions (Arabic version) (Appendix 13) were sent to three colleagues working at the Ministry of Education, one of whom has recently completed his PhD in education, to ask for their opinions and suggestions. A few questions were modified and re-worded for clarity.

Second, as Turner (2010) suggests that the pilot stage of the instrument should ideally be conducted with participants that have similar interests with participants of the main study, a Saudi teacher taking a Master's degree at a university in the UK in Science Education was interviewed by the researcher as a final stage of the pilot. Fortunately for the research, this teacher had recently participated in numerous CPD programmes, including programmes in the 5Es instructional model, before coming to the UK and was therefore able to answer the questions with the knowledge required and feedback could ensure questions were accurate and useful. The interviews lasted about 30 minutes and digitally audio recorded. The teacher was asked at the end of the interview for any comments or suggestions. Piloting the interviews helped in improving both the questions and the methods of asking the questions.

4.6.2.2 Interview Administration

McNamara (2009) makes some important recommendations that should be taken into account when carrying out an interview. Firstly, and possibly most importantly, the interviewer needs to check that the recording device is working for the duration of the interview. Furthermore, the interviewer should not ask more than one question at a time and should provide transition between major topics e.g., "we've been talking about (some topic) and now I'd like to move on to (another topic)". Keeping control of the interview is essential, and it is easy for respondents to stray on to another topic, take a long time to answer a question so that times begins to run out, or even begin asking questions to the interviewer.

An important element of interviewing effectively is remaining as neutral as possible (McNamara, 2009). Firstly, when receiving a response the interviewer should in turn

respond neutrally, whether this is in their facial expression or verbally, and should encourage and elicit responses with non-committal body language, such as nodding or murmuring but never showing strong emotion or responses. Neutrality also applies to taking notes; the interviewer should be careful how quickly or in what manner the interviewer does this as their behaviour could influence future questions.

In the present study, in order to allow a reasonable time to assess the knowledge retention of the teacher, the interview was administrated one month following the CPD programme. The interviews took place at the schools after the class observation. Before the interview process started, the confidentiality of the process was explained including the aims, format and type of interview. The teachers were assured that the data was only to be used for research purposes with limited access to it. At the end of the interview, teachers were given a means of contact in case they had any further problems or queries following the interview.

Eighteen teachers were interviewed face-to-face in Arabic, each interview lasting about 30 minutes. To avoid any missing data, the interview was recorded by a digital recorder and immediately downloaded on to a computer and converted to particular file formats which allow for ease of playback during transcription.

4.6.2.3 Interview Transcription

Having obtained a recording from the interviews, it became necessary to transcribe the recorded information. The priority of producing a transcript requires that it remains a representative of the spoken word (Poland, 2003). Transcribing is a demanding step with respect to time, costs, physical and human resources (Halcomb and Davidson, 2006). For example, Britten (1995) suggests that every hour of interview taped will require up to 6-7 hours of transcription. Nevertheless, it is known that regardless of the transcriber, whether they be a professional or the researcher himself, a number of human errors such as wrong sentence structure, mistaken words/phrases may still be encountered (Halcomb and Davidson, 2006) thus making the confidence in transcript questionable and simultaneously affecting its validity (Poland, 2003).

In light of this, the recorded information was self-transcribed, as this provides an extremely valuable avenue to be personally familiar with the data as a professional transcriber will not be able to benefit from this. The associated time with transcribing of the obtained recording in this study was about 5-6 hours for every 30 minutes of

recorded information, supporting the fact that qualitative data can be time consuming and resource demanding compared to other data collection techniques (Halcomb and Davidson, 2006). Also a verbatim transcription, which transcribes all the content of the recorded information such as 'I mean', 'as well', 'I found' etc. was also used as this ensures an optimum data pool for analysis (Merriam, 1998).

To ensure validity of the transcription, it is suggested that transcripts be offered to participants to provide them with the opportunity to check the accuracy of the transcription (Hinds, 2000). Therefore in this study the transcript sample was selected at random and sent by email to the respective teachers to review the transcript alongside the digital recordings. They were also required to provide accuracy (in percentage) and additional feedback. Overall, all feedback was excellent and positive.

4.6.2.4 Interview Data Translation

The data obtained in the study was recorded and transcribed in Arabic. Therefore, it was necessary to translate all the information and findings into English, as it is the required language of the intended research report. In light of this, a Machine Translator (MT) approach was integrated for a number of reasons, ranging from cost effectiveness to the accuracy of the approach (Aiken and Balan, 2011; Altay, 2004; Coughlin, 2003). For example, professional human translation is estimated to be priced at about £50 for every 500 words translated, suggesting the excessive amount that would have been paid considering the large number of words (8,000 words) that required translation.

Furthermore, associated delivery benefits with the use of machine translators are an added advantage as (Aiken and Balan, 2011) suggests that the MT was 195 times faster than human translators. Considering the research length, which is time bound, the use of MT was deemed appropriate as it enable translation within the dedicated timeframe. It is also worthy to mention that with the use of MT, biased translation can be avoided unlike during human translations (Balk et al., 2013; Coughlin, 2003).

A number of web based MT such as SDL Automated Translation solutions, Applied Language, Google Translator etc. may be used, however this study leaned towards the use of Google Translator, as it has proven dominant over other web based MT in terms of accuracy (Aiken and Balan, 2011; Balk et al., 2013). MT, on the other hand, may be limited in the sense that translations of complex sentences may be inaccurate and

sometimes not make sense as it does not integrate the cultural dimensions that humans can integrate to solve problems. Thus the obtained translations from Google Translator were carefully checked against the original transcript to ensure accuracy.

To ensure validity of the translated transcripts, they were sent to two colleagues who are PhD students at the University of Leeds and University of Aberdeen respectively, alongside the respective translation based on a random selection sample. Colleagues were required to follow the same procedure as the researcher and were required to rank the accuracy and provide additional comments. This proved an average of 98% accuracy and useful comments were integrated in all the translation drafts.

4.6.2.5 Interview Data Analysis

The data was analysed by hand using a thematic analysis approach, as it is considered that thematic analysis provides valuable information by organizing and describing the data in rich detail (Braun and Clarke, 2006). Every participant's transcript was read many times whilst listening to the digital recording which it was felt would help in increasing the familiarity with the data. The transcripts were printed out in double spacing to give room for additional comments and notes.

Using several coloured pens, the Braun and Clarke (2006) colour coding technique was embedded, where the respective texts were organised into portions of coherent and similar texts aimed at providing responses to the sub questions of the respective objectives. As described by Ezzy (2013), the common suggestions and input from the teachers' views were identified and developed on as emerging themes. The nature of the research meant that this approach was ideal as a result of the associated theoretical nature, which aimed to explore new and unexpected themes, which were subsequently presented carefully in tables to allow close comparison.

4.6.3 Observation

Observation aims to document behaviour through watching and listening (Harvey, 1998) and provides an opportunity to collect richer data than would be possible with inferential tools, such as interviews and questionnaires, as people can sometimes do things differently to how they report that they do them (Robson, 2003). Observation provides opportunities to assess the behaviour of those being observed (Cohen et al., 2007) while being effective for gathering data of interactions (Morrison, 1993), as an

important element of evaluation is the verbal interaction between the teacher and students, due to its significant impact on students' learning and achievement. For these reasons, observation is considered an appropriate method for evaluating the performance and practice of teachers in the classroom and for an effective evaluation of the CPD programmes.

However, there are a few but nevertheless significant problems with observations. Firstly, as a research tool, it can be costly in terms of both time and effort (Cohen et al., 2007). Although in a study with a small sample size, such as the present study, this is not a problem as all participants can be given appropriate time within the means of the study. In addition, the Observer's paradox, which is the idea that the very act of observation changes the phenomenon that is intended to be observed (Labov, 1972), could become a factor in the process of gathering the required information. In this situation, the fact that the observer is in the classroom with the teacher could possibly change what actually happens in the lesson. This, however, is unavoidable, and it is expected that the teacher should be used enough to being regularly observed by colleagues for them not to be overly concerned with the researcher's presence and so they should behave as normal.

A researcher can take on a number of roles in the classroom depending on how involved they want, or need, to be. Gold (1958) identified these on a continuum, from complete participant to complete non-participant observer. In the present study, the observer took on the role of a non-participant observer, as in a primary classroom it was thought the researcher's participation would substantially affect the lesson's dynamics.

Observation, as a research method, can be divided in terms of the how it is structured, and to what level it is structured. These levels can be defined into various types, accordingly, Cohen et al. (2007) identify four types of observation: structured observation, unstructured observation, non-directive observation and focused observation. Since the aim of the fourth research question in this study is to investigate the pattern of interaction in science classrooms, and also to investigate teaching practice in relation to the application of the 5Es instructional model, a structured observational tool with specific criteria in this regard was adopted. This is because a structured observation is very systematic and the content and procedure of the observation are well organised. A structured observational tool will enable the researcher to construct

numerical data which can facilitate the drawing of comparisons between different situations (Cohen et al., 2007) and, in the context of this study, the two different situations are the impact of online and f2f CPD programmes on the practice of science teachers.

Amongst the most useful structured observational tools is FIAC system that is used to monitor and record teacher–student communication over a specific period. A review of some studies (Evans, 1970; Monk et al., 1999; Sisk, 2007) provides evidence that the FIAC system is effective in terms of identifying various aspects of science teachers' behaviour in a classroom environment

To this effect, the FIAC system is useful for evaluating Guskey's level 4 in this study in yielding meaningful information regarding classroom interaction, as it is sensitive to this type of data. As a procedure, it is used in quantifying direct influences, for example teacher questions, and indirect influences, such as student centred responses which are closely related to teacher influence and can be identified within the classroom. Therefore, it is useful in answering and quantifying the second research question, which is about the effect of CPD programmes in changing the interactions in the primary science classroom.

4.6.3.1 Flanders' Interaction Analysis Category (FIAC) System

In this study, teacher observations were recorded and analysed through the use of the FIAC system, developed by Flanders and others between 1955 and 1960 at the University of Minnesota, USA. The FIAC system is an objective and reliable method for assessment of the classroom. It has been widely used in many studies to describe what happens in the classroom between teachers and their students (Monk et al., 1999; Sisk, 2007). It has also been used for in-service teachers to help them modify their behaviour in the classroom (Bushman, 1973; Psencik, 1969)

Table 4.3 presents the FIAC system. This system classifies total verbal behaviour into 10 categories, grouped into three major sections. The first seven categories are used to describe various aspects of the teacher's talk, two are used to describe the students' talk and the last category is used when there is silence in the classroom.

Table 4.3: Flanders' Interaction Analysis Categories system (Flanders, 1966, p. 5).

		Activities
Teacher Talk	Response	1. ACCEPTS FEELING: Accepts and clarifies the feeling tone of the students in a non-threatening manner. Feeling may be positive or negative. Predicting or recalling feeling is included.
		2. PRAISES OR ENCOURAGES: Praises or encourages student actions or behaviour. Jokes that release tension, not at the expense of another individual, nodding head or saying "um hum?" or "go on" are included.
		3. ACCEPTS OR USES IDEAS OF STUDENTS: Clarifying, building, or developing ideas suggested by a student. As a teacher brings more of his own ideas into play, shift to category five.
		4. ASK QUESTIONS: Asking a questions about the content or a procedure with the intent that a student answers.
	Initiation	5. LECTURING: Giving facts or opinion about the content or a procedure with his own ideas, asking rhetorical question.
		6. GIVING DIRECTIONS: Directions, commands or orders to which a student is expected to comply.
		7. CRITICIZING OR JUSTIFYING AUTHORITY: Statements intended to change a student's behaviour from a non-acceptable to an acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing; extremely self-reference.
Student Talk	Response	8. STUDENTS TALK-RESPONSE: A student makes a predictable response to the teacher. Teacher initiates the contact or solicits student statements and sets limits to what the student says.
	Initiation	9. STUDENTS TALK INITIATION: Speech made by students which they initiate. Unpredictable statements in response to the teacher. Shift from 8 to 9 as student introduced own ideas.
Silence		10. SILENCE OR CONFUSION: Pauses, short periods of silence and periods of confusion in which communication cannot be understood by the observer.

In order to utilize the FIAC system efficiently, it is essential that the user must be experienced in recording the types of class interaction; observer reliability is a crucial

requirement. An extensive period of training is therefore necessary to collect reliable data (Lambert et al., 1965).

Therefore, the method was piloted on the three 5Es instructional model expert video lessons available on YouTube (Awoods0806, 2009). The video used was taken in elementary schools in the UK, and was based around the 5Es instructional model. The video was watched for two reasons: firstly to practise the observational method and secondly to collect an average of the interaction patterns which could later be used as a comparative for the effectiveness of the CPD training. The exercise of observing and recording the videos was repeated until comparative results were obtained, then the last three results were averaged. These results were compared with the results obtained by a trained observer who studied the same video. This observer was a student at Aberdeen University taking a PhD in science education Table 4.4 and Table 4.5.

Table 4.4: Results obtained from the video

	Percentage of times spent on each category (%)				
		Observation 1	Observation 2	Observation 3	The average
Researcher observation results	Teacher Talk	53.13	55.02	48.08	52.07
	Student Talk	24.55	26.99	28.21	26.58
	Silent	22.32	17.99	23.72	21.34
Trained observation results	Teacher Talk	54.35	53.59	47.74	51.89
	Student Talk	24.51	26.49	28.19	26.39
	Silent	21.15	19.92	24.07	21.71

The average of both observation results were calculated and presented (Table 4.5) by working out the corresponding average of respective categories obtained from both the researcher's observation and the trained observer's results.

Table 4.5: The average of both observation results

Researcher's results			Trained observer's results			Average of both results		
Teacher Talk %	Student Talk %	Silent %	Teacher Talk %	Student Talk %	Silent %	Teacher Talk %	Student Talk %	Silent %
52 .07	26.58	21.34	51.89	26.39	21.71	51.98	26.49	21.52

From the results average, the percentages agreement rates of the two observation results are similar as seen in the following Table 4.6 below:

Table 4.6: Percentage agreement rate of the results

Teacher Talk %	Student Talk %	Silent %
98	96	95

4.6.3.2 Observation (FIAC System) Administration and Analysis

Classroom observations using the FIAC system were conducted for teachers before and after delivering the CPD programmes. Prior to delivering the CPD programmes, the researcher spent a full day for every single visit at the respective schools to observe individual teachers three times. Multiple observations were carried out because the nature of the 5Es instructional model means that it does not necessarily need to be applied within one session and can be completed over a phase of several lessons. Therefore it was deemed necessary to observe at least three sessions to ensure that the 5Es instructional model was in use by the teacher. This observation was, however, carried out in a single day for a number of reasons. Firstly, it was thought that visiting the teachers three times on different days for a limited time (maybe an hour) would not give enough opportunity to get to know the teachers and build a relationship and rapport with them. Furthermore, selecting different days for the observation would have been time and cost consuming, not to mention the possibility of teachers missing the sessions for reasons such as illness.

Three post observations were also carried out after the delivery of the CPD programmes similar to the pre-observation, however, this was carried out on two teachers less the initial sample (18 teachers). This was as a result of one school being closed down and thus the researcher was unable to assess the teacher, and the other teacher missed the session as a result of illness. Overall, observation in the study was carried out six times with three before the CPD programme and the other three carried out at the end of the CPD programme.

The procedure of using FIAC system can be divided into three main steps: 1) Encoding (putting behaviour into codes); 2) decoding (the interpretation of the codes) and 3) analysis of the ensuing interaction matrix.

1. Encoding

Before going into the classroom, each teacher was met individually by the researcher and the purpose of the observation was explained. This was to ease any apprehension or nervousness and to ensure that the class was to run as usual. Also in this meeting further information was given concerning the objectives of the research.

To make the encoding step easier, an observation sheet was developed based on FAIC system (Flanders, 1966) which enabled the classification and coding of classroom interactions to one of the ten categories (see Appendix 14). This action, of writing down the current interaction behaviour was repeated every three seconds by recording the category number that best represented the observed behaviour. The following standard FAIC system rules (Psencik, 1969) were followed to avoid confusion that might be encountered in the observation procedure:

Rule 1: when there was doubt of which two or more categories a statement belonged to, the category that was numerically furthest from category five, but not category ten, was chosen. For example, if there was doubt between category 2 or 3, then category 2 was chosen.

Rule 2: if more than one behaviour happened during a three second interval, then all the categories representing the behaviours were to be recorded. If there was no change in these categories after 3 seconds, then these categories were repeated in these seconds.

Rule 3: Observation was conducted as objectively as possible, without the any influence of personal viewpoint.

Rule 4: If a silence or confusion behavioural category was longer than three seconds, it was then recorded under number 10.

In the classroom, the researcher was located at the back and observed and recorded the teachers' and students' behaviours in a discreet, professional manner. During the lesson,

the researcher never spoke to, and avoided eye contact with, the teacher and the students, and did not cause any disruption that would make his presence noticed.

At the end of the classroom observation, the observed level of the 5Es instructional model was recorded to be compared with teachers' response during the interview. The aim of this question was practical; for verification purposes. The reliability of the teachers' responses were measured through comparing what they claimed they did in the class with what they actually did as documented in researchers' field notes after each lesson observed.

2. Decoding the data into the matrix.

After completing the encoding procedure, all data were recorded in a 10 x 10 matrix. Each number was entered in the form of sequence pairs, and the entire series should begin and end with the same number (see Figure 4.2). The number 10 was added in the beginning and at the end of the entered series, unless the number 10 already existed.

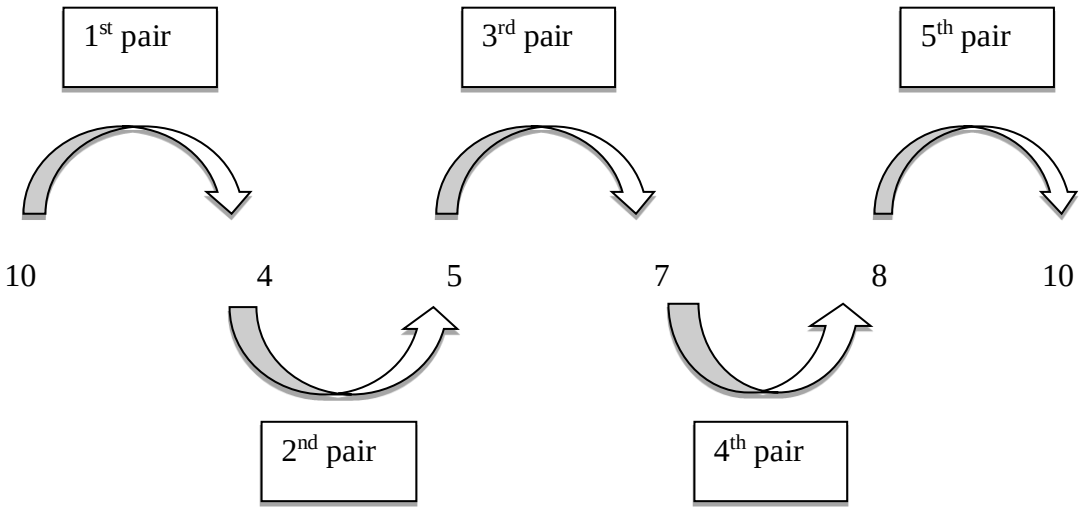


Figure 4.2: Decoding the data matrix

For example, if the series 4, 5, 7, 8, 10, was entered, then this series would be written as: (10, 4), (4, 5), (5, 7), (7, 8), (8, 10). The first number in the pairs represents the row and the second number indicates the column. Each pair represents one point in the

matrix. The sum of row 1 must be equal to the sum of column 1 and the sum of row 2 must be equal to the sum of column 2 and so on.

The data was manually entered into the spreadsheet using Excel software. It should be mentioned here that this step is crucial to the efficacy of the study and therefore data must be carefully recorded to avoid any mistakes, otherwise the data will have to be re-entered from the beginning. This is due to the sequential nature of the data.

3. Analysing the interaction matrix

Analysing the data obtained by FIAC system required careful attention and effort to present the results in an appropriate way. Therefore, after collecting the data, all the observation tools were reviewed once again by the researcher, to make sure that all the data required was recorded before the data analysis stage. Next sections detail the classroom interaction analysis:

1) The proportion of Teacher's Talk

Teacher's Talk shows a teacher's verbal activities in the classroom interaction, and it is represented by a concentration in columns 1 to 7. In order to determine the percentage of Teacher Talk in the classroom, the sum of columns 1, 2, 3, 4, 5, 6, 7, was divided by the total sum.

In Teacher Talk, there are two influences of the teacher; direct and indirect influence and can be classified as a Direct Teacher Talk and Indirect Teacher Talk as follows:

a) Direct Teacher Talk

Direct Teacher Talk indicates teacher's activities restricting student participation and is represented by a concentration in columns 5 to 7. The percentage of Direct Teacher Talk can be calculated by adding of columns 5, 6 and 7 and dividing by the total sum.

b) Indirect Teacher Talk

Indirect Teacher Talk indicates teacher's activities by raising questions and encouraging interactive participation. It is represented by a concentration in columns 1 to 4. The percentage can be calculated by adding of columns 1, 2, 3 and 4 and dividing by the total sum.

2) The proportion of student talk

Students' Talk indicates the students' activities in the classroom by responding to their teacher's questions or by raising questions. It is represented by a concentration in columns 8 and 9. In order to determine the percentage of Student Talk in the classroom, the columns 8 and 9 were added and divided by the total sum.

3) Silence Ratio

Silence indicates short periods of silence and pauses. It is represented by a concentration in column 10. In order to analyse the percentage of Silence in the classroom, the sum of column 10 was divided by the total sum.

Owing to variation in total observation time for each teacher, the raw calculated scores for each teacher were converted into a standardised score for a total of 135 minutes. The raw and standardised scores of each teacher were calculated and summarised.

To analyse the dataset, descriptive statistics including the respective means, median and range were applied using the SPSS software. In addition, to establish the differences in classroom interaction for pre and post CPD programme, a paired sample T-test was applied as well as a non-parametric test using the Wilcoxon Signed ranks test.

4.7 Study Population and Sample

It is necessary at this point to provide details about how a representative sample with the appropriate size and characteristics was selected from the whole population. These issues are discussed in the following sections.

4.7.1 Study Population

The population in statistics is a well-defined collection of objects or individuals, which have a common characteristic (Kirk, 2007). It is impossible in this or any other research project to cover the entire population of the study, as it is time consuming and costly in terms of both human resources and travel. The target population of this study is full-time science teachers in Saudi Arabia primary schools. Therefore, a sample of the population will be made, which is a considerably more cost effective and time efficient method of gathering data than creating a full census of the population.

In order to choose the sample population, it should be as representative as possible of primary science teachers in Saudi Arabia. Having looked at varies provinces in Saudi Arabia, Al-Quwayiyah province was selected. This region was selected for this study for a number of reasons; firstly, the researcher worked and lived in the area and has contacts with the educational authority which, given difficulties in obtaining access to schools, provided a pragmatic justification for selecting to study schools in this province (Garton and Copland, 2010). Another reason for the selection of Al-Quwayiyah was that it typifies the socio-cultural values and structures that prevail in many areas in Saudi Arabia. For example, as discussed in Chapter 2 (Saudi Context), the education system in the Kingdom of Saudi Arabia is centralized and there are therefore no significant differences in such things as the textbooks, teaching methods, school administration etc. (Ministry of Education, 2004; Ministry of Education, 2010) These features and characteristics make Al-Quwayiyah suitable if the findings and recommendations of this research are to be adopted on a wider scale in Saudi Arabia, as the representativeness of the sample is not expected to vary significantly. Al-Quwayiyah also is the largest and most populated province within Riyadh district of Saudi Arabia which covers six administrative sectors: Algelah, Halban, Alhasah, Al Guwaiyah, Alrwaidah, and Alrain (Ministry of Education, 2009). These sectors have numerous public primary schools that range from small schools in rural areas to large schools in urban and suburban areas as illustrated in Table 4.7 below.

Table 4.7: Distribution of teachers in Al-Quwayiyah province

Administrative sectors	Number of teachers	Number of science teachers
Algelah	170	24
Halban	188	35
Alhsah	200	43
Al-Quwayiyah	920	114
Alrwaidah	442	95
Alrain	419	84
Total	2339	395

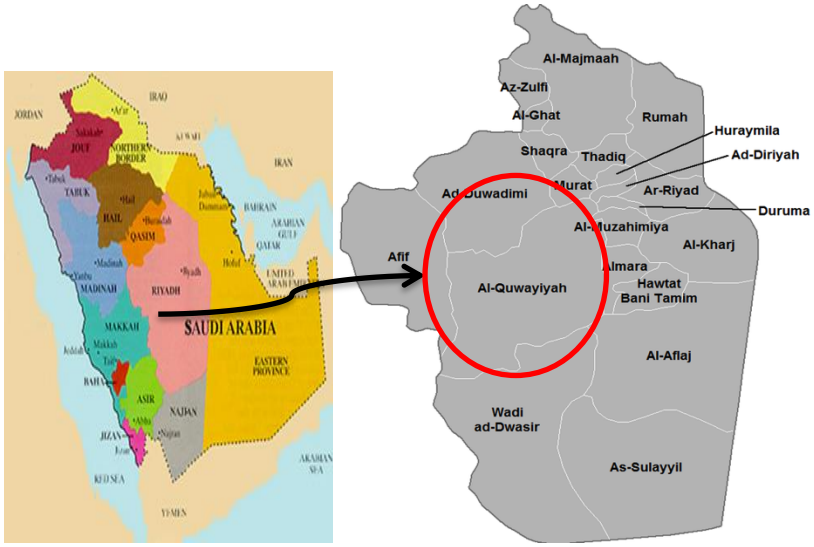


Figure 4.3: Sample region – Riyadh – Al-Quwayiyah (Riyadh Principalty, 2011).

4.7.2 The Study Sample Techniques

Sampling means that a subset of individuals can be selected so that a representation can be made about the population (Cohen et al., 2007). However, sampling can only be relied on if the sample is chosen carefully using the appropriate procedure to the type of research and conclusions to be made. Cohen et al. (2007) draw attention to such problems, and their suggestion that sampling decisions, such as how the population will be selected and how large it will be, must be considered in the early stages of the research plan.

In social research two main sampling methods exist; probability sampling, also termed random sampling, and non-probability sampling, termed purposive sampling (Cohen et al., 2007). The aim of the study should inform which type of sampling should be applied. Random sampling is applied to cases where the objective is to generalise the findings from a population (Onwuegbuzie and Leech, 2007), however this is not the case in this study as the objective is to obtain insight into a phenomenon, individual and events with a focus on the evaluation of CPD programmes. Purposive sampling, as opposed to random sampling, means that the respondents were selected so that the research had an equal number of teachers from different backgrounds. For this reason, this study employs a multistage purposive sample, which is detailed below.

4.7.2.1 **Multi Stage Purposive Sampling**

The technique used in this study is multistage purposive sampling, which is identified by Onwuegbuzie and Leech (2007) as a technique that involves the selection of samples in two or more stages. The two techniques used in this study are criterion sampling and random purposeful sampling.

- **Criterion Sampling Method**

The criterion sampling approach is purposeful sampling, which may be used to select samples that meet the intended criteria, and it is typically integrated for the purpose of quality assurance (Sandelowski, 2000). The criterion sampling method was used in this study due to the fact that it was necessary to select the respondents for their purpose and background, while random purposeful sampling was applied to the initially selected samples to divide them into two similar groups (online and f2f).

Based on the aims of the study, the criteria for choosing the sample were identified. Firstly, the teachers had to be specifically specialist science primary teachers, teaching upper level (equivalent to the UK's School Years 4, 5 and 6), with students aged 9, 10 and 11 respectively. Also, selection was made among teachers who held university degrees, and also did *not* have any formal training in the use of the 5Es instructional model. In addition, only male teachers were selected in this study due to the cultural values of Saudi Arabia that prohibit the mixing of different sexes in education (discussed in Chapter 1). The idea of collecting data from female teachers, using a female research assistant, was discarded to avoid any differences in the methods of collecting data that could occur if a second person was involved. Also the selection of the sample had to be from a combination of rural and urban schools in Saudi Arabia. This is because teachers from these different types of schools will have different views and needs with regard to what the CPD programme has to provide them. For example, online CPD may be more suitable for teachers in rural areas due to transport and travelling considerations. Therefore, it needs to be known whether a particular sub-population finds a particular type of CPD training more useful or effective than another. Teachers with varying degrees of teaching experience were chosen to ensure an equal spread of teaching experience across both groups (online and f2f). The amount of teaching experience of the participating teachers varied from one year to more than 15 years. The majority of teachers that participated in this study had a relatively little

experience in teaching, between one and five years, and were expected to be more enthusiastic in the training, as teachers with more experience are less likely to be willing to undergo a training programme (Jensen et al., 2012). Therefore, after obtaining the permission from the Ministry of Education, the Head of the Administration of science teachers department was met by the researcher and a request was made for the science teachers' database in Al-Quwayiyah province, where the research would be conducted. All required information about the teachers and their timetables were provided in order to select the appropriate area and teachers that meet the research criteria.

Within the region of Al-Quwayiyah, there are a total of approximately 200 teachers that meet the criteria required to be part of the study. However, Al-Quwayiyah is exceedingly large with the schools distant from each other, thus making it impossible to cover all the schools with the limited time and resources which were available for the research, especially as it requires the use of a number of mixed methods, each with a considerable level and depth of analysis. Financial impact also had to be put into consideration while selecting the sample population. Therefore, it was decided to select a sample of 20 teachers from a combination of large and small schools with 10 of the teachers being from rural schools and 10 from urban schools. This sample aligns with previous studies which carry out similar small scale comparative studies of participants using mixed methods (Campbell et al., 2008; Harlen and Doubler, 2004; Hawkes and Good, 2000).

A constructive consultation with the head of science teachers' and the science educational supervisor at Al-Quwayiyah was held to assist with selection of the schools for the study, from a combination of both the rural and the urban setting, as well as the teaching experience. This was aided using the map of Al-Quwayiyah (showing schools within the region) to identify and select appropriate schools from which a teacher was picked for the study (Table 4.8).

Table 4.8: Study Sample

No of Year experience	Rural	Urban	Total
1-5 years	4	4	8
6-10 years	2	2	4
11-15 years	2	2	4
16 + years	2	2	4
Total	10	10	20

Subsequently, contact was made with all of the twenty schools with a list of selected teachers, explaining the purpose of the study, the nature of the programmes, the time that would be taken and the process of investigation (i.e. observations and interview). Three weeks later, all of the schools contacted had welcomed the visit and replied by email with all of the required information, including their timetables which were provided in order to arrange a timetable for the visits.

Informed consent forms (see Appendix 17) were then sent to the twenty teachers with the request for them to read the forms carefully and make a decision as to whether or not they would like to participate in the research. Two weeks later, all of the informed consent forms had been signed by the teachers to confirm that they would be glad to participate.

- **Random Purposeful Sampling**

Random purposeful sampling basically works by selecting cases at random from a sample frame made up of purposively selected samples (Onwuegbuzie and Leech, 2007). The advantage of the approach lies in its ability to add validity to a sample, particularly when a purposeful sample would be too large (Miles and Huberman, 1994). Subsequent to the criterion sampling stage, the random purposeful sampling method was applied to the existing samples to divide them into two groups, i.e. the f2f and the online CPD programmes, whilst still giving every sample in the population the same probability of

selection for the study. The overall idea of the two groups (rural and urban) is to ensure representativeness of the sample and therefore the study as different types of school settings may have different needs or views about what CPD programmes offer, and in order to allow a comparison with regard to the effectiveness of CPD amongst these two settings.

From the criterion-selected sample (Table 4.8), a sub group was populated for urban and rural settings. These samples were then numbered and randomly selected using an online randomizer (website: www.randomizer.org/form.htm) to aid the classification into f2f and online CPD groups (see Table 4.9).

Table 4.9: Sample distribution

Teaching experience	No of teachers	(Control group) F2F CPD programme		(Experimental group) Online CPD programme	
		Rural	Urban	Rural	Urban
1-5 years	8	2	2	2	2
6-10 years	4	1	1	1	1
11-15 years	4	1	1	1	1
16 + years	4	1	1	1	1
Total	20	5	5	5	5

4.8 Quality and Trustworthiness of the Study

Epistemological issues in research studies, such as the validity, the dependability and the transferability of the study, are key principles embedded in cultural and historical realities with the intended aim of establishing their possible usage and interpretation (Tashakkori and Teddlie, 2008). These three principles are essential and it is recommended that they should be discussed according to the research approach integrated in any study (Teddlie and Tashakkori, 2009). Thus, the researcher and the participants are solely responsible for building these principles in the different research phases; data collection, analysis and interpretation.

Depending on the research approach integrated in a study, quality and trustworthiness may be evaluated using different approaches. This study on the other hand employs a mixed methods approach and thus it is essential to carry out an effective quality check on the research method. Accordingly, Grafton et al. (2011) suggest that the quality of mixed methods research can be evaluated in light of three perspectives; the individual validity and reliability of respective approaches, an integrated framework proposed by Teddlie and Tashakkori (2003) and Tashakkori and Teddlie (2008) and via a legitimation framework introduced by (Onwuegbuzie and Johnson, 2006). As a result of the wide range of potential threats to the study's validity and reliability, the integrated framework was adopted for this study as it appears useful in bridging qualitative and quantitative concepts (and paradigms) and, therefore, the subsequent discussion on epistemological issues will be centred on inference quality and inference transferability.

4.8.1 Inference Quality

Inference quality, also known as internal validity and credibility, is related to the extent to which research findings may be reproduced by other researchers presented with the same data or data obtained in in a comparable context. In addition, inference quality also measures the degree and extent of reliability to which the researcher measures what needs to be measured and can be sub-classified into design quality and interpretive rigour (Tashakkori and Teddlie, 2008; Teddlie and Tashakkori, 2003). In order to enhance the design quality, its suitability, adequacy and analysis needed to be considered in this study and so a combination of approaches suggested by (Merriam, 1998) was integrated.

Since the triangulation of methods can been considered to be useful in improving the reliability of data and validity to research (Dunne et al., 2005; Lillis, 2006), this study began with triangulation using multiple strategies in a way that uses the strengths of the different methods and approaches, whilst avoiding overlapping weaknesses as the use of a single approach may be questionable and weak. Thus questionnaires, interviews and observations were integrated as being appropriate (detailed in section 4.6) for the purposes of the study to collect the data needed to evaluate the respective Guskey's levels, for example satisfaction, learning, practice, etc.

Member checks were also carried out in this study to ensure the validity and credibility of the data for use in this study. This began with the validation of contents of the CPD programme by expert trainers of Ministry of Education to avoid any potential misinterpretation. Also, participants were required to agree that the information provided were true and reflected what they believed, therefore the transcript interview data samples were selected at random and sent by email to the respective teachers alongside the digital recordings for reviewing. They were also required to provide accuracy (in percentage) and additional feedback as this guarantees the plausibility and truthfulness of the provided and transcribed data. Overall, all feedback was excellent and positive.

To enhance the inference quality, peer examination at different stages of the research process was applied to the study design. For example, after the questionnaire was developed (in Arabic), and prior to piloting, two CPD programme specialists in Saudi Arabia were consulted who provided useful comments and suggestions. A specialist in translation helped to validate translations of the questionnaires into English. Peers, who included supervisors, were also used to validate the interview questions and respective transcription (section 4.6.2.3). In addition, extensive engagements and thorough discussions in regard to the research data with peers and senior colleagues at conferences, seminars and anonymous CPD programme specialists enhanced the credibility of this study (Lincoln and Guba, 1985).

Pilot tests of the instruments was also carried out to increase the validity of the study by involving participants with similar interests to the participants of the main study (section 4.6.2.1). Piloting instruments helped in improving both the questions and the methods of inquiry. This in particular was aimed at determining instrument reliability

and simultaneously helped the researcher to be more familiar with the procedures, including data collection and the length of time it would take to collect the data, as well as hands-on experience with the digital recorder and exploration of a conducive environment to carry out the research. In addition, practicing the FIAC system on the three 5Es instructional model expert video lessons available on YouTube through an extensive period of proper training (section 4.6.3.1) increased the reliability of the data (Lambert et al., 1965).

Furthermore, it is a known fact that every researcher has his/her own opinion, values, beliefs and worldviews (Zohrabi, 2013). Nevertheless, it is required that a researcher collects, analyses and interprets data without any form of bias. In light of this, the researcher has minimised every possible bias by integrating necessary approaches, for example by randomly selecting a sample from a purposely-selected population, adopting structured instruments and implementing an adequate statistical analysis method to enhance the study's accuracy and avoid biased interpretations. Lastly, this study was carried out objectively and ethically as explained in section 4.9.

4.8.2 Inference Transferability

Inference transferability, which can also be referred to as the external validity (in qualitative research), mainly asks questions about the generalizability or transferability of the study (Campbell et al., 1963). In other words, it assesses how applicable the findings are in other settings or fields of study. Examples of this are: population transferability, which relates to other individuals or groups; ecological transferability, which relates to other contexts and settings; temporal transferability, which relates to other time periods; and operational transferability, which are modes of measuring behaviours (Grafton et al., 2011).

Hence, for this research, the selected sample of the study (Science teachers in Al-Quwayiyah) is a representative sample of Saudi Arabia because Al-Quwayiyah typifies the socio-cultural values and structures that prevail in many areas in Saudi Arabia (see section 4.7.1) and the Saudi education system is centralised so that all Saudi schools follow the same national curriculum and teach using the same system. Also, all Science teachers in Saudi Arabia graduate from Teacher Colleges with the same courses and training. Moreover, even after graduation, teachers have the same in-service programmes, meaning that they often have similar styles of teaching (Ministry of

Education, 2009). It is hoped that the findings obtained from the selected sample is likely to be found amongst other schools in Saudi Arabia. Likewise, the outcomes and implications of the study would help to contribute to debates about the advantages of integrating online CPD programmes to enhance Saudi Arabia teachers' pedagogical practice.

4.9 Ethical Considerations

It is essential for any research that deals with people to be conducted in an ethically responsible manner (Robson, 2003). May (2011) stresses that research that neglects ethical issues could potentially harm both the participants and the researcher(s). Therefore, any research needs to be guided by ethical protocols as a preventative measure. The ethical issues that need to be considered include permission, the purpose of the study, how and which results are to be kept and the anonymity and confidently of the participants.

In this study, the data were gathered and conducted in a manner that complies with the ethical guidelines of the University of York and the British Educational Research Association (BERA). The ethical issues audit form was discussed, reviewed carefully with the supervisor and completed and signed by both the supervisor and the researcher's Thesis Advisory Panel (TAP) member (see Appendix 15).

In Saudi Arabian schools, a researcher must obtain permission from the Ministry of Education before they are able to embark on their research. This could be a bureaucratic and time-consuming process. After obtaining the approval from the Ministry of Education to conduct the research (see Appendix 16), contact was made with the head of the National Science Department and the Science Educational Supervisor in order to arrange for the selection of schools and those teachers who would be asked to participate in the research. Teachers' details (email addresses, phones numbers and school names) were obtained by the head of science teachers' supervisor. After this, consent letters were sent out to the teachers for their permission to visit their classes and collect the data (see Appendix 17).

It was stressed to the teachers that their participation in the study would be voluntary, and that every teacher could withdraw at any time and without any consequences. The teachers were also assured that any data collected would be used solely for the purpose

of the research and that their names would be kept anonymous. For anonymity, teachers were each given a letter and a number to be used to record the results. This was done by numbering the teachers involved in the online CPD programme using the letter O and a number, for example O_1, O_2, O_3 etc.. Participants involved in the f2f CPD programme were named similarly, using the letter F., for example, F1, F2, F3 et c.. It was also made clear that at the end of the study all data would be destroyed.

Assurance was also given that the researcher would not disrupt the lesson or make contact with the children. Consent forms were then signed by the teachers. In addition, the school's head teacher was contacted for access to the school and was assured by the researcher that any disruption to the school would be avoided or kept to an absolute minimum.

4.10 Summary of the Chapter

This chapter has detailed the methods which have been employed to ensure the successful completion of the proposed study with a brief insight into the selected pragmatic approach to achieve the research objectives. It has also provided details of the scope to which research has operated and justifies the selection of a mixed methods research design over other traditional methods (qualitative and quantitative). Furthermore, evidence that the selected sample population is representative has also been documented alongside an account of all of the research procedures, the CPD programme procedure and the content and data collection approaches which the study has embraced. Finally, the epistemological issues surrounding the study's quality and trustworthiness has been identified and implemented to achieve a quality piece of research, whilst putting ethical consideration at the core of the research methods.

The subsequent chapter will therefore detail the obtained results from the study and allow for a discussion to take place about the practicality of the carried out research.

Chapter 5. Analysis and Discussion of the Study Findings

5.1 Introduction

This chapter is concerned with the analysis of and discussion about the findings of the study. Results of the evaluation of the impact of both the online and f2f CPD programmes on teachers' satisfaction, learning, school support and the level of change in the school and the teacher's classroom practice, all of which relate to Guskey levels 1-4, are presented and discussed.

As discussed in the methodology chapter, 'Student Learning' (Guskey's level 5) is not the focus of this study, however the data gathered through this level is included as it can be beneficial in demonstrating the overall impact of the CPD programmes.

Section 5.2 comprises an analysis and discussion of Guskey's level 1 (teachers' satisfaction). Under this section the satisfaction towards both the on-line and f2f CPD programmes' content, procedure and context are analysed and discussed in detail. Section 5.3 is concerned with the analysis and discussion of qualitative findings of Guskey's level 2 (teachers' learning), which are gathered in the form of interviews. Section 5.4 contains an analysis and discussion the impact of the CPD programmes on the organisation change and the support that teachers gained as a result of participation in the programmes (Guskey's level 3). Section 5.5 analyses and discuss Guskey's level 4 (change in teacher practice). In this section, observations of the teachers' performance are analysed using the FIAC system (Flanders, 1966) and discussed, followed by a discussion of the interview findings. Finally, section 5.6 reports the impact of the programmes on students' learning as reported by the teachers.

5.2 Teachers' Satisfaction Towards both the Online and the f2f CPD Programmes

This section analyses and discusses the findings relating to teachers' satisfaction (Guskey's level 1) towards both CPD programmes, which is concerned with research question 1 of this study:

RQ1: What are the perceptions of primary science teachers towards f2f and online CPD programmes?

The study has investigated the perceived level of satisfaction of primary school science teachers (related to Guskey's level 1) towards three key aspects of both of the CPD programmes, namely content, procedures and context, when they were delivered. This was achieved by distributing a questionnaire at the end of the programme to the f2f group members and asking the online group members to complete the same questionnaire which they were provided online. The level of teacher satisfaction was assessed in terms of the mean values of teachers' responses collected using a five point Likert scale. Cronbach's Alpha co-efficients were calculated using SPSS to demonstrate the internal consistency reliability of the scale in relation to the sample of this study. The results of this test show that the Alpha values, for both the f2f CPD programme (0.89) and online CPD programme (0.77) are above 0.7, which is considered acceptable in social sciences (George and Mallery, 2003).

In order to compare the difference between the mean satisfaction levels of teachers in both groups, an independent sample t-test was carried out for content, procedures and context of the programmes separately. Owing to the small sample size, one of the basic conditions – normality - for t-test is not met and in order to overcome this potential weakness a Mann-Whitney U test, which is a nonparametric version of the independent sample t-test, has also been calculated. However, as the interpretation of the results of the Mann-Whitney U test (see

Appendix 18, Appendix 19, and Appendix 20) is exactly the same as the t-test results, only the findings of the t-test are discussed below.

Pallant (2011) claims that it is common practice in social sciences to consider 0.05 as a cut-off point for p-value for making decisions regarding whether the result of a test is statistically significant or not. It is also suggested that if the calculated p-value is less than, or equal to, the cut-off point, then the corresponding results should be considered statistically significant (Pallant, 2011). In this study, all decisions about the significance of the reported test results were made by adopting these guidelines. In order to know the magnitude of the differences between two groups, the effect size was also calculated. The effect size statistic used in this study was eta-squared which according to Cohen (1988) is one of the most commonly utilized in social science to assess the importance of the findings and can range from 0.01=small, 0.06=moderate and 0.14= large.

At the end of the questionnaire, two open-ended questions were also given to allow teachers to express additional information - if they had any - regarding their perceptions toward CPD programmes. More specifically, the teachers were asked to add what they found most interesting in the CPD programme and if they had any more information they wanted to add. The f2f CPD programme participants filled in their answers on the questionnaire sheets whilst the online participants typed their replies in the online questionnaires. These questions were optional (as a similar type of question was asked at the end of the interviews) and some teachers did not provide answers, but it is useful to comment on the general themes that appeared in the answers of those who did reply. The most recurrent themes when observing the replies to both questions from both sets of teachers were interest in the 5Es instructional model, the concerns towards the f2f programme versus the flexibility of the online programme with regards to time, and the discussion element of the programme. Quotes from the teachers' replies to these questions are integrated into the discussion to support the arguments.

5.2.1 Satisfaction Towards Content

Eight items were included in the questionnaire to assess the teachers' perceptions towards the content of both the CPD programmes. Table 5.1 presents mean values and t-test statistics of each item for both programmes separately.

Table 5.1: T-test comparisons between mean values of perceived levels of satisfaction of the online and f2f groups of science teachers about the CPD programme's content

Statements	Online group (N=10)		F2f CPD group (N=10)		Mean Diff.	F*	t-value	df	p. (2-tailed)	Effect size (eta^2)
	Mean	SD	Mean	SD						
1) The programme was generally useful.	4.80	0.40	3.50	1.00	1.30	7.75	-3.88	18	0.001**	0.50
2) The aims of the programme were fully met.	4.00	0.80	2.90	1.00	1.10	1.14	-2.70	18	0.015**	0.30
3) The aims of the programme were appropriate to my needs.	4.00	1.20	3.50	1.00	0.50	0.00	-1.05	18	0.309	0.10
4) The programme in general was clear and easy to understand.	4.70	0.50	2.90	0.90	1.80	3.95	-5.69	18	0.001**	0.60
5) All topics were covered in sufficient detail.	4.70	0.50	2.70	1.10	2.00	8.88	-5.43	18	0.001**	0.60
6) The content was arranged in a clear, logical manner.	4.60	0.70	3.40	1.10	1.20	1.53	-2.96	18	0.008**	0.30
7) The programme contained activities that helped me understand the 5Es model.	4.40	1.00	3.20	1.20	1.20	1.04	-2.43	18	0.026**	0.20
8) The content was relevant to the 5Es instructional model.	4.80	0.40	4.10	0.60	0.70	0.07	-3.13	18	0.006**	0.40
Overall level of satisfaction towards the CPD programme's content	4.50	0.50	3.30	0.60	1.20	0.36	-5.04	18	0.001**	0.60
*Equal variances assumed ** p-value < 0.05										

Table 5.1 shows that the mean score of the online CPD programme group for each item is equal to, or greater than, 4.00 which suggests that the sample was at least highly satisfied with respect to the content of the online CPD programme. However, in the case of f2f CPD programme group, the mean score ranged from as low as 2.70 to a high of 4.10, which suggests that the respondents were less satisfied with many of the measured

aspects of the f2f CPD programme. The difference in the mean scores of both groups, reported in Table 5.1 indicates that the mean scores of the online CPD programme, in terms of each of the eight items, are numerically greater than those of the f2f CPD programme. The results of an independent sample t-test indicate the p-values of all items (except item 3) were less than 0.05 (cut-off point), which indicates that the mean values of the online CPD programme were significantly greater than that of f2f CPD programme for these items. The value of the effect size (eta squared) of each item was greater than 0.14, which indicates, using (Cohen, 1988) in which 0.01=small; 0.06=moderate and 0.14=large, that the observed effect was large. It should be noted that this result is clearly significant, despite the small sample size, because the results show that the significant differences go cross most *if not all* of the questionnaire items, and because of the effect size results (0.14), which the work focuses on, confirm this.

The p-value of item 3 is greater than the 0.05 cut-off point, which implies that there is no significant difference between the mean scores of both groups with reference to item 3. The results also show that the overall level of satisfaction towards the online CPD programme is significantly higher than that of the f2f CPD programme.

The radar chart (Figure 5.1) also illustrates the level of satisfaction towards the content of both CPD programmes graphically.

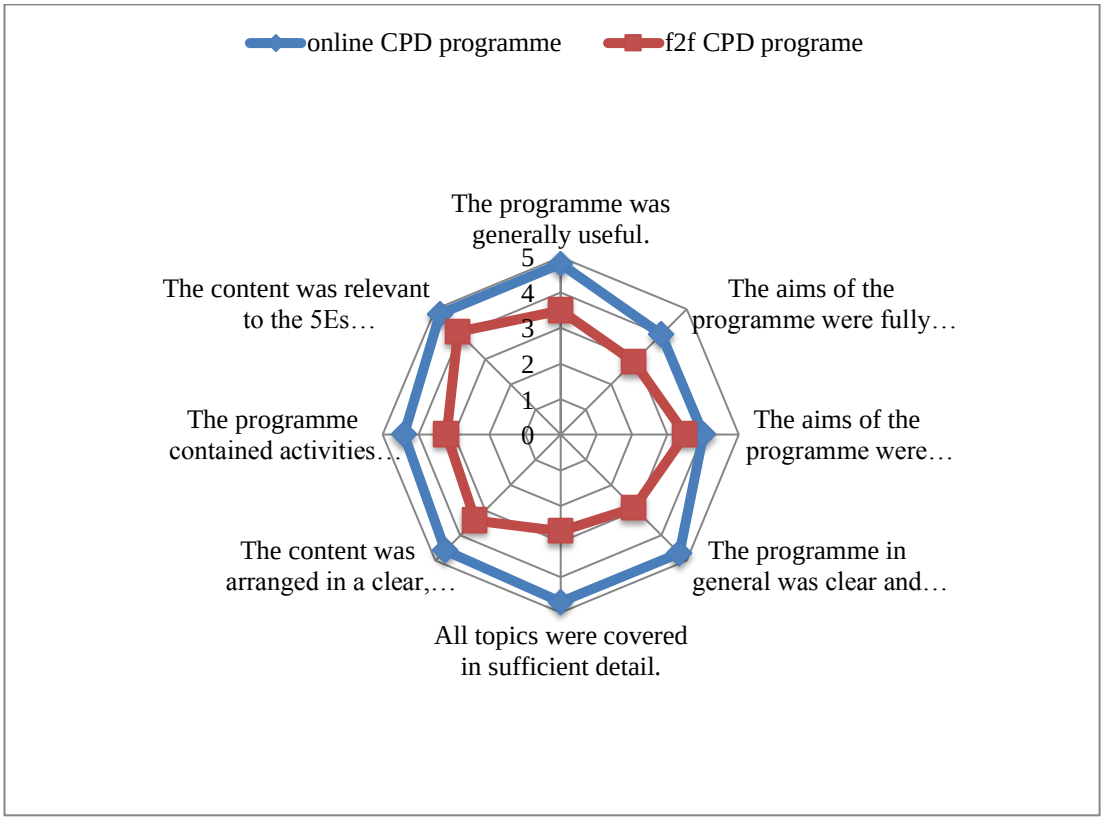


Figure 5.1: Overall level of satisfaction towards the CPD programme's content

Whilst significant differences emerged in the levels of satisfaction between both groups of teachers, these results must have arisen as a result of the difference in the method of delivery rather than the content of the CPD, which was identical in both programmes. There are arguably two reasons for this difference. Firstly, the instructor of the f2f CPD programme has an important part to play in determining and delivering the content, whereas the online programme has a fixed content on the programme's website. Therefore, instructors differ in their capabilities, experience and background and vary in their levels of competence and confidence (Hobart and Lundberg, 1995; Rosner, 1972). Secondly, the instructor may decide to focus on a certain item in the material (for example brainstorming as an activity), and focus less attention on other items. These individual instructor preferences will differ from one instructor to another and might, therefore, affect the understanding of the teachers, in that points that are not focused on by the instructor might not be fully understood by the teachers. Hustler et al. (2003, p. 88) claim that:

> There are many aspects of CPD programme, which contribute towards a teacher's perception of its usefulness, and it would be impossible to identify the particular part of an activity that most influenced a teacher's rating of its value.

This is especially the case when different activities and elements of the content are given different levels of attention and focus by different instructors. Nemanich et al. (2009) claim that if the learners are happy with the instructor's level of competence, expertise and confidence, then the level of understanding increases also. One feature of the online CPD programme that addresses this issue is standardisation. Having one unified content across all online courses is beneficial in that there are no instructors as such, and hence, levels of competence, expertise and confidence are not so important. Although this assumes that the person who has put the online CPD programme together has done a good job of it and has not, for example, missed out an important part.

The most recurrent themes in the open-ended questions when observing the replies to both questions from both sets of teachers were interest in the 5Es instructional model, the concerns towards the f2f CPD programme versus the flexibility of the online CPD programme with regards to time, and the discussion element of the programmes. Ten of the teachers, five from each group, expressed an interest and admiration in the 5Es instructional model, or some aspect of it. O5 said: "The 5Es model is extremely beneficial and I truly desire its application." Some of the members of the online group, for example, liked the role of the teachers and students in each of the levels of instruction which, to them, was new, interesting and useful information. O3 expressed his admiration in the "roles of the teachers and students in each level." Others mentioned the model's feature of focusing on the students, which there was a very little amount of in the traditional ways of delivering the material. F5 said: "The focus on students and giving them a more active role to play was 'fresh' and new to us." The traditional teaching methods in Saudi Arabia give less focus on students, and the role of the teacher is more of a deliverer of the curriculum, rather than a facilitator of learning (Al-Aklobi, 2008; Alabdelwahab, 2002; Algarfi, 2010). The aspects of engagement and exploration are almost non-existent, especially the active role of the student at these levels, and it is also clear from section 5.3 (interview data analysis) below that these aspects of teaching were new to the science teachers, which is why it raised their interest and provoked their thinking.

The time needed for the instructor to deliver the content in the f2f CPD programme is also narrower than the time available for the online group to read and interact with the material. These factors have an effect on the teachers in regard to their overall satisfaction with the content, as three teachers from the f2f group mentioned in their replies to the open-ended questions that the time given for the duration of the programme was not enough and the content was not fully covered. F10 said: "The time wasn't enough for the instructor to cover the material", and F1 said that they "needed more time to engage with all the material and discuss thoroughly". Thomas (2009) argues that online professional development allows teachers to participate in professional development over a long period of time. Garet et al. (2001) also mention that professional development should be sustained over time:

> The duration of professional development activities is expected to be important in two ways. First, longer activities are more likely to provide an opportunity for in-depth discussion of content, student conceptions and misconceptions, and pedagogical strategies. Second, activities that extend over time are more likely to allow teachers to try out new practices in the classroom and obtain feedback on their teaching (pp. 921-922).

The online material, on the other hand, is fixed and understanding and coverage depends on the learner. This also relates to the second reason, which is to do with the limited time that the instructor has to deliver the material in the f2f CPD programme. The programme itself, as mentioned in the methodology, was delivered in a five-hour course. The instructor effectively had much less than one hour to deliver each of the five different phases of the programme whilst these same phases were covered over five days in the online CPD programme. Delfino and Persico (2007) conducted a 5-year longitudinal case study experimenting with different techniques for teacher professional development and they found that the online approach, being free from time constraints and having a permanent record of the text-based discussions and interactions, favours in-depth discussion about the content and promoted critical thinking. Therefore, in this study, as the results showed, in addition to the comments made by three teachers to the open-ended question, this contributed to a greater satisfaction with the content of the online programme.

5.2.2 CPD Programme Procedure

A group of seven items in the questionnaire measured the respondents' level of satisfaction about the procedures adopted for both CPD programmes.

Table 5.2: T-test comparisons between the mean values of the perceived level of satisfaction of online and f2f teachers regarding the CPD programmes' procedure

Statements	Online CPD group (N=10)		F2f CPD group (N=10)		Mean Diff.	F*	t-value	df	p. (2-tailed)	Effect Size
	Mean	SD	Mean	SD						(eta^2)
9) Explanation of course aims and objectives.	4.70	0.50	4.20	0.90	0.50	1.13	-1.52	18	0.145	0.10
10) Quality of the instruction.	4.10	0.90	3.40	1.20	0.70	2.98	-1.51	18	0.148	0.10
11) Quality of the activities.	4.40	0.50	3.10	1.20	1.30	3.84	-3.15	18	0.006**	0.40
12) Quality of the materials.	4.30	0.90	2.90	1.40	1.40	1.80	-2.66	18	0.016**	0.30
13) The programme time management.	4.20	1.00	3.50	1.40	0.70	1.07	-1.30	18	0.210	0.10
14) Time spent on each topic of the programme.	4.40	1.00	3.20	1.00	1.20	0.23	-2.68	18	0.015**	0.30
15) The instructional process was motivated.	4.40	0.50	3.60	1.00	0.80	2.59	-2.31	18	0.033**	0.20
Overall level of satisfaction towards the CPD programme's procedure.	4.40	0.40	3.40	0.80	1.00	3.40	-3.32	18	0.004**	0.40
*Equal variances assumed ** p-value < 0.05										

The comparison of the mean scores of both groups is presented in Table 5.2. It can be seen that the mean values of online CPD programme for all seven items is, as before, above 4, while those of the f2f CPD programme range from a low of 2.90 to a high of 4.20. Therefore the mean scores of online CPD programme for all seven items are numerically greater than that of f2f CPD programme. The results of the t-test show that these differences are statistically significant with regards items 11, 12, 14 and 15 because their respective p-values are less than the cut-off value (0.05) and that the effect size (eta squared) value is larger (greater than 0.14) (Cohen, 1988). Consequently, the overall satisfaction level of the online CPD programme with the procedures is higher

than that of f2f CPD programme. As with the previous results, the p-value is significant, despite the small sample size, because the significant differences can be found across most of the questionnaire items.

Figure 5.2 (radar chart) illustrates the level of satisfaction towards the procedures of both CPD programmes graphically.

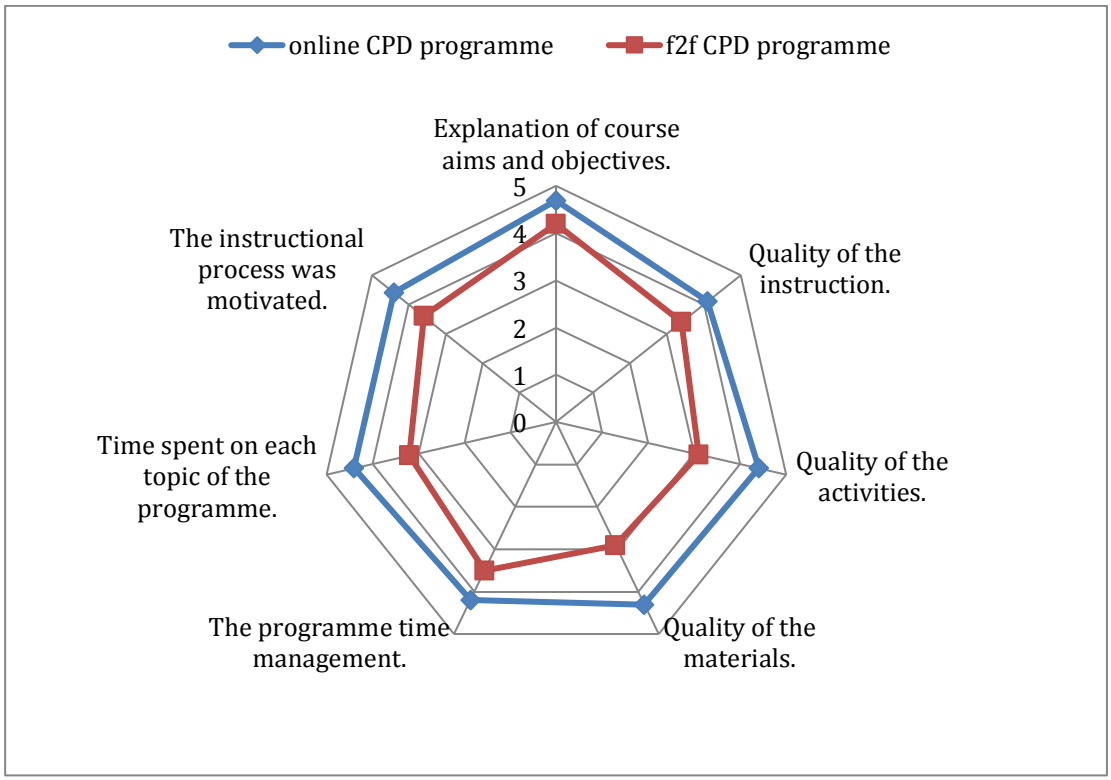


Figure 5.2: Overall level of satisfaction towards the CPD programmes' procedures

The results revealed that the satisfaction with the quality of activities, materials and time spent on each topic were responsible for the main differences in the levels of satisfaction.

A short background on these particular activities would be useful at this juncture. The online participants had a discussion forum on the programme's website where there would be a daily question. The nature of the activity was that every teacher had to reply to the question on the online discussion board and then a discussion would commence between the teachers where they were given the opportunity to reflect on each other's

responses. In the end, the course facilitator, who did not interfere at all during the discussions, then appointed one of the teachers to provide a summary of the discussion. The results suggest that the teachers were satisfied with this activity and some of them mentioned this in their replies in the interviews and open-ended questions. For example O2 said: "I benefitted a lot from the discussion and gained experience", and O4 said: "I really enjoyed the interactivity between the teachers throughout the discussion".

The f2f CPD programme also had such activities included in the course outline and design, but the extent to which these activities was actually implemented is unknown and a lower level of implementation might offer some explanation of the much lower levels of teacher satisfaction compared to the online group. Based on the aims of the f2f CPD programme, the teachers are to be divided into pairs or groups and discuss with each other the question asked. One speaker from the groups would then provide a summary of the discussions and give the collective answer to the question asked. However, the satisfaction results suggest that this method was either not implemented in full by the instructor, or that it was merely not as satisfactory as the discussion board activity on the online course. Russell et al. (2009a) claim that the use of online forms in professional development courses, similar to the one used in this study, offer "several potential advantages over face-to-face instruction" (p. 72). These two mediums differ in that the asynchronous learning environments that are text-based provide conditions that encourage discussion and inquiry:

> Threaded discussion available in online environments differ from face-to-face discussions in that they enable exchanges across time and space, provide a permanent record of interactions, and allow participants more time to reflect on a given topic before responding (Russell et al., 2009a, p. 72).

The features of having more time and space to discuss and respond, in addition to the record being permanent, are not possible in the f2f CPD programme. This is perhaps the point of difference, which led to the teachers of the online course being more satisfied with their quality of activities.

Satisfaction with the quality of materials also differed between the participants of the two groups, despite the fact that all teachers had the same written materials. The f2f CPD group had printed versions of the PDF document which was available online. This point, however, has the biggest difference in satisfaction levels. This was unexpected as

the material is identical, which leads to the assumption that this result must be connected to other factors related to the material, such as the quality of instruction, that is, delivery of the material, and perhaps the time spent on each topic and whether or not the material was fully covered or not. The f2f instructor is constrained by time and his role is different to that of the online programme facilitator. Harlen and Doubler (2004) claim that the regulation of the pace of learning in an online CPD programme is more in the hands of the learner than in an f2f CPD programme. The learner is not as constrained by time as is the instructor, who has limited time to cover the material. The learner has much longer periods of time to ponder the material and reflect upon it in the asynchronous discussions. Online participants reflected upon this in their replies to the open-ended question, as O4 said: "the flexibility with regards to time was really good", and O6 also had a very similar view, saying: "The programme was flexible. We could spend as much time on it as we needed." The quality of instruction is also a relevant factor. In the online course, as Harlen and Doubler (2004) also mention is likely to be the case, real time boundaries did not exist, the discussion continued with the facilitator, if desired, having much more time to read, assess, consider and plan carefully the best way to further the learning process. The f2f programme does not offer this option and the instructor has very little time for mediating learning (Meyer, 2003). This is where the quality of instruction may be affected. The high levels of satisfaction with the quality of activities and material and the time spent on each topic perhaps also led to the high levels of satisfaction with the instructional process (Schiefele, 1991).

5.2.3 CPD Programme Context

Two sets of items were included in the questionnaire to gather teachers' views about the context of CPD programmes. The first set consisted of five items (16, 17, 18, 19 and 20), which were designed to measure the level of satisfaction with the common features of online and f2f CPD programmes. The second set comprised four different items for the online CPD programme (items 21, 22 23, 24) and the f2f CPD programme (items 21a, 22a 23a, 24a) in order to measure the teachers' perceptions of the distinctive features of those CPD programme respectively. As a comparison can be made only between two similar things, the first set of items is used for comparing the level of satisfaction with regard to the context of the CPD programme as these items measure aspects of both programmes that are similar (see Table 5.3). However, the second set of items are used for analysing the views of teachers about the distinctive features of both programmes separately (see Table 5.4).

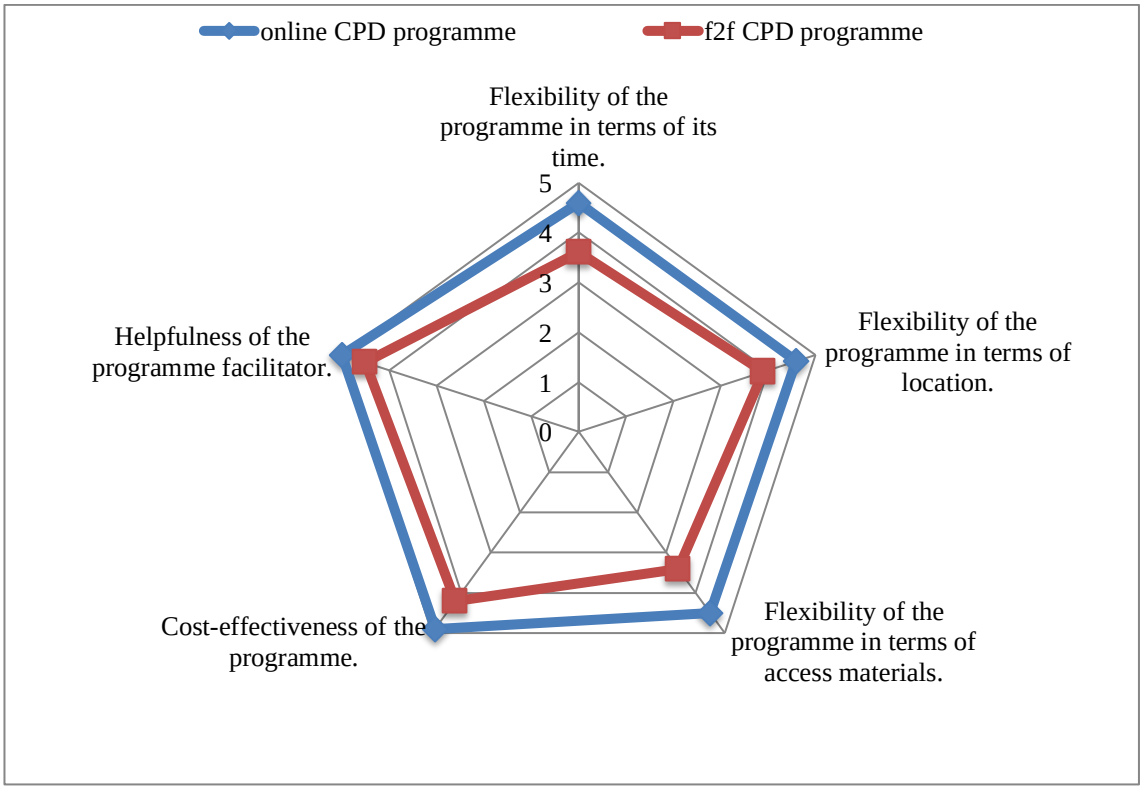
Table 5.3: T-test comparisons between mean values of the perceived levels of satisfaction of science teachers about the CPD programmes' context

Statements	Online CPD group (N=10) Mean	SD	F2f CPD group (N=10) Mean	SD	Mean Diff.	F	t-value	df	p. (2-tailed)	Effect Size (eta^2)
16) Flexibility of the programme in terms of its time.	4.60	0.50	3.60	1.30	1.00	11.44*	-2.31	18	0.039**	0.20
17) Flexibility of the programme in terms of location.	4.60	0.50	3.90	1.60	0.70	13.21*	-1.32	18	0.214	0.10
18) Flexibility of the programme in terms of access materials.	4.50	1.00	3.40	1.10	1.10	00.79	-2.40	18	0.027**	0.20
19) Cost-effectiveness of the programme.	4.90	0.30	4.20	0.90	0.70	04.67	-2.28	18	0.035**	0.20
20) Helpfulness of the programme facilitator.	5.00	0.00	4.50	0.70	0.50	36.00*	-2.23	18	0.052**	0.20
Overall level of satisfaction towards the CPD programme's context.	4.70	0.20	3.90	0.80	0.80	04.20	-2.96	18	0.008**	0.30

* Equal variances not assumed
** p-value ≤ 0.05

Table 5.3 shows the results of t-tests for comparing the mean level of satisfaction of both groups with the common features of the CPD programme's context. The table shows that the mean scores of the f2f CPD group for all of the five items range from

3.40 to 4.50 whilst those of the online CPD programme group range from 4.50 to 5.00 The numerical mean differences of these groups, as presented in Table 5.3, indicate the high level of satisfaction with the online CPD programme in comparison with f2f CPD programme group. The results of the t-test show that these differences are also statistically significant as p-values of all but one of these (item 20) are less than 0.05. The significance of the differences is confirmed by the value of effect size (eta squared) of these items, which, being greater than 0.14, is defined as being high (Cohen, 1988). Figure 5.3 illustrates the level of satisfaction towards the context of both CPD programmes.



1=Very dissatisfied 2=Dissatisfied 3=Unsure 4 =Satisfied 5 =Very satisfied

Figure 5.3: Overall level of satisfaction towards the CPD programme's context

Table 5.4 presents the data of the second set of items which are used for analysing the views of teachers about the distinctive features of both programmes.

Table 5.4: Mean and Median of perceived level of satisfaction of both groups about the distinctive features of the CPD programme's context.

Statements	Mean	SD	Median
Online CPD programme			
21) Interactivity of the website.	4.60	0.50	5.00
22) The environment offers the opportunity for interaction with other virtual students in group discussions.	5.00	0.00	5.00
23) Feeling of involvement with other students in class in an online community.	4.50	0.70	5.00
24) Satisfaction of the online training mode – as compared with face-to-face mode.	4.50	0.50	5.00
Face-to-Face CPD programme			
21a) The temperature of the room	4.10	1.10	4.50
22a) The comfort of the chair	3.20	1.50	4.00
23a) The environment offers opportunity for interaction with your colleague during the discussions	3.90	1.60	5.00
24a) Satisfaction of the face-to-face mode – if compared with an online mode	3.60	1.20	4.00

The data show that the mean and median scores for four items (21, 22, 23, and 24) related to context of online CPD programme vary from 4.50 to 5.00 which shows a high level of satisfaction of the respondents in this regard. As the mean values for the four items (21a, 22a, 23a, and 24a) relating to the context of f2f CPD programme range from 3.20 to 4.10 and the median values of these items lies between 4.00 and 5.00, it can be concluded that the respondents also tend to show satisfaction about the context of f2f CPD programme, although not as high a level of satisfaction as their online group counterparts. The lowest score was towards the comfort of the chairs in the f2f group classroom. The teachers sat like students on wooden desks and felt uncomfortable.

Based on the above results, the three main features with regards to the context of the CPD programme were time, location and cost effectiveness, as indicated by Table 5.3. It has been mentioned (see section 3.3.3 literature review and section 5.3 interview analysis) that both programmes have certain advantages and disadvantages. The

flexibility of the online programme with regard to time and place is important and hence scored a higher satisfaction level that its f2f programme counterpart. Chen et al. (2009) state that the online CPD programme is flexible with regard to time and place and can be accessed anytime and anywhere, as long as there is a computer and an internet connection. In contrast, the teachers who undertook the f2f CPD programme were restricted to attending the course at a specific time and date and subsequently needed to prepare and take measures for their absence from class. Although F10 claimed that he "liked the planning and structure of the programme," he highlighted that he had to plan himself and get "a substitute teacher in order to attend". The fact that the learning is accessible whenever and wherever needed and learners can study at their own pace means that they can fit online study in to their busy job schedule or around their family commitments (Davis, 2007; Sun et al., 2008). It is known in Saudi Arabia that families are large in size (Central Department of Statistics & Information, 2012), and hence there are pressures to ensure that individuals have free family time. The country is also very large, with a big desert, and sometimes a programme participant would have to travel very long distances to attend the CPD programme. Russell et al. (2009a) mention that teachers who live in remote areas can gain access to development courses online, which would otherwise be expensive or impractical to attend in a face-to-face environment.

Another relevant factor that contributes to satisfaction levels and is related to time and location is access to materials. Online materials can be accessed at any time and are ever-present, unlike the paper-based materials that are distributed in the f2f CPD programme. Teacher O8 expressed his admiration for the organisation of the materials and appreciated the fact that the materials were "online and can be accessed whenever needed". Similarly in their responses to the open-ended interview questions, teachers O9 and O10 highlighted the flexibility that the online programme provides in accessing the course itself, as well as comments and feedback from other participants. These findings support previous studies and the common argument of "anytime, anywhere" (Ally, 2004; Govindasamy, 2001)

The cost effectiveness of the programme is also an element that requires consideration. The nature of online programmes means that less time and money is spent on travelling (Chen et al., 2009). From the data gathered in this study, it appears that there is a significant difference between online and f2f in terms of cost effectiveness, thus leaning the study towards agreement with numerous other studies that the online approach may

effectively relieve the hurdles associated with cost (Kimbrough Kidwell et al., 2004; Piskurich, 2006). It is also worthwhile to mention that because of the nature of the economy of today, where a good bargain is essential, the cost of professional development is expected to be affordable to encourage participants or instructors. Therefore, the integration of online techniques for CPD programmes will, no doubt, aid the associated costs.

There are also other cost-effective features of the online programme which have been discussed in section 3.3.3 (literature review), such as lower fee expectancies for online programmes (Kimbrough Kidwell et al., 2004). On the hand, the cost of the development of materials is usually relatively high (Clarke, 2002). The programmes were both free of charge, with the difference being the online group did not require any travel arrangements, whereas the f2f participants needed to make travel arrangements and reserve accommodation, which the funder, in this case the Ministry of Education, had to reimburse. The teachers also had to be paid overtime for their attendance of the programme. This was a source of motivation for the teachers (Ministry of Civil Service, 2010), whereas no such persuasive techniques were needed for the online group. Hustler et al. (2003) argue that financial costs and workload are the most likely reasons for non-participation in traditional f2f CPD programmes, in addition to the fact that, in their study, some teachers:

> Were reluctant to leave their classrooms, either because they felt that supply staff were not of a high enough quality, or they simply felt that their own presence in the classroom was more important (Hustler et al., 2003, p. 147).

Other features of the programme that received mention were the organisation of the programme, independence of the learning and the friendliness of the instructor. Some teachers found that the opportunity for online discussion with peers provided valuable experience.

Overall, the measured satisfaction of the teachers towards the course content, procedure and context of the online CPD programmes was higher than those of the f2f CPD programme. These findings support existing studies that offer encouraging statistics with regard to satisfaction with online courses, as well as the first category of arguments

suggesting the online approach may be used to effectively deliver CPD programmes (Driscoll et al., 2012; Fisher et al., 2010; Fishman et al., 2013). More importantly, this current study correlates with Russell et al. (2009a) who concluded that mathematics teachers who engaged in the online course demonstrated more satisfaction by their willingness to engage in more online courses in the near future, unlike the responses of teachers who participated in f2f CPD programme. Although this study used a small sample, the results compares and aligns with existing studies with varying sample populations, thus, it may be inferred that irrespective of the course content, context and procedure, teachers' satisfaction with the use of online approach surpasses the traditional f2f approach.

On the contrary, the findings in this study contradicts that of Johnson et al. (2000) and Summers et al. (2005) who found that students who participated in f2f courses demonstrated more positive levels of satisfaction about their instructor and course quality. The reasons for the disagreement might be as a result of how their studies were engaged with, as the earlier study provides limited information about the procedure of course delivery, thus suggesting that they may not have used an effective online delivery model, such as Salmon's five stage model for E learning (Salmon, 2012) which was used in this study. Also, contrary to the later study Summers et al. (2005) who used different instructors to deliver courses for both groups in their study, this study embraced the delivery of CPD courses by the same ministry of education personnel. The role of the researcher in the online course was simply to facilitate the process.

5.3 Teachers' Learning in relation to the 5Es Instructional Model

This section analyses and discusses findings relating to Gusky's level 2, which measures the impact of f2f and online CPD programmes on teachers' learning and understanding of the material in the programmes (Guskey, 2002) , which is related to research question 2 of this study, namely:

RQ2: To what extent do f2f and online CPD programmes impact teachers' knowledge and skills in terms of the 5Es instructional model?

To address this research question, the investigation into what teachers learned, in relation to the 5Es instructional model was approached through asking five specific questions in the interviews with the teachers (See section 4.6.2.1 in Methodology chapter). These questions were designed to gain a deeper knowledge and insight into any differences in teachers' understanding of the 5Es instructional model that arose as a consequence of their having undertaken either the f2f or the online CPD programmes. They were asked about what they felt they had learnt from their CPD programmes and what specific learning outcomes they had achieved. Because of the centrality of *explanation* and *exploration* within the 5Es framework, they were asked to explain what instructional strategies of *engagement* they have learnt, what they understood by the term 'explanation', what the teacher's role is at the *explanation* level and, lastly, what the students' role is at the *exploration* level. The next sub sections are organised according to each individual question, presenting a qualitative analysis of the replies of the teachers to that specific question. A comparison between the replies of the f2f CPD programme participants and the online CPD programme participants is made in order to determine the impact of both programmes and the levels of understanding of the 5Es instructional model gained by the participants.

5.3.1 Course Outcomes and Benefits

In order to investigate the extent to which the science teachers learnt from their programmes and what learning outcomes they had achieved, the teachers were asked the following interview question:

Q1: Have you learned something from the programme? If so, what specific outcomes have you achieved from the CPD programme? Please give an example. If not, could you please tell me the reason for your answer?

The question was designed to find out what the teachers had learnt about the 5Es instructional model and what outcomes they had achieved in their teaching, which is in line with Guskey's level 2. They were also asked to give an example for this. Only two teachers covered these points and many others did not. The first finding to emerge from the thematic analysis of the replies – to which all teachers in both groups responded – was that all the teachers mentioned that they had learnt something. However, only two

of the teachers in the f2f CPD programme group gave complete replies to all the elements of the question, such as in the following response:

> Yes, I benefited. I learned about constructivism theory and how to use it in class. I also learned that the student should try to get information by himself and that I should encourage him by hinting only and that I should have a smooth start and then go deeper in the lesson. For example, in a lesson on movement, I moved from one place to another and asked the students "Who can tell what I just did?" One student answered "you walked". I asked them whether there was another meaning. They tried until they understood the meaning of movement. I then moved on to talk about speed and place. (F2)

All of the other participants failed to give an example of how they applied their learning in class and what they did. Table 5.5 shows a summary gained from thematic analysis of the teacher's replies to the above question.

Table 5.5: Q1 response analysis of f2f and online CPD programme participants

Participant		What teachers claimed to have learnt
F2f CPD programme	F1	5Es instructional model, engagement level, exploration level
	F2	Constructivism theory, exploration level, explanation level
	F3	5Es instructional model
	F4	(Limited understanding)
	F5	5Es instructional model with limited understanding and unanswered questions
	F6	Constructivism theory
	F7	5Es instructional model
	F8	Explanation level, class organisation
Online CPD programme	O1	5Es instructional model
	O2	5Es instructional model
	O3	5Es instructional model, constructivism theory
	O4	Exploration
	O5	5Es instructional model
	O6	Exploration level
	O7	Engagement level, evaluation level
	O8	5Es instructional model
	O9	5Es instructional model
	O10	5Es instructional model

What can be seen in Table 5.5 is a slight favouring among those who have had the online CPD programme to mention the 5Es instructional model specifically by name,

whereas in the f2f group some people mentioned it but this did not appear as widespread. However, the mere mention of 5Es instructional model by name in the replies of the teachers does prove that they understood the programme. Their affirmative responses to the question are exemplified in the following:

> Yes, I have learned about active learning and about the 5Es instructional model, which is new to me and constitutes five levels and aims at active learning and that the student explores the information by himself and the teacher's role is to guide the student properly. (F7).
>
> Of course, I learned everything about the 5Es model and its five stages, engagement, exploration, explanation, evaluation, elaboration and its application from the website on the Internet. (O2).

The teachers' quotes reveal that they have learnt about the 5Es instructional model, implying that it is new to them and different from the teaching methods they used previously. None of the teachers mentioned at any point in the interviews and questionnaires that they had come across this model prior to the CPD programme. The data sample, as mentioned in the methodology, was specifically identified to be teachers that had no prior experience with the 5Es instructional model and this is evident in their replies.

An interesting element that was observed in the responses was that teachers from each group (O4, O6, F1, and F2) specifically mentioned *exploration* and reported, in their understanding, that exploration was the outstanding feature of the CPD programmes that differentiated it from traditional teaching (Bybee et al., 2006). The fact that students are encouraged to "explore and research" (O6) for themselves is relatively new to these teachers and hence stands out in their reflections of understanding. Teaching in Saudi Arabia follows an approach where the teacher simply delivers the course content and does not engage students and encourage them to be active learners (Al-Aklobi, 2008; Al-Sadaawi, 2007; Alabdelwahab, 2002; Algarfi, 2010). Therefore the two programmes here both had the capacity of delivering new knowledge to the teachers who are, in this situation, themselves learners. These findings are consistent with those of Russell et al. (2009a) who suggest that both programmes show significant impact on teachers' mathematical learning.

However, not all the teachers replied affirmatively, stating that they understood the programme. Teachers F4 and F5 expressed some misunderstanding and/or had unanswered questions at the end of the programme.

> [I benefited] somewhat and learned some new things. I learned some strategies such as using flip charts and dividing students into groups. (F4)
>
> Yes, to some extent. I learned some important points, such as the levels of exploration and investigation, ways of presenting the lesson and evaluation and elaboration levels. But there was some difficulty in understanding the course, besides that there were some questions that had not been clarified in the course. (F5)

Teacher F4's comments, whilst interesting, make no reference to any learning about the 5Es instructional model by name, which is the core of the content of the programme. Teacher F5 is more elaborate in mentioning what he has learnt but mentions he experienced difficulty understanding some of the aspects of the course, and had some questions that were left unanswered. F2F courses, in general, provide the opportunity for immediate feedback and replies to questions can be given straight away with both classmates and the trainer (Vonderwell, 2003; Wang and Woo, 2007). However, the instructor was also constrained by time, which may have been a factor that limited their understanding (Caris et al., 2002). In the open ended question, Teacher F7 expressed that the length of the programme was not enough and suggested:

> I prefer the course duration in the future to be no less than three days so that the teacher could benefit more. Moreover, the course needs practical application. (F7)

Also, in the f2f groups in general and in this study's group in particular, only a relatively small percentage of participants can take part in the group discussions and question and answer sessions with the instructor due to time constraints. However, in online programmes, because of the absence of either the teacher or the trainers' physical presence, many in-person cues to personality are also absent and there is a general feeling of anonymity. Participants who usually feel shy in a face-to-face contexts can

participate and discuss more effectively than would otherwise be the case (Caris et al., 2002). This factor may enrich the discussion among the online participants.

Another factor relating to the f2f instructor himself may be that he did not possess the competence to answer the questions. Every instructor has individual differences and developing countries such as Saudi Arabia still require more qualified instructors who have good experience in training teachers (Mansour et al., 2012). The lack of instructors might also be a reason that affects the Ministry of Education's choice of instructor, some of whom may be not as competent as would be desired. Felder (2004) argues that teachers tend to teach in the same way that they are taught, and this applies not only to the teachers undertaking the professional development, but also the instructors who are delivering it.

Nonetheless, there have been numerous studies (Fisher et al., 2010; Fishman et al., 2013; Johnson et al., 2000; Ross and Bell, 2007; Steinweg et al., 2005) that suggest that there is no significant difference between online and f2f instruction with regard to outcomes. Similarly, as discussed above, the outcomes of this question in the interviews showed that the level of understanding of the teachers in both programmes is similar, with the online CPD programme arguably having a slight advantage and showing marginally better results than the f2f CPD programme.

5.3.2 Strategies to Engage Students

Teachers were asked what instructional strategies they used in class to promote student engagement. This question was designed to reveal aspects about their understanding of the 5Es instructional programmes they attended, whether f2f or online, and what impact this had on their teaching strategies in general and student engagement strategies in particular. Bybee et al. (2006) state that such engagement strategies are "short activities that promote curiosity and elicit prior knowledge" (p. 2). Table 5.6 shows the responses of the teachers and the range of student engagement strategies that were mentioned. The categories in Table 5.6 emerged from an analysis of the quotes and fell into four distinct groups: (i) *brainstorming* as a mental activity that is an engagement strategy. (ii) *Physical activities,* including chart drawing, role-playing, looking at photographs and maps and observing or making experiments. (iii) *Group activities*, which are those activities that specifically need either more than one student, or both the students and

the teacher to perform, such as questions and answers and cooperative learning. (iv) *Investigation* was also mentioned by teachers, and is itself a complex set of activities (National Research Council, 2006) involving more than one activity as an instructional engagement strategy. The way that the different teachers are allocated to the different categories is simply based on the activities that they specifically mention in their replies to Q2 and was determined by analysing their responses to the question.

Table 5.6: Q2 thematic analysis of f2f and online CPD programme participants

	Themes / Teachers	Students' engagement strategies				
		Mental activities	Physical activities	Group activities		Complex activities
		Brainstorming	Photographs, maps, experiments, chart drawing, role play	CL[1]	Q&A[2]	Investigation
F2f CPD programme	F1	X	X	X		
	F2	X	X			X
	F3			X	X	
	F4				X	
	F5				X	
	F6	X	X			
	F7		X		X	X
	F8	X		X	X	X
Total		4	4	3	5	3
Online CPD programme	O1		X	X	X	
	O2				X	
	O3				X	
	O4				X	
	O5					
	O6				X	
	O7		X			
	O8					
	O9					
	O10					X
Total		0	2	1	5	1

1. CL: Cooperative Learning
2. Q&A: Questions and Answers

What can be seen from Table 5.6 is that f2f CPD programme participants provided a much wider range of answers compared to those who undertook the online CPD. Of the f2f CPD programme participants, seven out of eight participants gave more than one example of engagement strategies in their answers. For example, teachers F3, F7 and F8 all mentioned three strategies in their replies:

> It is often a question and an answer [discussion], and sometimes some activities are added to strengthen students' interaction, such as role-play and cooperative learning. (F3)
>
> I use some instructional strategies such as the investigation method, look and think and also maps. (F7)
>
> Firstly through the use of cooperative learning, and secondly brainstorming and mental maps, then through asking questions that draw the students' attention. This helps them in gathering information independently and also cooperatively. (F8)

This can be due to the fact that each of the CPD programmes might have emphasised specific points while not mentioning others. Brainstorming, as a mental activity mentioned only by the f2f group, could have been a focused upon by their instructor whilst it is not specifically mentioned in the online CPD programme content.

In fact, only one teacher who took the online programme mentioned more than one strategy:

> First of all, at the engagement level, a teacher starts his lesson by showing a photo or experiment then he distributes to students into small groups according to their individual differences. Afterwards, he asks some questions to motivate students to discover information through their answers. (O1)

Bybee et al. (2006) mention questions and answers as an engagement activity, which is what is written in the CPD material. This material is in the form of a document in the online CPD programme and also given to the f2f group instructor. Therefore, this explains the recurrence of questions and answers as a particular activity as mentioned by the online group as they have read this in the material. The absence of an instructor in the online group means that focus cannot be given on certain activities such as brainstorming that are not mentioned in the material, whereas a f2f instructor can do this.

> I sometimes ask questions and discuss with the students; I use the practical method by concluding the idea from experiment. (F5)
>
> I depend on asking some question to know what the student has of information before starting new lesson. (O3)

With such a frequency among both f2f and online CPD programme participants, it is evident that engaging students in class through asking questions is the most reportedly practised and most recognised student engagement strategy. As self-reporting might not reflect actual practice, evidence from the lesson observations (discussed in section 5.5.1) also revealed that the amount of questions and answers by both the teachers and the students increased after the programmes had been undertaken, which supports this claim. Russell et al. (2009a) argue that the purpose of manipulating levels of interaction among learners and between learners and the instructor was to "examine whether these design features influenced the intended outcomes of the course" (p.72).

5.3.3 Teachers' Understanding of *Explanation* and their Role at this Level

In order to investigate the extent to which the science teachers understood the level of explanation in the 5Es instructional model through their programmes, and their understanding of the role of the teacher, the teachers were asked the following questions:

Q3. Can you tell me what you understand by 'explanation'?

Q4: Can you please explain what the teacher's role is at the explanation level?

Different answers were given by different teachers, which reflected their understanding of this level within the 5Es instructional model. It seems that not all of the teachers have completely understood the concept of explanation according to the model from the varied answers. A thematic analysis of these replies is provided in Table 5.7.

Four themes emerged from the replies to Q3. Some teachers gave an ideal definition of the explanation level that was in accordance with Bybee et al. (2006) and, in so doing, demonstrated that they had understood the concept. An answer, that covers all the points in the question and reflects understanding, would express the fact that at the explanation level the students are encouraged to explain the information that they have learnt to the teacher and to each other cooperatively (Bybee et al., 2006). The teacher here uses correct responses by students for his explanation of certain concepts, or rectifies wrong

information, and provides the scientific definitions or explanations. Teacher understanding is reflected in their responses:

> For example, in today's lesson on movement I asked the students to read the lesson at the beginning, then I asked them to highlight the odd vocabularies in yellow. After that, I asked them to give their own definitions. Later, we used the illustrative images, and then used reading to rectify these definitions if there were mistakes. We used student definitions if they were correct. (F1)
>
> In my point of view, it [explanation] is considered the most important stage at 5Es. It depends basically on the student himself and his participation with other students. In this stage, the student tries to explain to his colleagues what he has learned from the lesson. Where there were any wrong concepts, the teacher's role is to rectify them. (O2)

Teacher F1 gave the students three tasks to enable them to explore information by themselves and then gave them the opportunity to explain it. Although he did not mention *explanation* specifically, his understanding of this concept is reflected and *implied* in his teaching method. Teacher O2 gave a more direct explanation of his understanding of *explanation,* which is in accordance with Bybee et al. (2006) definition.

Table 5.7: Q3 thematic analysis of f2f and online CPD programme participants.

Themes	Teachers' understanding of explanation based on their replies	Teachers		Type of reply	Examples
		f2f CPD programme	Online CPD programme		
5Es ideal concept of explanation	After exploration, students explain what they know in different ways and the teacher rectifies answers and gives scientific definitions.	F1, F2	O2, O6, O8, O9, O10	Complete answers reflecting understanding of explanation level in 5Es instructional model from the programme.	This stage comes after exploration in which the student tries to link information, corrects wrong concepts and enhances correct concepts with examples. All these depend on student's work in the exploration stage. (O8).
Student dominant	Students explore the material by themselves.	F3, F7	O1	These are incomplete answers where the teachers have started by stating that the student explores the material, but did not continue to talk about the explanation level.	It is the student who explores the information by himself. (F7).
Teacher dominant	Teacher has the dominant role in explaining the subject to students, who are just listeners.	F5, F6, F8	O5, O7	These answers reflect traditional teaching approaches, showing that the teachers have not understood the concept of explanation.	Explanation is to introduce the main idea of the lesson to the student. (F5).
Misunderstanding of the concept	Students engage in activities such as cooperative learning and questions and answers.	F4	O4	These answers merely mention student engagement activities, suggesting that these teachers have misunderstood the concept of explanation.	It relates to the students extracting information by themselves by asking simple questions related to the lesson. (O4).

It can be seen from Table 5.7 that more participants from the online group gave these types of ideal replies that reflected their understanding of the concept. This is perhaps due to the fact that they had a broader opportunity to discuss what they found most interesting in the programme due to the time they had. In the open-ended questions at the end of the questionnaire (discussed in section 5.2) one of the emergent themes was an admiration for the focus on students and the roles of both teacher and student in the different levels. One teacher (O3) expressed his admiration for the "roles of the teachers and students in each level." Whilst another (O5) said: "the focus on students and giving them a more active role to play was 'fresh' and new to us." These were in fact a subject of discussion on the online discussion forum between the teachers, which perhaps explains their higher level of understanding, when compared to the f2f programme participants who had limited time to discuss or reflect upon what they found most interesting in the programme. Wu and Hiltz (2004) state that online discussions play an important part in student learning and that this medium can actually improve students' perceived learning.

The second emergent theme was that some teachers reflected what could arguably be labelled as partial understanding, implying that students were the dominant actors at this level and the teachers' role was minimal, but not continuing to say what the teacher's role was as if they were talking about exploration rather than explanation. Some teachers, namely F3, F7 and O1 said that the student has the main role of exploring information and expressing his ideas. These are incomplete responses in the sense that they said that the first stage of explanation is encouraging students to express their understanding of the material after exploration, but fail to state that then it is the teacher's role to rectify any deficiencies (Bybee et al., 2006). In this case, these responses are classified as incomplete and show a partial understanding of the concept.

The teachers' failure to mention that they should rectify any mistakes made by the students while they are explaining what they have explored or read can be due to the fact that this role is taken for granted. As a teacher, rectifying mistakes is the norm and not something that has to be mentioned, that is, if a student made mistakes in his replies, the teacher would not let those mistakes go un-rectified.

Others indicated, as the third emergent theme, that the explanation level was teacher dominant and students were passive listeners reflecting the traditional approach to

teaching. Three out of eight of the teachers who undertook the f2f CPD programme and two out of eight of undertaking the online CPD programme gave replies that expressed a traditional teaching approach. That is, their understanding of the concept of explanation involved the teacher being a dominant actor, explaining the subject in full to the students who are, at this stage, passive recipients of knowledge and whose role is to concentrate on listening to the teacher. This teaching method is practised in most Saudi Arabian science classes, the teachers of which use 'chalk and talk' methods (Alabdelwahab, 2002; Algarfi, 2010; Ministry of Education, 2009), and this can also be noted by the pre-observation results discussed in section 5.5.1.1. These teachers have evidently not understood the concept of explanation according to the 5Es instructional model. Some examples are:

> It is that the teacher shall explain the information to the student. (F6)
>
> After conveying all the concepts to the students, the teacher shall link them correctly and explain them in scientific language. (O7)

Teachers F6 and O7 here, in addition to F5, F8 and O5, all explained that the teacher has the dominant role which is essentially to explain the lesson to the students who are passive listeners. This may again be due to the fact that they have been taught in this way, and this is how they themselves teach (Sywelem and Witte, 2013). They also may not have had previous CPD programmes that have brought them up-to-date with modern teaching methods.

The online CPD programme again proved its effectiveness here as more teachers from the f2f CPD programme showed this type of misunderstanding.

Completely incorrect responses were given by two participants (F4 and O4) in addition to the fact that O3 gave the reply of "I don't know" to the question. F4 and O4 both started talking about student engagement strategies such as cooperative learning and questions and answers, without mentioning anything directly linked to *explanation*.

> It is to divide students into groups or workshops and create competitions between the groups. (F4).
>
> It relates to the students extracting information by themselves by asking simple questions related to the lesson. (O4).

Overall more teachers from the online CPD programme expressed an understanding of the concept of explanation, whilst six out of eight of the f2f CPD programme participants gave responses that suggested that they have not understood the concept from their programme. The online CPD programme has arguably proved more effective and has had a larger impact in the case of understanding *explanation*.

In addition to being asked about their understanding of the concept of explanation in the 5Es instructional model, the teachers were also asked to express what they thought the specific role of the teacher is at the explanation level. The purpose of this question was to confirm the reliability and coherence of their answers to Q3. An exemplary reply, according to the material in the programme the teachers undertook and to Bybee et al. (2006) model, would mention the following:

- The teacher directs students' attention to specific aspects of the engagement and exploration experiences.
- The teacher asks students to give their explanations.
- The teacher introduces scientific or technological explanations in a direct, explicit and formal manner, rectifying any misconceptions.

The teachers gave several different replies to this questions, reflecting a range of degrees of understanding, showing that they have either completely understood the concept in the programme, completely misunderstood it, or that their understanding lies somewhere in between. Only two of the teachers showed a full degree of understanding and mentioned the fact that the teacher directs attention to the exploration experiences before asking the students to give their explanations and then give the scientific explanations directly and explicitly. Teacher F1 gave this reply to the question:

> The role of the teacher is to direct the attention of the students to the exploration and engagement, and then explain the terms directly in a much clearer way, rectifying any mistakes. (F1)

This exemplary reply was one of four emerging themes with regards to this question, being considered as a reply according to Bybee et al. (2006) definition of the role of the teacher at the explanation level.

The second emerging theme, reflecting partial understanding, was that the teacher is a ‘mistake rectifier’. The majority of the teachers seem to have grasped an understanding of the role of the teacher in rectifying misconceptions, but fail to mention any link to what the students have, or should have, done in the engagement and exploration stages. The words “rectifying incorrect misconceptions” were recurrent throughout the answers of some teachers as shown in Table 5.8.

Table 5.8: Q4 thematic analysis of f2f and online CPD programme participants.

Themes	Teachers' understanding of teacher role at explanation level based on their replies	Teachers		Type of reply	Examples
		f2f CPD programme	Online CPD programme		
Teacher's role according to Bybee et al. (2006)	After exploration, the teacher clarifies, corrects, and defines	F1	O8	Complete answers reflecting understanding of the teacher's role at explanation level in 5Es instructional model from the programme.	The role of the teacher is to link the information to what the students have explored, and then explain the terms directly in a much clearer way, rectifying any mistakes. (F1).
Mistake rectifier	Rectifies misconceptions	F2, F3, F6	O1, O2, O5, O7, O9	These answers are incomplete where the teachers give no reference to exploration.	The teacher has to play the role of instructor who guides students properly to the right information and corrects wrong concepts. (O2).
Director to self-exploration	Directs students to self-exploration	F4, F7	O4, O6, O10	These answers show that the teacher should encourage students to explore the information by themselves, suggesting that these teachers have misunderstood the role of the teacher at explanation level in5Es instructional model.	To direct and guide the student, prepare the appropriate learning environment and tools. (O10).
Deliverer of information	Delivers, explains information directly	F5, F8	O3	These answers suggest that the teacher delivers the information directly to the students reflecting that no reference to 5Es at all (traditional approach).	The teacher's role at this level is essential. The student might have the main role in Engagement, but the role here is for the teacher, since he delivers information directly. (F5).

Some teachers claimed that the role of the teacher at the explanation level is as a 'mistake rectifier'.

> The teacher's role is to give remarks and rectify student's wrong conceptions. (F3)
>
> Rectifies any mistakes, explains any unclear concepts and expresses them in a scientific way. (O9)

These teachers show a partial understanding of the role of the teacher at the explanation stage, according to what they were taught in the CPD programmes. Some of their answers, such as that of F3, are complementary to each other in that F3 said that his understanding of *explanation* started with a reference to the exploration stage, and then went on to claim that the role of the teacher was one of rectifying mistakes.

The third theme was interpreted as a misunderstanding, as some teachers said that the role of the teacher at this stage is one of direction and guidance, without giving much elaboration. Some go further by stating that the teacher directs and/or guides the students to the exploration stage, which shows a clear misunderstanding as the exploration stage precedes the explanation stage, and this does not answer the question appropriately. Examples of such replies are:

> The teacher's role is to direct the student to explore the information by himself. (F7).
>
> It is to guide the student to make him discover information by himself. (O4).

These responses would be correct if they were asked about *exploration*, but are clearly incorrect with regard the role of the teacher at the *explanation* stage.

Three of the teachers, namely F5, F8 and O3 talk about the role of the teacher as being a traditional deliverer of information, implying that the role of the students is one of passive listening only. Again these responses support the claim that science teachers in Saudi Arabia are not actively engaging the students and just act as a deliverer of

information (Al-Aklobi, 2008; Alabdelwahab, 2002; Algarfi, 2010). F5 and F8 both gave similar replies to Q3, while O3 gave the reply of "I don't know" to Q3. A consistency is shown here between the replies to both questions suggesting that their understanding of the concept of the role of the teacher at the *explanation* stage is incomplete and does not contradict Guskey's level 2.

The results based on the replies to Q4 suggest that there is little difference in terms of which CPD programme was undertaken, when considered in terms of the development of an understanding of the role of the teacher at the explanation stage. This strengthens the claim that the online CPD programme can be just as effective (i.e. ineffective) as the f2f CPD programme (Fisher et al., 2010; Fishman et al., 2013; Killion, 2000; Russell et al., 2009a; Russell, 1999) and has, in some areas, been more advantageous.

5.3.4 Teachers' understanding of the Students' Role at the Exploration Level

Students are the more active participants at the level of exploration, while the teacher's role is that of a facilitator and coach (Bybee et al., 2006). The science teachers in this study were asked what they thought the role of the student was at the *exploration* level in order to gather knowledge of their understanding of this level from their programmes. Four main themes emerged from the replies to this question which reflect varying degrees of understanding. The majority of the teachers mentioned that the role of the students at this level was to explore information on their own, which is in line with Bybee's definition: "the students have time in which they can explore objects, events or situations" (Bybee et al., 2006, p. 9). Some took it further by mentioning that students had specific roles, such as making assumptions, recording observations and reaching conclusions on their own, which is also relevant. However, some teachers claimed that the role of the student is weak at this level, reflecting an arguable misunderstanding, while others gave irrelevant answers. The coding of Table 5.9 is based on these four themes, implying these levels of understanding, as it shows the range of responses that the teachers gave.

Table 5.9: Q5 analysis of f2f and online CPD programme participants.

Emerging themes	Teachers	
	f2f CPD programme	Online CPD programme
Self-explorers	F1, F6, F7, F8	O1, O3, O4, O6, O7, O8, O9, O10
Specific roles	F5	O2, O5
Weak role	F4	
Irrelevant answers:		
Teacher's role	F2	
Teacher deliverer	F3	

From Table 5.9 it can be seen that the majority of teachers have picked up on the fact that the role of students at the *exploration* is to explore information by themselves. Although, the students' role, according to Bybee et al. (2006) is more detailed and requires students to "establish relationships, observe patterns, identify variables and question events" (p. 9), the teachers have clearly picked up on the idea that self-exploration is involved and that this is the standout feature of the *exploration* level. Four out of eight of the teachers in the f2f group and eight out of ten within the online group gave replies that reflect this feature, for example:

> The student's role is essential. The student shall do the information exploration by himself and write down such information on a piece of paper and the teacher shall then properly guide and direct the student. (F1)

> This stage depends completely on the student and comes after the engagement stage, in which the teacher gives the student indirect information about the lesson. The student in his turn tries to discover information about the lesson by himself and starts making comparisons, links and assumptions related to the lesson. (O8)

Teachers F1 and O8 exemplify those teachers who have shown that they understand the *exploration* level, as their responses were similar to Bybee et al. (2006). Such replies were the most common amongst all the teachers. This was also evident in the replies to

the open-ended questions as some teachers mentioned that the roles of the students stood out to them in the programme and, for the teachers, this was new and welcomed information.

The second theme, reflecting a degree of partial understanding, emerged from the replies of three teachers (F5, O2 and O5) who gave answers that reflected some understanding of the concept of *exploration* and the role of the student in it, but they failed to fully express their understanding correctly. It is difficult to assume whether they have fully comprehended this part of the programme or not since there is not enough evidence in their replies. These three replies were the following:

> The student's role is essential, as he makes assumptions, ideas or conclusions through a number of questions or work. (F5)
>
> The student's role is to present an assumption, then he tests it and verifies whether this assumption is true or not. For example, upon performing an experiment, he examines the results to know if they were compatible with his assumption or not. (O2)
>
> It is to perform the activity related to the lesson and record observations in participation with his colleagues, then summarise the conclusions that he has reached. (O5)

These replies do not refer directly to exploration as a level, and they may refer to the elaboration level, where students apply their understanding gained through exploration and explanation to practical experiments or other such activities that enable them to extend their knowledge (Madu and Amaechi, 2012). However, they have mentioned concepts such as performing activities and recording observations, which may refer to the exploration experiences, so it is difficult to define whether they have completely understood or not. These replies have therefore been classified as ones of partial understanding, as they have clearly picked up on some of the concepts affiliated with exploration but are not explicit in their replies.

The remaining three teachers, all from the f2f group, gave incorrect or irrelevant replies to the question, as Table 5.9 and the example below show. One such example is:

> Student's role at the exploration level is weak and it differs from a student to another and from an environment to another. (F4).

Teachers in these categories have either misunderstood the question or the relevant part of the programme completely. The fact that these teachers are all from the f2f group implies immediately that the online group participants arguably gathered a better understanding of the role of the student at the exploration level. Of course this is debateable since their replies and the fact that they mention certain exploration related concepts does not necessarily reflect complete understanding, but this research can only base its claims on the findings in the data. This overall infers that the online CPD programme at this particular level was more successful than its f2f counterpart.

To sum up, the teachers gave a wide range of answers to the questions that reflected the impact of the CPD programme at Guskey's level 2 relating to what the teachers learnt from undertaking the CPD programme. Despite the fact that the sample size is small in this study, these results suggest that, in relation to teacher learning, the overall online programme for CPD programme is no less effective than the f2f CPD programme and would in fact be more effective in those areas discussed above. In her survey data results, Kirtman (2009) also encountered replies that expressed no significant difference at the learning level between online courses and in-class courses for students, although a small number of students mentioned the lack of peer discussion in the online course affected their learning slightly, whereas in the online CPD programme in this study, the discussion forum was a highlight and was mentioned favourably by the online group. Delfino and Persico (2007) found that such online discussions promote critical thinking, particularly as they are free from time constraints. Also Cavalluzzo et al. (2005) confirmed that the online professional development programmes have a direct impact on teachers' knowledge.

Overall, this study concurs with the general body of knowledge that online education can be just as good as traditional face-to-face education in terms of learning outcomes (Fisher et al., 2010; Fishman et al., 2013; Johnson et al., 2000; Russell et al., 2009a; Russell, 1999; Tucker, 2001). In addition, the findings obtained from the study particularly identify the possibility of the online approach as being more beneficial than

the traditional f2f for the delivery of CPD programmes. This aligns with studies such as Harlen and Doubler (2004) who also identified the potential impacts of online CPD courses for building science understanding skills and inquiry; and Russell et al. (2009) who established a significant impact on teachers' mathematical understanding and pedagogical beliefs with the use of online approach for delivery for CPD programmes. The findings from this study suggests that despite the mode of data acquisition, which varied between this study and the literature, a similar finding suggesting the effectiveness of the online approach over the traditional f2f may be obtained.

5.4 Organisational Support and Change

This section analyses and discusses the results relating to the impact of CPD programmes on the organisation and the organisational support (Guskey's level 3), and is concerned with research question 3 of this study, namely:

RQ3: To what extent do f2f and online CPD programmes impact on the school and are organisational support structures improved by the programmes from the teachers' perspective?

To address this research question, the science teachers who participated in the CPD programmes were asked three interview questions. These questions were concerned with whether the teachers had spoken to their colleagues about the programme, whether they thought the CPD programme had any effects on the organisational climate or procedures, and what specifically this impact was on the school administration, including the school's head. Finally, they were asked if any organisational policies in the school were in conflict with the programme or activity goals.

The first interview question with regard to organisational support and change was Q6:

'Have you told your colleagues anything about the CPD programme?'

Table 5.10: Summary of teacher responses to interview question 6.

	Teachers	Teacher who mentioned the CPD programme				Teachers who did not mention the CPD programme
		Who mentioned to?		What was mentioned?		
		To head-teacher	To their colleagues	About the programme	About 5Es	
F2f CPD programme	F1	X	X	X	X	
	F2		X	X	X	
	F3	X	X			
	F4		X			
	F5	X				
	F6		X	X	X	
	F7					X
	F8					X
Total		3	5	3	3	2
Online CPD programme	O1					X
	O2		X	X	X	
	O3		X	X		
	O4					X
	O5					X
	O6		X	X		
	O7		X	X	X	
	O8		X	X	X	
	O9	X	X			
	O10	X	X			
Total		2	7	5	3	3

Table 5.10 provides a summary of teachers' responses to Q6. The coding for this table was formulated by observing the replies and coding whether or not they spoke about the programme and whether it was to their colleagues or to the head teacher. The table also presents the analytical themes that occurred when teachers did mention the programme with regard to what they said about it. For instance, whether they merely told a colleague that they were taking a course, or whether they spoke about the 5Es instructional model, which is the content of the course.

As can be seen the results are quite similar. With regards to the f2f CPD programme, more teachers spoke about it to their colleagues than to the head teacher. From the few who did speak to the head teacher, the explanations suggested this was more for administrative reasons, for example:

> I talked to the head teacher only to allow me to attend the programme. (F5)

In some cases a replacement teacher needed to be arranged in order to cover classes in the absence of the participant teacher, resulting in a need to involve the head teacher. In other cases, the teachers needed an approval letter from the head teacher to be able to attend the programme.

In the case of the online CPD programme, the teachers who did involve the head teacher did not do so due to the need for approval, mostly providing no distinction between their mentioning the programme to the head teacher or their colleagues. One teacher did however mention the need to involve the head teacher for further logistical support:

> I asked the head teacher to provide me with some tools that help us in the model's application. He was very responsive and cooperative. (O10)

One teacher gave the head teacher his feedback from the programme:

> I talked to the head teacher several times and informed him that I enjoyed the course and benefited so much. (O9).

The majority of teachers participating in both programmes shared their thoughts with their colleagues about the programme in general, or merely mentioned their participation. Others gave more specific details regarding the content, namely the 5E's instructional model, for example:

> Yes, I told the head teacher and some of my colleagues about the programme and the 5Es instructional model and its effectiveness on students. I gave them an idea about the course. (F1)
>
> Yes, I spoke to my colleague who is an Arabic teacher about the programme and its website. He showed his interest and admiration. (O3)

These quotes show that the programmes, at least as reported by the teachers, also generated interest from the teachers' colleagues who asked questions about the

programme and the possibilities of joining. Much of the interest of the colleagues of teachers who attended the f2f CPD programme can possibly be attributed to the fact that the teachers were absent from the school for a period of time:

> Yes, I talked about the course… to my colleagues at school, as I did not see them during the course. When I was back they asked me if there was anything new, and I told them I attended the 5Es instructional model, which is a new method in teaching. One colleague expressed his wish to see the course contents. (F2)

More of the online participants talked about their experiences in a positive way, as there was no negativity or critical comments in their replies to the question. Another reason behind this enthusiasm from both sides could be that the online delivery format was new to the teachers, state-of-the-art and an attractive alternative to traditional CPD methods (Klein and Ware, 2003), hence proving to be a talking point:

> Yes, I talked to one of my colleagues who is a mathematics teacher. He inquired about the benefits of the programme in general and its website in particular, how we were interacting with it, its contents, and about 5Es itself. He showed his admiration and said to me that it will be better than normal training. Also, he asked about the possibility of participating in this programme. (O2)

It is interesting to observe that the colleagues involved are teachers of varying subjects which is a sign that the teachers felt that this programme was perhaps beneficial and interesting not just for science teachers, but also colleagues of other specialisms. However, it is noted that the responses of those teachers who spoke to other teachers of subjects other than science, were brief in comparison with those who mentioned the programme to other science-teaching colleagues:

> I spoke to the head teacher several times and informed him that I joined the course and benefited so much. Also I talked to mathematics teacher in short. (O9)
>
> Yes, I talked to mathematics teacher and head teacher. I gave them a glimpse about the programme and its importance. I asked the head

> teacher to provide me with some tools that help us in the model's application. He was very responsive and cooperative. (O10)

However, discussions with colleagues with shared specialised knowledge did present teachers with opportunities to elaborate on the programmes content and its application. Teacher O7 spoke to another science teacher about the ways to apply the methods he learnt, specifically to the science lessons:

> Yes, I spoke to one of my colleagues, who is a science teacher, about the ways of applying the programme where I mentioned to him that I participate in a training programme through the internet along with a group of my peers. Each teacher participates with what he knows about 5Es. He showed his admiration and interest in this course. (O7)

Some of the teachers did not comment on or talk about the programme to anyone, and only two of these teachers gave a reason for why they did not. Teacher F7 said, "no, because the programme is short and needs a longer time", and O4 said it was because "the programme came at the end of the year" and he could not, at that point, change his teaching methods that he had been following all year long. These two points are discussed in section 5.5.1.2.

It is clear from the analysis that most teachers did mention the programme to their colleagues with some sharing more specific details with other science teachers. However, the head teacher was only really consulted when the teachers needed approval, support or to give feedback.

The second interview question with regard to organisational support and change was Q7:

> 'Has the CPD programme affected your organizational climate or procedures? What has the impact of the CPD programme been, for example, on the school, administrations, head teacher, duty head teacher etc.)?'

Table 5.11 shows an analysis of the replies. The coding of the table is based on whether the teachers gave a reply of positive impact, some (or weak) impact or no impact.

Table 5.11: Summary of teachers' responses to Q7

Teacher		Yes, positive impact	Some (weak impact)	No impact
F2f CPD programme	F1		X	
	F2			X
	F3			X
	F4		X	
	F5			X
	F6	X		
	F7			X
	F8			X
Total		1	2	5
Online CPD programme	O1			X
	O2		X	
	O3			X
	O4			X
	O5		X	
	O6			X
	O7	X		
	O8			X
	O9			X
	O10			X
Total		1	2	7

It is clear that the vast majority of teachers did not perceive any impact of the CPD programme on the school. The general reason for this, reported by some of the teachers, was because of the fact that they took the programme by themselves and their colleagues did not attend the programmes with them nor did they participate in the programme online:

> Only one teacher out of nine in my school attended the programme so I think its influence is weak. (F1)

> Not too much, since I was the only teacher who attended the course. (F4)

> There wasn't any influence; even the school administration hadn't any idea about the programme. (O3)

Albeit to a lesser degree, teachers from both programmes mentioned that they did not have sufficient time to share their experiences in order for them to have any impact:

> I didn't notice any change because of being busy in school and performing other tasks such as supervision. (O8)
>
> Actually, there is no effect on the school due to the fact that I didn't have time to talk about the course, but I was personally influenced by it. (O1)

The response of teacher F1 can be linked with what Garet et al. (2001) refer to as "collective participation" (p. 922), which refers to professional development in which teachers participate alongside other teachers from their same institution. There are some clear advantages to this approach, as teachers who work together are more likely to have discussions about concepts, skills and problems that arise during the CPD programmes. Secondly, teachers who are colleagues at the same institution are more likely to share common curriculum materials and assessment requirements. Thirdly, as these teachers share the same students, they can discuss the students' needs across classes and grade levels (Garet et al., 2001). This approach also leads to the construction of professional communities of teachers taking the professional development courses (Penuel et al., 2007). CPD programmes may also help sustain changes in practice when focused on a group of teachers from the same school, as some teachers are likely to leave the school over time, and other teachers will join at a later date (Garet et al., 2001). There is evidence from a wide range of studies of schools engaged in such CPD programmes that suggests that the schools that make use of teacher collaboration are the more successful when it comes to promoting implementation (Bryk and Schneider, 2002). The response of teacher F1 suggests that if more teachers had participated from the same school, then a larger impact might be noticeable. The role of the head teacher is also mentioned by F1 as being "encouraging." Loxley et al. (2007) argue that the school head teacher occupies an essential role in promoting and supporting CPD programmes within school change. The responses of teachers O1 and O3 suggest that, because the programme was taken online, no organisational measures were taken, that is, the school administration did not have to take any administrative measures, the only way that the school would know the programme even existed was through the teachers who are participating. One of the main advantages of the online programme is its flexibility, but this also leads to one of its main drawbacks, which is knowledge about

and promotion of the programme. It is important for the school to have knowledge of the CPD programme, not only so it can offer organisational support, but also because CPD programmes are unlikely to have a lasting effect if not all the teachers participate in the CPD programme. These are important factors in securing change as a result, claim Edmonds and Lee (2002). Timperley et al. (2007) also suggest that an effective CPD programme is one that involves the teachers, the students and the organisation.

However only one teachers gave positive replies confirming that the programme did have impact on the school:

> Yes, there was a positive influence. For example when another teacher sees my application of this method and notices students' great interest, he may change his way of teaching. (O7)

It is clear that the perceived impact for these teachers was that the positive effect on the development levels of the students was due to the higher level of interest which was generated by implementing the programme. This positively suggests that the measure of the impact for the teachers lies in student interest or attainment.

It can be deduced from the responses that the reasons why there was no perceived impact on the school related to external factors such as a lack of involvement of other teachers from the same school and a shortage of time. These reasons were the same for both programmes.

Q8: Were there any factors in the school, which conflicted with the programme or activity goals?

In relation to the point above about support from the schools' administrations, the teachers were asked the above question in order to gain knowledge of the existence of any difficulties they had in attending and implementing the programme. Table 5.12 shows a reply of thematic analysis of Q8.

Table 5.12: Summary of teachers' responses to Q8

Teacher		No conflict	Conflicting factors	
			Attendance of the CPD programme	Implementation of 5Es (equipment/seating)
F2f CPD programme	F1		X	
	F2	X		
	F3	X		
	F4	X		
	F5	X		
	F6		X	
	F7	X		
	F8	X		
Total		6	4	
Online CPD programme	O1			X
	O2	X		
	O3	X		
	O4	X		
	O5	X		
	O6			X
	O7			X
	O8	X		
	O9	X		
	O10			X
Total		6		4

All online participants reported that there was no conflict in the attendance of the programme. One feature that was noticed among the replies was that attendance was not an issue, as some of them specifically mentioned that they could take the programme any time and often did so during out-of-school hours.

> There is no conflict between them; I always participate in the programme in the evening after completing scholastic work. (O2).
>
> There is no conflict with school policy as I can attend the programme any time and from anywhere. (O4)

Being online and flexible with regard to time and place (Chen et al., 2009), with no need for physical attendance, leads to the application and attendance of the programme without affecting school policies in any way. In other words, the teachers did not have to leave school or take time off from teaching meaning that they did not need to find a replacement or substitute teacher to attend the programme.

It is perhaps obvious that time and attendance were not issues with the online CPD programme, however there were some difficulties in implementing the 5Es instructional model in particular in relation to teaching resources and time:

> There is no conflict. However unavailability of the required equipment may limit applying it. (O6)

Similarly, teacher O1 reports a shortage in scholastic means and tools, such as a projector or an interactive whiteboard, stating that having twenty hours of teaching a week makes using such equipment limited as generally the whole school has one or two of these, and that teacher would deprive his colleagues of their use in other subjects if he used one of them full time. Teacher O10 also states that there was a conflict as the school's policy was to organise the seating of the students in class in the form of straight rows, whereas the methods of teaching in the 5Es instructional model involve interaction and discussion between students, especially in group activities, and such a seating formation would not be practical (Rosenfield et al., 1985). None of the online CPD programme participants mentioned a conflict with regard to attendance or taking part in the programme.

With regard to the f2f CPD programme most of the teachers in this group answered the question by commenting on the issues they had and preparations they had to make with regards to attending the CPD programme, and what effects that had on school policy. The majority of teachers mentioned no conflicts in either the attendance of or implementation of the programme. However, all of these had support from the administration of the school in arranging cover for the teacher in their absence. School administrations had to be informed and involved in finding replacement teachers to cover the lessons that the science teachers were absent from due to attending the CPD programme. With regard to the support received from the school, some teachers did mention that the administration was cooperative and positive towards the programme, its attendance and its application:

> The head teacher encouraged me and there was no conflict, but there were physical factors that affected my attendance in the course, such as the distance between my residence and the location of the course. (F4)
>
> No, there was no conflict with organisational policies of the school. I coordinated with some colleagues and when I returned I made up for the lessons. The administrator and my colleagues were very cooperative. (F5)
>
> There is no conflict at all and school policy is encouraging for such programmes. Furthermore, the flexibility of the time of course is suitable. (O8)

Contrary to this study, Alhajeri (2004) claims that in Saudi Arabia many head teachers do not support teachers in attending professional development courses because of the difficulties in substituting teachers. Furthermore, in an evaluation study it was found that science and mathematics teachers saw that there was insufficient organisational support for CPD programme (Almazroa et al., 2015).

Alshamrani et al. (2012) identified impediments faced by Saudi science teachers, related to the support from both the ministry and administration levels, when participating in professional development programmes. A heavy teaching schedule, the inconvenient timing of the professional development programme, a lack of awareness because of inadequate advertising, the scarcity of available professional development programmes and limited participation incentives were shown to be the most important of these impediments.

The consequences of a lack of support can be presupposed in the few negative comments found in this level where despite having support, some teachers felt that their attendance was a conflicting factor due to its negative effect on their students' plan of learning and that lost time needed to be made up:

> My colleagues covered my absence for the course and attended my classes. However, my absence affected the progress of the subject plan. (F1)
>
> The problem was that the course took place during school days. My absence from school to attend the course delayed some lessons and affected the implementation of the time action plan. (F6)

This is in line with other studies, which suggest that teacher absence can have a substantial negative impact on student learning (Alhajeri, 2004; Miller et al., 2008). Teachers are, in many cases, unlikely to attend such professional development programmes unless they have the organisational conditions and support to do so (Timperley et al., 2007). It is reported that in Saudi Arabia there is a particular lack of free time, after hours, to pursue CPD programmes, in addition to there being inadequate resources (Alharbi, 2011; Sywelem and Witte, 2013). In contrast, the online programme participants do not need to take such measures as they are able to undertake the programme at home in their own time, without directly affecting their work schedule.

In relation to Guskey's level 3, the perceived impact that both programmes had on the school's climate or procedures was limited. When asked about whether the programme conflicted with any of the schools' organisational policies, the general answer was also in the negative. However, for the f2f group, this was largely due to the measures taken by the schools' administration departments, which coordinated with teachers to provide substitutions, though in some cases this resulted in the teachers' planning to be negatively affected. The participants of the online CPD programme had no such issues with attendance and acknowledged that this was due to the flexibility afforded by this medium. However, unlike the f2f programme participants who focussed on attendance, some teachers in this group highlighted conflicts with the implementation of the 5Es instructional model, focussing primarily on resources.

5.5 Teachers' use of New Knowledge

This section analyses and discusses the results relating to the impact of CPD programmes on teachers' practices (Guskey's level 4). That is, teachers' use of new knowledge which is, in turn, concerned with research question 4 of this study namely:

RQ4: To what extent do f2f and online CPD programmes change science teachers' practice?

To address this research question, the data were gathered through two main methods; classroom observation using the FIAC system and in depth interview questions. Section 5.5.1 discusses the classroom observation findings using Flanders, and under this section (5.5.1.1) pre-CPD programme classroom interactions analysis for each

programme, online (5.5.1.1.1) and f2f (5.5.1.1.2), is discussed and compared (5.5.1.1.3). Section 5.5.1.2 discusses the findings of both online (5.5.1.2.1) and f2f (5.5.1.2.2) post-CPD programmes, which are subsequently compared (5.5.1.2.3). The results of the interviews are analysed and discussed in section 5.5.2. The data from both of these methods are analysed and discussed in the following sections.

5.5.1 Classroom Observation Findings (FIAC System)

Three lessons of each teacher from both the online and f2f groups were observed before and after the CPD programme by using FIAC system. As discussed earlier in the methodology chapter (see section 4.6.3.1), the observations were recorded and an interaction matrix was constructed to calculate the time spent on the different categories: Teacher Talk, Student Talk and Silence. Owing to variation in the total observation time for each teacher, the raw calculated scores for each teacher were converted into a standardised score for a total of 135 minutes. The raw and standardised scores of each teacher were calculated and summarised (Appendix 21, Appendix 22, Appendix 23, Appendix 24).

In the following sections, the overall state of the teacher-student interactions of each group, based on the standardised scores, from the pre- and post-CPD programme lesson are analysed and discussed in detail. Moreover, changes in the teacher-student interaction after the CPD programmes were also examined.

5.5.1.1 Pre-CPD Programme Classroom Interactions Analysis

This section is concerned with the state of teacher-student interactions as measured using the FIAC system before the two groups of teachers participated in their CPD programmes.

5.5.1.1.1 Pre-CPD Online Programme Teachers' Classroom Interaction Analysis

Table 5.13 shows the nature of classroom interaction in lessons given by teachers before they participated in the online CPD programme. It can be seen that Teacher Talk was the most dominant characteristic in these pre-online CPD classrooms with a total 68.7% of classroom time. Teachers spent most of their talking time (56.8%) in Direct Teaching Talk. Approximately 54.0% of this was used for Lecturing, where they were just giving

facts and opinions about the subject content, and 2.5% was used for Giving Directions. Only 0.3% time was spent in Criticizing or justifying Authority.

Teachers spent just over a tenth of their talking time on Indirect Teacher Talk, most of which was spent Asking Questions. Comparatively less time was recorded for praise or Encouragement, Accepting or Using Pupils' ideas and Accepting Feelings.

Table 5.13: The total nature of classroom interaction for pre-CPD online programme

Teacher-Student Interaction	Overall Statistic of online group					
	Total Time*	%	Median	Mean	Max	Min
Teachers' Talk						
Indirect Teacher Talk						
Accepts Feelings	83	0.3	6	8	17	2
Praise or Encouragement	528	2.0	40	53	120	11
Accepts or Uses ideas of Pupils	286	1.1	21	29	91	8
Asking Questions	2303	8.5	204	230	404	91
Total Indirect Teacher Talk	3200	11.9	275	320	580	119
Direct Teacher Talk						
Lecture	14579	54.0	1698	1458	1930	472
Giving Directions	679	2.5	63	68	123	23
Criticizing or Justifying Authority	77	0.3	1	8	26	0
Total Direct Teacher Talk	15335	56.8	1749	1534	1954	621
Total Teacher Talk and Direct Talk	18535	68.7	1994	1854	2175	1197
Student Talk						
Student Talk Response	3543	13.1	262	354	678	189
Student Talk Initiation	164	0.6	5	16	66	0
Total Student Talk	3707	13.7	269	371	744	189
Silence	4758	17.6	423	476	758	286
Overall Total	**27000**	**100.0**	**2700**	**2700**	**2700**	**2700**

* Total time is measured in unites of three seconds.

The second most dominant characteristic of the online CPD classroom was Silence, that is, time spent in doing activities. Following this was Student Talk, which consisted of talk amongst themselves, as well as with the teachers. The vast majority of this time was used to respond to teachers' questions while only a very small proportion (0.6%) was spent in initiating talk.

5.5.1.1.2 Pre-CPD f2f Programme Teachers' Classroom Interaction Analysis

Similar to the online CPD programme, it can be clearly observed from Table 5.14 that the most dominant characteristic of the f2f pre-CPD programme was also Teacher Talk (75.0%). Once again the majority of this consisted of Direct Teacher Talk (67.8%) and

only (7.2%) in Indirect Teacher Talk. Just as the online programme, the second highest proportion within this group was Silence (16.0%) with the smallest proportion being Student Talk (9.0%).

Table 5.14: The total nature of classroom interaction for pre-CPD f2f programme teachers

Teacher-Student Interaction	Overall Statistic of f2f group					
	Total Time *	%	Median	Mean	Max	Min
Teachers' Talk						
Indirect Teacher Talk						
Accepts Feelings	53	0.2	4	5	14	1
Praise or Encouragement	240	0.9	24	24	42	4
Accepts or Uses ideas of Pupils	207	0.8	11	21	78	1
Asking Questions	1439	5.3	141	144	218	53
Total Indirect Teacher Talk	1939	7.2	227	194	276	66
Direct Teacher Talk						
Lecture	17809	66.0	1783	1781	2058	1508
Giving Directions	471	1.7	53	47	90	11
Criticizing or Justifying Authority	36	0.1	2	4	17	0
Total Direct Teacher Talk	18316	67.8	1854	1832	2112	1581
Total Teacher Talk (Direct +Indirect)	20255	75.0	2079	2026	2191	1826
Student Talk						
Student Talk Response	2403	8.9	218	240	396	113
Student Talk Initiation	21	0.1	0	2	15	0
Total Student Talk	2424	9.0	219	242	396	116
Silence	4320	16.0	419	432	597	327
Overall Total	**27000**	**100.0**	**2700**	**2700**	**2700**	**2700**

* Total time is measured in unites of three seconds

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5.5.1.1.3 Comparison of Pre-CPD Teachers' Classroom Interaction of Online and f2f Groups

Figure 5.4 compares the results of both pre-CPD programmes. It is clear to see that both programmes have similar levels of Teacher Talk. However it can be noted that more time was spent in Direct Teacher Talk by the teachers in the f2f group. Student Talk in the lessons of the teachers in the online group is considerably higher than those in the f2f group. A similar amount of time for both groups was spent in Silence.

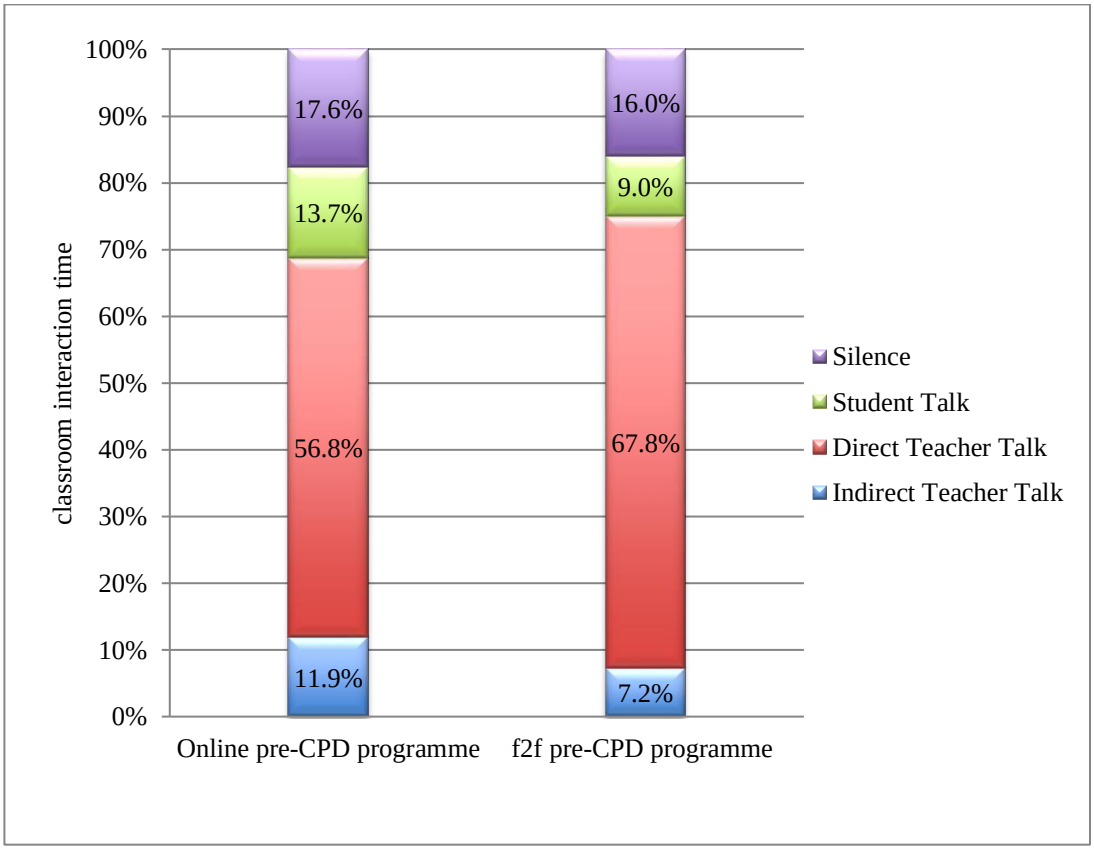

Figure 5.4: Comparison of online and f2f pre-CPD programmes' interaction

To address whether there is a significant difference in the comparison of pre-CPD teacher-student interaction of both programmes, a sample T-test was calculated. In order to know the magnitude of the differences between two groups, the effect size (eta squared) was also calculated (see Table 5.15). The findings show that Indirect and Direct Teacher Talk were the only categories that had significant differences with their p-value being less than 0.05 (cut-off point) and the effect size value more than 0.14 (Cohen, 1988), although it can be noticed that there was no significant difference in the total of these categories.

Table 5.15: Comparison of t-test of pre-CPD teachers' classroom interaction of online and f2f

Teacher-Student Interaction	Pre-online CPD Mean	Pre-f2f CPD Mean	Mean Diff.	t	df	p (2-tailed)	Effect size (eta^2)
Teachers' Talk							
Indirect Teacher Talk							
Accepts Feelings	8.3	5.3	3.0	1.8	9	.10	0.26
Praise or Encouragement	52.8	24.0	28.8	2.1	9	.06	0.33
Accepts or Uses ideas of Pupils	28.6	20.7	7.9	1.3	9	.22	0.16
Asking Questions	230.0	143.9	86.4	2.5	9	.06	0.41
Total Indirect Teacher Talk	319.7	193.8	126.2	2.6	9	.02*	0.43
Direct Teacher Talk							
Lecture	1457.9	1780.9	-323.0	-2.4	9	.06	0.39
Giving Directions	67.9	47.1	20.8	2.0	9	.07	0.31
Criticizing or Justifying Authority	7.7	3.6	4.1	1.3	9	.20	0.16
Total Direct Teacher Talk	1533.5	1831.6	-298.2	-2.4	9	.04*	0.39
Total Teacher Talk (Indirect +Direct)	1853.2	2025.6	172.1	-2.2	9	.06	0.35
Student Talk							
Student Talk Response	354.3	240.3	114.0	2.1	9	.06	0.33
Student Talk Initiation	16.3	2.1	14.2	1.8	9	.10	0.26
Total Student Talk	370.6	242.4	128.3	2.1	9	.06	0.33
Silence	475.8	432.1	43.7	1.0	9	.33	0.10

* $p < 0.05$

The above results show that the science classroom was essentially teacher-centred indicating that the students were not verbally very active in the lesson. Although this is a small sample, previous studies such as Al-Aklobi (2008), Alabdelwahab (2002) and Algarfi (2010) have also found that Saudi Arabian science classrooms are dominated by Teacher Talk. Teacher Talk dominated the lessons, while students were sitting passively for the majority of the time. Teachers seemed to focus on giving facts and ideas, rather than posing questions that would encourage student interaction and participation. From my observations, high Teacher Talk means that the teacher was lecturing and students were not actively participating, and a low Teacher Talk means that the teacher was facilitating the active engagement of the students, which is in line with Wilson et al. (2010). The 5Es instructional model states that the teacher should encourage the student

to discover knowledge for themselves, by asking questions rather than by only giving the facts (Bybee et al., 2006).

However, encouraging students to ask questions can sometimes put the teacher on the spot as they are expected to provide students with answers and some teachers appeared not only to struggle with the syllabus, but also lacked the necessary skill, preparation and subject knowledge to answer these questions properly. Alaqeel (2005) also reported that Saudi Arabian teachers were not competent, lacked skill and required training. In one particular example, the researcher was asked to complete the lesson by the teacher, as the teacher felt unable to complete and follow the syllabus. Of course, the researcher did not do so as this would negatively impact the reliability of the data. Other teachers were using such methods as asking the students to read aloud from the book while other students listened. The problems faced with the syllabus could be due to the fact that they were unable to break out of traditional methods of teaching and therefore struggled with the new syllabus, which is designed towards the 5Es instructional model by McGraw-Hill (2011). Some remained seated at the front of the class and lectured throughout the lesson from this position. It has been mentioned that teachers teach as they have been taught (Felder, 2004) and are not familiar with modern teaching methods.

These results are explicable as the teachers observed did not have any previous training in the use of the 5Es instructional model and were still adopting more traditional methods of instruction. This means that the teachers need appropriate training to instruct them in the 5Es instructional model so that they are able to teach the new syllabus in a manner that will engage as many students as possible, and make sure that they are not just lecturing but are ensuring that students are interacting with the material actively. In a study by Mansour et al. (2012), it was shown that there is a need for teacher training through CPD programmes in Saudi Arabia.

Another factor that may contribute to the excessive use of lecturing is the duration of the lesson, which is 45 minutes long. During lesson observations, there were incidents in which some teachers arrived late to class and procrastinated in the first few minutes. There have been studies (Bybee et al., 2006; Levitt, 2002; Richardson, 1997) that have claimed that active learning, or enquiry-based learning, requires time and teachers have complained in the interview questions (discussed in section 5.5.2) that the time of the lessons was not enough to do this. Another source of complaint is the science teachers'

workload (Qablan et al., 2015; Richardson, 1997). In response to a study conducted by (Qablan et al., 2015) Saudi science teachers reported that the greatest challenge they face when they are trying to implement what they have learnt in the CPD programme is the heavy teaching workload. A teaching workload of 24 lessons per week (Ministry of Education, 2009), which included not only science, but also additional subjects such as maths, history and geography is a cause for concern. When the specified workload is not covered through science lessons, it is the norm to have science teachers teach other subjects, and they are also often given administrative duties. This of course affects the teacher's performance and productivity (Byrne and Flood, 2003).

Some schools also have a shortage of teaching resources and tools, such as science laboratories and instruments (Musalam, 2003). Teacher F1 in the open-ended interview questions mentions this point. The seating arrangements in traditional Saudi Arabian school classes is one of rows and columns, and this renders the implementation of any type of active or cooperative learning more difficult. This may result in the teacher simply lecturing to the class and infrequently responding to feedback and interacting as well as possible with the students. In order to have an environment that permits and encourages interaction and discussion between students and teachers, a seating arrangement of semi-circles and group tables is needed for sharing understanding and the development of knowledge between students, asking questions and investigating topics. Rosenfield et al. (1985, p. 101) claim that it is "common sense" that grouping students into small clusters heightens interaction, but that it may also affect classroom control.

5.5.1.2 Post-CPD Programme Classroom Interaction Analysis

After an initial observation of the teaching methods adopted by the participating teachers before they attended the CPD programmes using FIAC system, a similar observation was conducted after the programmes so as to note any differences that occurred in the amounts of Teacher Talk, Student Talk and Silence. This provided a basis for the comparison of the two states and provided a 'hard' measure of the impact of the CPD programmes on the teaching practices.

5.5.1.2.1 Post-CPD Online Programme Classroom Interaction Analysis

Table 5.16 shows the nature of the post-CPD online programme classroom interaction. It was evident that this group was also dominated by Teacher Talk activities (64.1%), consisting mostly of Direct Teacher Talk, where the majority of the class involved teachers lecturing the students. Just less than a quarter of class time (23.0%) was spent in Silence and the remainder of the time (12.9%) was Student Talk.

Table 5.16: The total nature of classroom interaction for post-CPD online programme teachers

Teacher-Student Interaction	Overall Statistic of online CPD programme					
	Total Time *	%	Median	Mean	Max	Min
Teachers' Talk						
Indirect Teacher Talk						
Accepts Feelings	96	0.4	8	10	28	0
Praise or Encouragement	360	1.3	16	36	147	1
Accepts or Uses ideas of Pupils	403	1.5	42	40	80	7
Asking Questions	3616	13.4	274	362	916	124
Total Indirect Teacher Talk	4475	16.6	359	448	988	155
Direct Teacher Talk						
Lecture	12118	44.9	1314	1212	1651	389
Giving Directions	619	2.3	59	62	97	23
Criticizing or Justifying Authority	81	0.3	6	8	27	0
Total Direct Teacher Talk	12818	47.5	1375	1282	1758	492
Total Teacher Talk (Indirect + Direct)	17293	64.1	1798	1730	2131	1176
Student Talk						
Student Talk Response	3384	12.5	198	338	894	104
Student Talk Initiation	116	0.4	5	12	59	0
Total Student Talk	3500	12.9	211	350	953	106
Silence	6207	23.0	636	620	802	417
Overall Total	**27000**	**100.0**	**2700**	**2700**	**2700**	**2700**

* Total time is measured in unites of three seconds.

However, despite of the fact that Teacher Talk was still the dominant activity in class, there has been a significant drop in lecturing students and an increase in asking questions. It can be also noted that Silence has increased from 17.6% to approximately 23.0%. This increase indicates that students were more actively participating in the lesson activities because, generally speaking, silent times were observed to be those

periods of a lesson in which students were given opportunities to engage with the tasks. To measure this significance, a T-test was made to show the differences between in-class interaction pre- and post-CPD programmes, as shown in Table 5.17.

Table 5.17: Test Statistics of paired sample t-test for online CPD-programme

Teacher-Student Interaction	Pre-CPD Mean	Post-CPD Mean	Mean Diff.	t	df	p (2-tailed)	Effect size (eta^2)
Teachers' Talk							
Indirect Teacher Talk							
Accepts Feelings	8.3	9.6	-1.3	-0.9	9	0.41	0.08
Praise or Encouragement	52.8	36.0	16.8	2.3	9	0.04*	0.38
Accepts or Uses ideas of Pupils	28.6	40.3	-11.7	-1.1	9	0.30	0.12
Asking Questions	230.0	362.0	-131.0	-2.0	9	0.07	0.31
Total Indirect Teacher Talk	319.7	447.5	-127.5	-1.9	9	0.09	0.29
Direct Teacher Talk							
Lecture	1457.9	1211.8	246.1	4.0	9	< 0.01*	0.64
Giving Directions	67.9	61.9	6.0	0.7	9	0.51	0.05
Criticizing or Justifying Authority	7.7	8.1	-0.4	-0.1	9	0.89	<0.01
Total Direct Teacher Talk	1533.5	1281.8	251.6	4.2	9	< 0.01*	0.67
Total Teacher Talk (Indirect +Direct)	1853.2	1729.3	124.2	3.8	9	< 0.01*	0.61
Student Talk							
Student Talk Response	354.3	338.4	15.9	0.5	9	0.65	0.02
Student Talk Initiation	16.3	11.5	4.8	0.9	9	0.37	0.09
Total Student Talk	370.6	350.0	20.7	0.6	9	0.55	0.04
Silence	475.8	620.6	-144.8	-3.2	9	0.01*	0.53

* $p < 0.05$

The findings show that Teacher Talk and Silence were the only categories that had significant changes, with their p-values being less than 0.05 (cut-off point) and the effect size value more than 0.14 (Cohen, 1988). Within Teacher Talk, the most substantial change was seen in Direct Teacher Talk, in particular within Lecturing and Asking Questions. Lecturing time decreased from 54.0% to 44.9% after the CPD programme with the P-value and effect size value also being significant, while the amount of time afforded for asking questions increased from 8.5% to 13.0%, showing significance in the P-value and effect size values also. This demonstrates an impact in teacher focus following the CPD programme. There were, however, no notable changes

in total Indirect Teacher Talk other than within the praise and encouragement category. In contrast to Teacher Talk, Silence levels increased from 17.6% to 23.0%, indicating that teachers improved their instruction to allow students more time to engage with activities.

In order to address the doubts about the results of the paired sample t-test for a small sample size (as it is a more reliable test for larger sample sizes) a Wilcoxon Signed ranks test, which is a nonparametric test and is more appropriate for smaller samples, was also calculated (Appendix 25). It was observed that both the tests produced the same results.

Figure 5.5 compares pre-CPD and post-CPD interaction times for the classes of the online CPD programme participants. The impact of the CPD programme is evident in the reduction of time spent in Direct Teacher Talk and the increase in the levels of Indirect Teacher Talk. A similar increase was found in Silence levels, indicating that students were engaged more in the learning materials following the CPD programme. Student Talk levels, however, showed little change between the two periods.

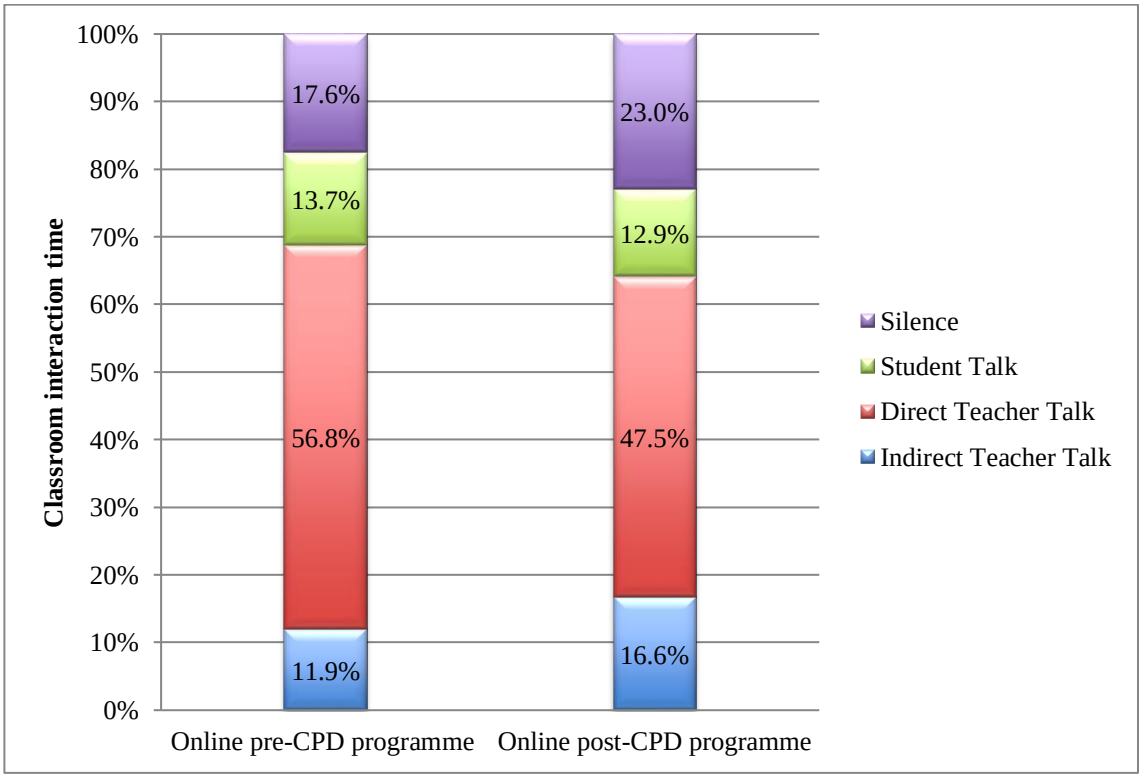

Figure 5.5: Comparison of online pre and post-CPD programme interaction.

This tentatively suggests that teachers benefited from the CPD programme and were, as a consequence, made aware that they needed to change their approach in Lecturing, Asking Questions, and allowing time for student-led activities. However, as no other category of Indirect Teacher Talk has changed, in addition to the fact that there was no significant change in Student Talk, this could also indicate that the online CPD programme has only been partially successful in changing teaching practice. The teachers commented on the changes they noted in their teaching practices and the classroom environment in the interview questions (Q9). In their replies, all the teachers on the online CPD programme reported a change, with a focus on an increase in student interaction and engagement. The increase in Silence did indeed reflect an increase in engagement activities, but students' interaction did not change statistically (reflected in Student Talk). The teachers also reported noting an increase in student's interest in the material and the lesson, which perhaps explains their reports of an increase in interaction levels, where in fact there was an unsubstantial increase. These are, however, still positive outcomes. Of course, other factors that have been mentioned previously, such as the length of the science lesson and the heavy teaching load that the science teachers have (Ministry of Education, 2009), can also be reasons for the initial limited overall impact of the CPD programme. If the science lesson was longer and the teachers were more comfortable, perhaps with a lighter teaching load, the results might reflect more teacher belief (Levitt, 2002) towards being capable of implementing more student interaction and less Teacher Talk and, in turn, belief in being capable of implementing the 5Es instructional model. Nevertheless, based upon above results, the online CPD programme had a positive impact on the teachers' practice as Teacher Talk did decrease and Silence increased, despite the fact that Student Talk did not change.

5.5.1.2.2 Post-CPD f2f Programme Classroom Interaction Analysis

Table 5.18 illustrates the results for the post-CPD f2f programme classroom interaction. The differences before and after CPD in the f2f CPD programme followed similar trends to those in the online CPD programmes. Teacher Talk activities constitute a significant proportion of interaction time, the majority of which was Direct Teacher Talk rather than Indirect Teacher Talk. The time recorded for Silence was more than twice that of Student Talk, indicating that students had little opportunity to interact with other students or their teacher.

Table 5.18: The total nature of classroom interaction for post-CPD f2f programme teachers

Teacher-Student Interaction	Overall Statistic of f2f group					
	Total Time*	%	Median	Mean	Max	Min
Teachers' Talk						
Indirect Teacher Talk						
Accepts Feelings	28	0.1	0	4	25	0
Praise or Encouragement	63	0.3	6	8	25	0
Accepts or Uses ideas of Pupils	493	2.3	72	62	91	14
Asking Questions	2113	9.8	256	264	360	149
Total Indirect Teacher Talk	2697	12.5	356	338	440	184
Direct Teacher Talk						
Lecture	11791	54.6	1553	1474	1633	1201
Giving Directions	807	3.7	97	101	154	54
Criticizing or Justifying Authority	22	0.1	1	3	15	0
Total Direct Teacher Talk	12620	58.4	1642	1578	1730	1355
Total Teacher Talk (Indirect +Direct)	15317	70.9	1885	1916	2124	1748
Student Talk						
Student Talk Response	1691	7.8	199	211	352	132
Student Talk Initiation	27	0.1	1	3	15	0
Total Student Talk	**1718**	**7.9**	**199**	**214**	**355**	**145**
Silence	4565	21.2	557	570	769	390
Overall Total	**21600**	**100**	**2700**	**2700**	**2700**	**2700**

* Total time is measured in unites of three seconds.

A sample t-test (see Table 5.19) and Wilcoxon Signed Ranks Test (Appendix 26) was also computed for the f2f group. Both tests recorded the same results and, therefore, only the results of the Paired sample t-test are presented and discussed in detail.

Table 5.19: Test Statistics of paired sample t-test for f2f CPD-programme

Teacher-Student Interaction	Pre- CPD Mean	Post-CPD Mean	Mean Diff.	t	df	p (2-tailed)	Effect size (eta^2)
Teachers' Talk							
Indirect Teacher Talk							
Accepts Feelings	6.4	3.5	2.9	0.7	7	0.46	0.08
Praise or Encouragement	24.6	7.9	16.8	4.0	7	< 0.01*	0.70
Accepts or Uses ideas of Pupils	19.0	61.6	-42.6	-4.8	7	< 0.01*	0.77
Asking Questions	154.3	264.1	-109.9	-4.2	7	< 0.01*	0.72
Total Indirect Teacher Talk	204.1	337.1	-133.0	-4.3	7	< 0.01*	0.73
Direct Teacher Talk							
Lecture	1726.4	1473.9	252.5	5.2	7	< 0.01*	0.80
Giving Directions	50.9	100.9	-50.0	-3.4	7	0.01*	0.63
Criticizing or Justifying Authority	4.4	2.8	1.6	0.5	7	0.62	0.04
Total Direct Teacher Talk	1781.6	1577.8	203.9	5.7	7	< 0.01*	0.83
Total Teacher Talk (Indirect + Direct)	1985.9	1914.6	71.3	2.6	7	0.03*	0.49
Student Talk							
Student Talk Response	264.1	211.4	52.8	1.4	7	0.19	0.23
Student Talk Initiation	2.6	3.4	-0.8	-0.2	7	0.81	0.01
Total Student Talk	266.8	214.8	52.0	1.5	7	0.18	0.24
Silence	447.5	570.5	-123.0	-2.8	7	0.02*	0.54

* $p<0.05$

Similar to the findings of the online group, within this group the only significant changes were found in Teacher Talk and Silence. Lecturing time decreased and Asking Questions increased, with their significance measured in the p-value and effect size (eta squared) values in the T-test. In line with the online group, this is evidence that the CPD programme had some positive impact on the teaching process. Also, indicating the effectiveness of the CPD programme, Silence levels increased noticeably. There were no changes in the amount of time spent in Student Talk between the two periods.

Figure 5.6 compares pre-CPD and post-CPD interaction times for the classes of the f2f group participants. The impact of the CPD programme is evident in the reduction of time spent in Direct Teacher Talk and the increase in the levels of Indirect Teacher Talk.

A similar increase was found in Silence levels indicating that students were engaged more in learning materials following the CPD programme. Student Talk levels, however, showed little change between the two periods.

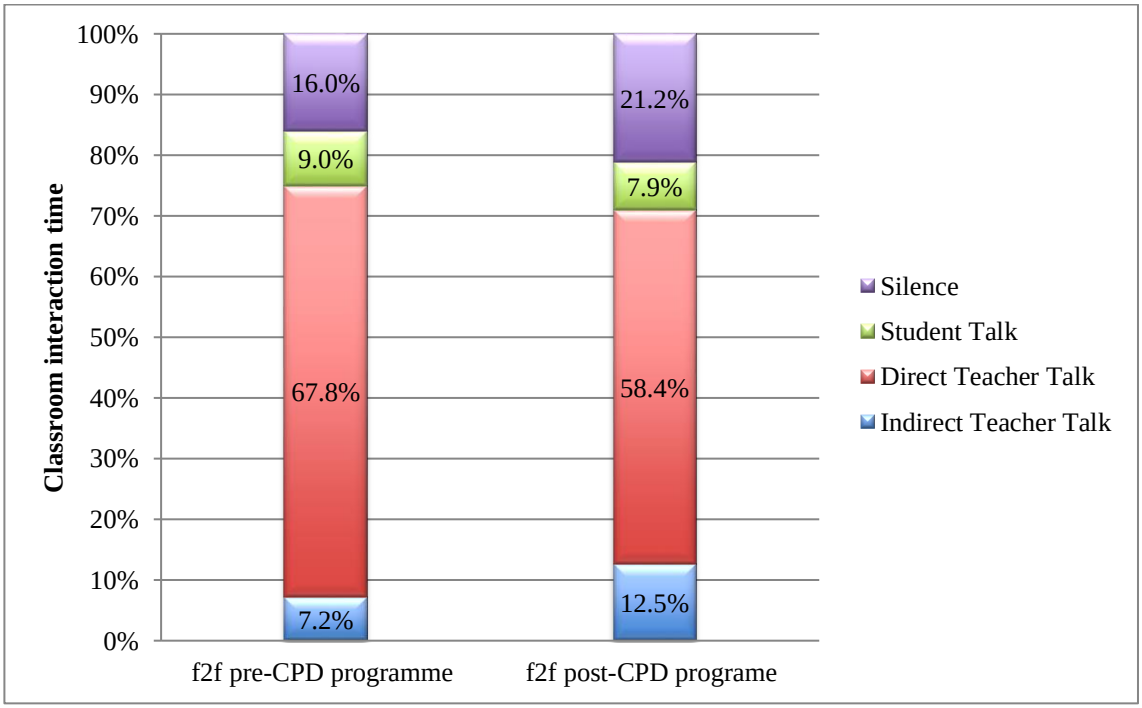

Figure 5.6 : Comparison of f2f pre and post-CPD programmes' interaction

Many factors can contribute to the again superficial results found in comparing teaching practices before and after the f2f CPD programme. Such factors, as mentioned by the teachers themselves in the interview questions (see section 5.5.2) and supported in the relevant literature, can include the duration of the science lesson (Bybee et al., 2006; Levitt, 2002; Richardson, 1997), the number of the students (Bonwell and Eison, 1991), teaching load (Qablan et al., 2015; Richardson, 1997) and the abilities of the teachers themselves (Alaqeel, 2005; Alhammed, 2004). When asked whether they felt that they could apply what they had learned about the 5Es instructional model, some teachers in the f2f group claimed that they did not understand the content, while others complained that they had too many students in one class, and that the competency levels of the students also sometimes did not help. Others admitted that they still lacked sufficient experience and needed more training.

Supovitz (2002) claims that delivering CPD courses in short bursts, as is the case in the CPD programmes in this study, rather than over time has been shown to have little, or no, effect on teaching practices. Indeed, some of the teachers' replies mentioned that the course was short and that they would have benefitted more from a longer, and perhaps more regular, CPD programme, that also came at a different time in the academic calendar. Longer professional development courses given at an earlier time with regard to the academic year, in addition to having a larger sample of teachers to observe, might show more positive results. Nonetheless, the above results, although a small data sample, are encouraging.

5.5.1.2.3 Comparison of Post-CPD Teacher-Student Interaction in Both Groups

Figure 5.7 compares the results of the two CPD programmes with regard to their impact on the teaching practices of the participating teachers. Also, this figure shows the amount of the change between both groups.

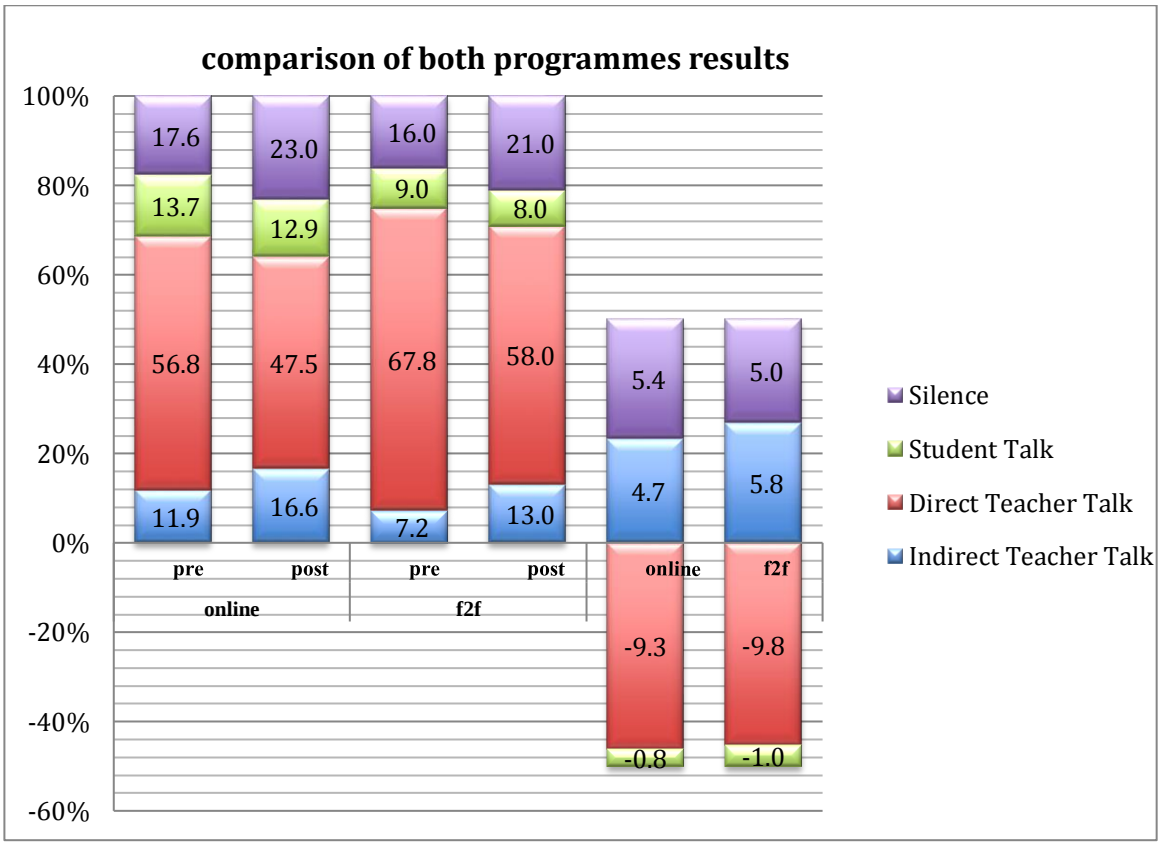

Figure 5.7: The summary comparison of both group results

The difference between the states of Silence, Student Talk, Direct Teacher Talk and Indirect Teacher Talk before and after the CPD programmes in both online and f2f groups were very similar. The difference in Direct Teacher Talk in particular is identical, with both groups of teachers showing a decrease of Direct Talk to the students, that is, Lecturing, Giving Directions and Criticising, by 10%. The amount of Silence and Student Talk also changed in both groups in similar quantities.

Also, in order to address whether or not there is a significant difference in the comparison of post-CPD teacher-student interaction of both programmes, a sample T-test was classroom (see Table 5.20).

Table 5.20: The differences in p-value of the post online and post f2f CPD programme

Teacher-Student Interaction	Post-online CPD Mean	Post-f2f CPD Mean	Mean Diff.	t	df	p (2-tailed)	Effect size (eta^2)
Teachers' Talk							
Indirect Teacher Talk							
Accepts Feelings	11.8	3.5	8.4	1.7	7	0.14	0.29
Praise or Encouragement	44.0	7.9	36.1	1.9	7	0.10	0.34
Accepts or Uses ideas of Pupils	33.5	61.6	-28.1	-4.5	7	<0.01*	0.74
Asking Questions	393.6	264.1	129.5	1.4	7	0.21	0.22
Total Indirect Teacher Talk	483.0	337.1	145.9	1.4	7	0.21	0.22
Direct Teacher Talk							0.41
Lecture	1104.7	1473.9	-369.1	-2.2	7	0.06	0.47
Giving Directions	55.1	100.9	-45.8	-2.5	7	0.04*	0.13
Criticizing or Justifying Authority	7.1	2.8	4.4	1.0	7	0.32	0.53
Total Direct Teacher Talk	1166.9	1577.8	-410.9	-2.8	7	0.03*	0.55
Total Teacher Talk (Indirect +Direct)	1649.9	1914.6	-264.8	-2.9	7	0.02*	0.32
Student Talk							0.27
Student Talk Response	394.4	211.4	183.0	1.8	7	0.12	0.32
Student Talk Initiation	14.3	3.4	10.9	1.6	7	0.16	0.17
Total Student Talk	408.6	214.8	193.9	1.8	7	0.12	0.29
Silence	641.4	570.5	70.8	1.2	7	0.25	0.34

* $p < 0.05$

Although the sample of the study is small, the findings show that these differences in post-CPD programmes' interaction was not significant accept the Direct and Indirect

Teacher Talk categories that had significant differences with their p-value being less 0.05 (cut-off point) and the effect size (eta squared) value more than 0.14.

This implies that the impact of the online CPD programme on teaching practices, which is one of the benefits of online CPD programmes as Thomas (2009) claims, is no less than that of the f2f programme participants, which in turn is encouraging for the application of the online programme. The notable decrease in Teacher Talk and an increase in Silence, may imply more interactive teaching is taking place, suggesting a general acceptance of the 5Es instructional model among teachers.

At this stage, findings obtained from classroom observations from the comparative evaluation in terms of teachers knowledge agrees with the earlier evaluations with respect to satisfaction and teachers' learning collated in the study, suggesting that the online approach can be at least as effective as the traditional f2f approach for the delivery of CPD programmes. This also aligns with Fisher et al. (2010), Fishman et al. (2013), and Russell et al. (2009a) who have highlighted positive effects on teacher's knowledge and instructional practices with the use of the online approach.

5.5.2 Analyses and Discussion of Interview Data

The science teachers were asked about how they implemented what they had learned in the programmes and what different methods they used in their teaching, which is in line with Guskey's level 4. This level was also verified by the use of the FIAC system (Flanders, 1966) in the observation process, as discussed above. Three interview questions targeted this issue, asking them about whether they believed that their teaching practice had changed in the classroom, whether they felt they were able to effectively apply the 5Es instructional model in the class, and which particular 5Es level they applied in the lesson that they were observed in.

Table 5.21: Q9 response analysis of f2f and online CPD programme participants.

	Teacher	Yes there is change	Themes: Changes due to use		No change	Reason for no change
			Student interaction increased	Student interest increased		
F2f CPD programme	F1	X	X	X		
	F2	X	X			
	F3	X				One lesson is not enough time to apply 5Es
	F4				X	I did not understand the programme
	F5				X	
	F6	X				
	F7				X	Student learning levels too low
	F8	X	X			
Total		5	3	1	3	
Online CPD programme	O1	X		X		
	O2	X	X			
	O3	X	X			
	O4	X				
	O5	X				
	O6	X		X		
	O7	X				Large numbers of students was obstacle
	O8	X				
	O9	X	X			
	O10	X		X		
Total		10	3	3	0	

The majority of teachers gave a positive response and claimed that their practice had in some way indeed changed in the classroom. Those reporting a change included all of the online participants and five of the eight f2f CPD programme participants – three teachers in this group reported that they believed that there had been no post-CPD change in their practice. This suggests, at least in this evaluation, that the online programme had a marginally greater impact on teachers' self-reported changes to their teaching practice. Some teachers continued by elaborating on the nature of the change they believed had taken place in their own lessons as a result of the CPD practice and two main themes emerged which were that student *interest* and student *interactivity* had both increased with the implementation of the 5Es instructional model.

> Yes, my practice in the classroom has significantly changed. The old method was static and lacked interaction and I always felt as if we were a ruler and oppressed people. But when I applied the new method I found more interaction and activity in the classroom and felt that students were eager to attend the science class to interact and participate and to feel some kind of freedom and change. (F1)
>
> Yes, to a certain extent. I applied it in sixth class and I found out that students' interest in learning has increased considerably. On the other hand, interaction among students in third class was less than that of sixth class, maybe due to the young age of the students. (O1)

In their study of a trial of the 5Es instructional model, Boddy et al. (2003) reported that students found the model to be interesting and fun, and Hokkanen (2011) claimed that the same model may help teachers overcome challenges such as a lack of interest in science on the part of students. Teacher F1's realisation that students were more eager to attend the science class was a positive sign of increase in interest. This point was further reinforced in the interview questions, which sought to measure student outcomes (Guskey's level 5), where the same teacher attributed the increased confidence of students to the interest and engagement he noticed in class. The increase in interactivity in the classroom environment was perhaps the main reason behind the increase in an interest in science. This could be due to the fact that the 5Es instructional model gives students more freedom to interact and discuss, and even move around in the classroom, and this is reinforced by Boddy et al. (2003) who claimed that "engagement promotes

interest and motivation" (p. 29). The traditional method of teaching that is still widespread in Saudi Arabia is not characterised by engaging students and encouraging interaction and arguably, as passive learners, the students find the method less interesting (Alaqeel, 2005).

> Yes, there were changes in my teaching practices with the students and in my way of explanation, and my movement in the class increased. The students felt freer to move and discuss with each other. (F2)

Teacher F2 claimed that he felt freer with regard to his movement in class, and the same applies to the students, who also had some freedom of movement and were able to discuss with each other and with the teacher more freely. In the observation using FIAC system (Flanders, 1966), the level of silence increased in classrooms after the teachers had attended their CPD programmes. This reflected an increase in classroom activities and interaction with the material. Teachers' Direct and Indirect talk also decreased, which is a sign of a change from traditional 'lecturing' towards a more interactive model.

Teachers also reported an increase in the level of interactivity in their classrooms to support this claim. This was a positive sign and a welcomed change from the traditional teaching methods of delivering the material, making the teachers feel like they were "a ruler of oppressed people" as F1 stated.

The general impact of the programme was positive with regard to what was reflected in the methods of teaching adopted by the teachers and their implementation of what they have learned from the programmes. However, some of the teachers did mention that they faced difficulties in implementing the 5Es instructional model for various reasons as the following example illustrates:

> Yes, my teaching methods changed, but there is a problem related to the short length of the lesson. The 5Es model needs more time as it involves elaboration, conducting experiments and solving exercises. I need two classes to finish a subject. Moreover, the number of students is small, only three, and the cooperative learning was not effective with three students. (F3)

The issue of time has been discussed in numerous parts of this study (see sections 5.2 and 5.3) and is one of the main causes for concern for the teachers (F1, F3, O1, and O8). The science lesson is only forty-five minutes long, with time lost at the beginning and the end of the lessons, as confirmed in the observation process, as it takes a few minutes to settle and get started with the lesson and also a few minutes to wrap up at the end of the class, in addition to the fact that sometimes the teachers walk their students to the science laboratory in the school, which is at a distance. Hence, the teachers rightly expressed their concerns with the ability to apply the 5Es instructional model in such a tight time frame. Gejda and LaRocco (2006) argue that the length of the classroom period is an important factor that affects the implementation of inquiry-based learning. Bonwell and Eison (1991) and Alghamdi and Al-Salouli (2013) also argue that Limited instructional time is one of the major challenges that teachers encountered to applying active learning.

F1, in his reply to Q10 (mentioned below) explains that he divides the levels across different lessons:

> Yes, I am applying the 5Es instructional model in my class, but I cannot apply all the levels in one lesson. For example, I apply engagement and exploration in one lesson and explanation and evaluation in another lesson, etc. (F1)

Whereas other teachers did not seem as positive as F1, as they classed the period of 45 minutes as a difficulty and obstruction (also in their replies to Q10):

> Currently, I didn't apply the programme because of the short time of the lesson. (O7)

The short period of the science lesson was also mentioned by some of the teachers in their replies to the open-ended question at the end of the interview.

> I think the 5Es model is wonderful and would like to apply it in class but I don't think the period of the lesson allows me to do this, as it is too time-consuming and will not be fully applicable within a 45 minute lesson. (F5)

> There were some obstacles when applying the 5Es model such as the large number of students in a classroom, in addition to the educational level of some of the students, which doesn't help. The seating arrangement is not fit for this model and of course the important factor of time. The course is full of information, and we did not have enough time in the 45 minutes to go through all the levels with our students. There was not enough time to apply 5Es in one lesson. (O8)

Some teachers improvised to some extent and attempted to apply the different levels of the 5Es instructional model across more than one lesson, as can be seen in F1's reply above, for example. Similar replies were given to Q11 discussed below.

Other factors that affected the applicability of the teaching model included the number of students in each class:

> Yes, there is a change to some extent but the large number of students affected the application of the programme negatively. (O7)

This problem was mentioned more than once as it seems that there is an inadequate number of students that is a requirement for the successful application of 5Es instruction model, whereas too many, or even too few students can have negative impact on the programme's application. High classroom density makes it difficult for the teachers to interact fully with all the students and give individual students help as Mansour (2007) claims, and Bonwell and Eison (1991) also mention that the size of classes can affect the application of active learning models. Also in his study Qablan et al. (2015) found that over than 60% of science teachers in Saudi Arabia reported that small classrooms combined with the large numbers of students in each classroom is the biggest challenge that they face when they trying to implement what they learnt through CPD programme.

One other reason, also mentioned by F4, was that they had difficulty in understanding the programme itself:

> I did not fully apply the programme because I did not understand the method properly. (F4)

F4 has a right to make such an expression, as it is evident from his reply to the interview questions concerning learning that he had a few misconceptions and did not fully comprehend the material in the CPD programme. However, only a small fraction of teachers showed this level of misunderstanding and this is not a discouraging factor.

What can be taken from the reply analysis to this question is that all of the online programme participants self-reported a changed in their teaching methods and their attempts to apply the 5Es instructional model in some way in class (Guskey's level 4). This supports the claim that the online programme is more successful than its f2f counterpart with regard to its application and impact on teaching methods in class. The next question is concerned with the teachers' opinions towards the model's applicability.

Q10: Do you feel you can effectively apply the 5Es instructional model in your class? How? Could you give me an example?

The teachers were asked the above question to gain an understanding of what they feel about the 5Es instructional model and their ability to apply it in their classes and teaching. The trends that appear from the thematic analysis of their replies were expectedly very similar to those of the previous question. Table 5.22 shows their reply analysis.

Table 5.22: Q10 response analysis of f2f and online CPD programme participants.

	Teacher	Themes: degree of applying 5Es				
		Yes	Some lesson	Some lesson with difficulty	No	Obstacle to use 5Es
F2f CPD programme	F1			X		Lesson length is a problem
	F2				X	Did not understand
	F3*					Difficult judging my self
	F4				X	Did not understand
	F5		X			In some
	F6		X			In some
	F7		X			Students' level do not help
	F8		X			In some
Total			4	1	2	
Online CPD programme	O1			X		Large number of students, short time of lesson
	O2			X		Unavailability of instruments, tools
	O3				X	Number of students
	O4				X	Unavailability of instruments, tools
	O5			X		Number of students
	O6*					
	O7		X			Short time of lesson
	O8	X				
	O9	X				
	O10	X				Number of students
Total		3	1	3	2	

*F3 did not give a relevant answer
* O6 did not reply

Some teachers from the online group answered affirmatively, claiming that they can apply the 5Es instructional model and it would be effective in their opinion, but O10 did mention that the number of students would be an issue. For example:

> Yes, I applied it and it was effective. (O8)
>
> Yes, to a considerable extent. (O9)

Teacher O8 and O9 gave positive responses. These two teachers continually showed understanding of the 5Es instructional model throughout their replies to the interview questions. For example, they both gave ideal replies to questions 3 and 4 concerning an understanding of *explanation* and the teacher's role at this level (discussed in section 5.3.3) which were in accordance to Bybee et al. (2006) definition. They also showed a level of learning and understanding of the students' role at the *exploration* level which was in according to Bybee et al. (2006) definition. Therefore, after accumulating satisfactory knowledge, they felt that they could apply the model as the timing of the

interview came after the period of observation, where the teachers were given the opportunity to apply their new learning. Guskey (1986) describes teacher development programmes as an attempt to achieve "change in the classroom practices of teachers, change in their beliefs and attitude, and change in the learning outcomes of students" (p. 5). The responses of teachers O8 and O9 suggest that such as change was noticed and after the CPD programme, the teachers claimed to have changed their classroom practices, and saw a positive change in student learning outcomes, which in turn led to a change in their beliefs and attitudes. This claim is also supported by the replies of these same teachers to the questions concerning students learning an outcome that is in line with Guskey's level 5, (discussed section 5.6). However, O10 did say that he could apply the method, but only to a class that contained less than 26 students and would have difficulty applying the methods to a class that contained more

> The course wasn't applied always. I have applied it with the fourth years but I didn't apply it in sixth and fifth years due to the large number of students in each class, which exceeded 26 students. (O10)

The number of students in a class was also mentioned as a difficulty faced by other teachers from the online programme also (Bonwell and Eison, 1991).

> I applied it in a good way but there are some problems that I faced such as the large number of lessons and students. (O1)
>
> Not completely due to reasons related to the number of students there and participation in lessons. Sometimes the subject of the lesson is quite demanding, which results in less student reaction in the lessons. (O3)
>
> There is sufferance, especially in primary classes, due to the small number of students and difficulty of its application. (O5)

Similar to the responses to question nine, this question again generated replies relating to numbers of students, who can either be too many or too few, in the opinions of the teachers, for the 5Es instructional model to be effectively adopted and applied.

Some teachers from the f2f CPD programme expressed that either they themselves or their students did not have the level of understanding needed to teach or learn the lesson according to the 5Es instructional model. F4 and F7 exemplify this:

> I did not fully apply the programme because I did not understand the method properly. (F4)
>
> I tried to use it but the learning level of students did not help me. (F7)

F4's level of understanding was discussed in the section on Q9 and his reply here only reinforces the fact that he had difficulty understanding the content of the CPD programme. Bybee (2009) claims that the 5Es instructional model is recognised internationally and can be applied by science teachers to all students at all levels, and the individual levels of the students should not be an obstruction as teacher F7 claims.

The above results suggest that there are no signs of the failure of the online CPD programme versus the f2f CPD programme in changing teachers' practices relating to Guskey's level 4. The difficulties faced and mentioned by the teachers are ones relating to external factors to the programme itself, such as number of students and length of the lesson, and not factors that relate to whether the programme was taken online or through a f2f experience.

Q11: Can you tell me which level of the 5Es you used in the lesson I observed today?

This part of the interview involved asking about the teachers' recognition and application of the 5Es levels. The above question was asked in order to gather an idea of the teachers' recognition of the levels and ability to apply them in class. The teachers' replies were verified through the observation process. The teachers were observed before and after the completion of the CPD programme using FIAC observation model in addition to taking field notes. The replies to this question are compared to the observation to formulate an account of the teachers' ability to recognise and apply the levels. Table 5.23 is a reply analysis to the question.

Table 5.23: Q11 response analysis of f2f and online programme participants

	Teacher	Engagement		Exploration		Explanation		Elaboration		Evaluation		None		Matching
		Interview	Observation	Interview	Observation	Interview	Observation	Interview	Observation	Interview	Observation	Interview	Observation	
F2f CPD programme	F1	X	X	X	X									✓
	F2					X	X							✓
	F3	X	X											✓
	F4											X	X	✓
	F5											X	X	✓
	F6					X	X			X	-			✗
	F7											X	X	✓
	F8				X	X								✓
Online CPD programme	O1	X	X	X	X	X	X							✓
	O2					X	X							✓
	O3			X									X	✗
	O4											X	X	✓
	O5			X	X									✓
	O6	X		X			X							✗
	O7					X	X							✓
	O8	X	X	X	X	X	X							✓
	O9			X	X			X	X					✓
	O10	X	X	X	X	X	X	X	X					✓

The aim of this question was practical, for verification purposes. The reliability of the teachers' responses was measured through comparing what they claimed they did in the class with what they actually did as documented in researchers' field notes after each lesson observed.

What can be seen from the table is that the majority of the teachers' replies match the researcher's field note observations. Only three teachers claimed that they had used some 5Es levels that were not actually observed. However, these three teachers are a minority and the rest of the teachers have given replies that are accurate and match the researcher's observations. This majority supports the argument that they understood what they had learned and are able to recognise whether they have or have not applied the 5Es instructional models in its individual levels. It is true that some teachers did say that they did not apply the model, but this does not conflict with the accuracy of the results. The teachers who did claim that they used one or more of the levels did so accurately, as observations show and prove.

Conclusively, the interview results correlate with those which were obtained from the observation approach. These, alongside the teaching practices and teachers' responses to the interview questions, aligns with studies of Ginsburg et al. (2004) and Russell et al. (2009a) suggesting that the online CPD programme is at least as effective as the f2f experience for the evaluation of teacher's practice

5.6 Student Learning Outcomes

This section presents and discusses the impact of the CPD programmes on student learning as commented upon by the teachers and in relation to Guskey's level 5. As stipulated in the methodology chapter, the precise measurement and evaluation of student learning is beyond the scope of this study nor is it the focus. However, as suggested by Guskey (2002), the data gathered through this level can be beneficial in demonstrating the overall impact of professional development. Therefore, two interview questions addressed this issue. Firstly, the teachers were asked; "Have you noticed any change in the students' learning? How? Could you give me an example?" The second question was concerned with the level of confidence: "To what extent has the students' confidence as learners developed?" The teachers' responses to both questions are presented in Table 5.24.

Table 5.24: Q12, Q13 response analysis of f2f and online CPD programme participants.

	Teacher	Student learning level			Student confidence level		
		Increased	Decline	No change	Increased	Decline	No change
F2f CPD programme	F1	X			X		
	F2			X	X		
	F3		X				X
	F4	X			X		
	F5			X	X		
	F6	X			X		
	F7	X			X		
	F8			X			X
Total		4	1	3	6		2
Online CPD programme	O1	X			X		
	O2	X			X		
	O3	X			X		
	O4	X			X		
	O5	X			X		
	O6	X			X		
	O7	X			X		
	O8	X			X		
	O9	X			X		
	O10	X			X		
Total		10			10		

All of the online CPD programme participants reported a positive change or impact on students' learning levels in addition to an increase in student confidence levels. In contrast some teachers from the f2f group reported no change in student learning while fewer saw no change in student confidence. From those teachers who replied in the affirmative, a quarter measured the increases in students learning through formal assessments, thus providing some verification of the changes:

> There has been a good influence. The periodic evaluation showed that the level of the weak students improved to satisfactory and the distinguished students became more creative. (F1)
>
> Yes, the students' level, especially at the higher grades, improved. This was evident in the students' worksheets. (F6)

Although student results cannot be solely attributed to the success of the CPD programme, the fact that teachers mentioned increases in formative assessment results demonstrates some impact of the effective implementation of the 5Es instructional model. Most teachers who reported a positive impact on learning did so based on their observations in class and in particular the level of engagement from students, for example:

> There is an increase in students' concentration levels and more interactivity in the classroom. (O4)
>
> Yes, there is good improvement in students' level in view of the fact that students have become more interactive. (O7)

Interestingly, one teacher highlighted the effectiveness of the engagement stage of the 5Es instructional model in enhancing students learning when in comparison with the traditional method of rote learning:

> Some students were interactive in lesson and others didn't comprehend the idea. However there was a noticeable improvement when the

> previous lessons were reviewed and it became more understandable by the students who didn't just memorize them but they understood them and started to answer questions more correctly. (O1)

The few teachers who reported no change in learning or confidence attributed this to a lack of time for students to adjust or for the teachers to implement the method:

> No, I cannot say that there was an improvement or decline in the students' level because the course was at the end of the year, which was not a suitable timing. (F2)
>
> There was a slight impact, because when the method changes from traditional to another method students need time to adapt. (F4)

The responses to the second question correlated with those for the first. Student confidence was seen to increase and again this was measured through the levels of engagement and interest.

> Yes, to a large extent. Student interaction and participation in class was significant and noticeable. One of my colleagues informed me that every time they entered his class after my lesson he noticed that the students were more interactive. (F1)
>
> Yes, there is a noticeable improvement in students' confidence as learners. They began to interact and discuss with the teacher, while in the traditional method they used to only listen to the teacher. (F6)

The traditional methods of teaching where students are passive listeners do not permit interaction from which confidence can easily be measured. The change to the 5Es instructional model therefore resulted in a significantly different classroom environment in which student confidence was reflected in engagement and discussion. Three teachers of the f2f group said that there was no real significance or change in student levels whilst one teacher implied a slight decline, and another reported a definite decline in student levels.

> No, I cannot ensure that there was an improvement or decline in the students' level because the course was at the end of the year and this timing is unsuitable. (F2)

Although one teacher gave an example of where he applied one of the levels he saw negative results in learning outcomes:

> There is no positive impact on students, but rather there was a decline in levels. I applied the engagement level and used role-playing to introduce the subject on electricity. (F3)

Despite recording negative responses, none of these were based on actual, measurable learning outcomes. However, even where teachers have relied on formative assessment to measure learning outcomes, Fletcher and Barufaldi (2002) have agreed that students achievement measures do not necessarily reveal classroom changes as a result of CPD programmes. Other research has also shown that using the performance of students by itself to evaluate the impact of CPD programme is not very effective and successful (Shymansky et al., 2001).

Students learning and confidence levels were commented upon by the teachers after they took part in the programmes. What emerged from the responses to the questions relevant to this section is that the online CPD programme participants all reported an increase in the levels and confidence of the students, while the f2f CPD programme participants had varied replies, some expressing an increase, others reporting that there was no change and some even claiming that there was a decline in student levels. As noticeable in the table, all of the online CPD programme participants' responded positively to both questions while half of the f2f CPD programme saw no change. This is surprising considering the results for most of the other questions indicate very little difference between the two. However when taking into account that the levels of satisfaction of the online group (Guskey's level 1) were significantly higher than those of the f2f group, it can be seen how this can filter through to student learning outcomes. It might be that teachers who were more satisfied with the CPD programmes were more enthusiastic in implementing the 5Es instructional model and thus more positive in

measuring results. In addition, the teachers that were more satisfied with the CPD programme may have been more enthusiastic in observing any change in students, particularly as the change noticed in both questions was linked by the teachers to the interest and engagement seen in students in class.

5.7 Summary of the Chapter

The aim of this chapter was to report and discuss the data gathered through the evaluation of the f2f and online CPD programmes in relation to Guskey 5 levels. Both quantitative and qualitative data has been analysed, discussed and linked with the literature review.

It was found that teachers were more satisfied with the online programme, largely due to the flexibility it affords. In relation to teacher learning it was found that the online programme was more effective than the f2f programme as, in some areas, the latter had a higher impact on teacher knowledge. The findings of the third level almost conclusively suggested no perceived impact on organisational change mostly due to a lack of support from the schools' administration. The analysis of classroom practices through observation and interview confirmed that teachers who participated in the online CPD programme were as effective in implementing the 5E's model as their f2f counterparts. This was further supported by the teachers' positive responses to the interview questions relating to student learning.

Chapter 6. Conclusions and Recommendations

6.1 Introduction

The main aim of this study was to compare an online CPD programme with Saudi Arabia's Ministry of Education's current face-to-face (f2f) CPD programme. In this study, Guskey's (2000) framework of impact evaluation for CPD programmes was used as the theoretical framework as a guideline for interpreting the data gained from teachers who participated in this study. Although Guskey's framework contains five levels, this study assessed the CPD programmes' impact according to four levels: (1) the teachers' satisfaction with materials and provisions; (2) improvements in the teachers' learning and skills; (3) resultant organisational change and support networks arising from the CPD provision; (4) the impact of both CPD programmes on teachers' practical application of the programme's principles. Nevertheless, data on Guskey's level 5 (student learning) was indirectly gathered from teacher interviews, enabling the researcher to infer study results. Accordingly four research questions were identified, each relating to these four levels (see section 4.5.1 Table 4.1).

This chapter has six main sections. Section 6.2 provides a reflective summary of the four research questions analysed, as discussed in the previous chapter. Section 6.3 highlights the contributions of this study to Saudi Arabian educational theory and practice as well as our understanding of teacher CPD programmes across the world, especially in large developing countries. Section 6.4 suggests certain implications that the findings have for policy and practice. Section 6.5 presents the limitation of the study and the final section 6.6 recommends foci for further research in this area.

6.2 Key Research Findings

As Chapter 5 has already analysed and discussed the findings in full, the aim of this section is not to repeat the results but rather to summarise them and conceptually place them firmly within Guskey's theoretical framework.

6.2.1 Primary science teachers' perceptions towards f2f and online CPD programmes

Responses obtained from the questionnaires suggest satisfaction levels (Guskey's level 1) for the online CPD programme were higher than those of the f2f CPD programme, even though the contents of the online CPD programme were designed to be the same as the f2f CPD programme. The reasons given for this by respondents were mostly to do with flexibility in time and place and the cost effectiveness which characterises the online programme. This aligns with the notion that travelling to deliver or attend professional development may be a challenge (Brown and Green, 2003; Chen et al., 2009) considering that cost effectiveness is of greater importance in the current economic climate. More specifically, some respondents suggested that learning online is a more accessible practice and learners can study at their own pace, meaning they can fit the programme into their professional and private commitments more easily. Others suggested reasons might be related to variations in the f2f CPD programme providers, who might vary in such factors such as the quality of instruction, delivery of the material, the time spent on each topic and time spent discussing a topic. This current study has observed the overall advantages which the online CPD programme has in comparison to the f2f CPD programme with reference to teachers' satisfaction. This is in agreement with other studies of a similar nature (Driscoll et al., 2012; Fisher et al., 2010; Fishman et al., 2013; Russell et al., 2009a).

6.2.2 The impact of f2f and online CPD programmes on teachers' knowledge and skills

The interview results indicated that the level of understanding of the 5Es instructional model (Guskey's level 2) among the teachers in both programmes was similar with both groups being positive about the programme. Although this is a small sample, some of the data from the interviewees suggests the online programme had a slight advantage over the f2f programme, however, in other areas the f2f CPD programme displayed some advantages of its own. The f2f CPD programme seemed to have a greater impact in terms of providing a much wider range of practical engagement strategies of the 5Es instructional model (Bybee et al., 2006) compared to the online programme. In contrast, when it came to understanding the explanation level of 5Es instructional model (Bybee et al., 2006), the online CPD programme proved to be more effective. It may be a

general rule that online CPD programmes have as much impact as f2f CPD programmes, regardless of the context. For example, a study by Ryan (2002) evaluating students' learning in a mathematical course of study at an undergraduate level proved that a similar level of effectiveness of the f2f course may be obtained with the adoption of an online approach. Overall, the findings of this study with regard to teachers' learning are in line with other studies, which indicate that learning online is at least as effective as learning in a f2f environment (Fisher et al., 2010; Fishman et al., 2013; Johnson et al., 2000; Killion, 2000; Russell et al., 2009a; Russell, 1999; Tucker, 2001).

6.2.3 The impact of f2f and online CPD programmes on the organisation and organisational support

The findings revealed that there was a little or no impact from either CPD programme on the sampled educational organisations (Guskey's level 3). The results also indicated that there was no conflict with school policies in terms of the online CPD programme whereas, in the case of f2f provisions, a certain degree of co-ordination was required to cover teachers' absence when they attended the programme. In the online CPD programme, participants had no such issues with attendance and acknowledged the fact that they could engage in the programme anytime and anywhere. There was also partial evidence, however, that administrative teams were prepared to support teachers in attending the f2f CPD programmes and in supporting teachers in applying the programme's principles in the classroom. This contradicts Almazroa et al. (2015) and Alhajeri (2004), as well as other similar studies, which claim that educational organisations in Saudi Arabia often do not assist teachers to attend CPD programmes because of, for example, a lack of substitute teachers, heavy workloads and inappropriate timing of the CPD programme

6.2.4 The impact of f2f and online CPD programmes on science teachers' practice

The observational findings revealed little difference in classroom interaction before and after the CPD programmes in both the online and the f2f groups as practices and methods (Guskey's level 4) were very similar in both observations. The interview responses also revealed little change in teaching practice as a result of the teachers' participation in the programmes. The findings suggested that the online CPD

programmes were at least as effective as the f2f CPD programmes. Teachers from both groups felt that they could apply the 5Es instructional model effectively and confidently, although there were often external factors that could have affected its successful implementation, such as time constraints and class size issues. This findings reinforce other study findings such as Fisher et al. (2010), Fishman et al. (2013) and Russell et al. (2009a) who have highlighted a positive effects on teachers' knowledge and instructional practices with the use of the online method of conducting CPD programmes.

Although an evaluation of student learning is not the focus of this study, data on this was gathered from teachers' interview responses in order to triangulate the other findings. From the study's findings it was clear that online CPD programmes can be as effective as f2f CPD programmes.

Thus, from the overall data provided by the study, it seems that the online delivery of the planned CPD programmes is the most appropriate within the Saudi context and culture, rather than the traditional f2f methods of CPD delivery. The current f2f CPD programmes in Saudi Arabia are faced with many challenges which limit their effectiveness. This includes the fact that Saudi Arabia is a vast country and, for participants to travel to attend CPD programmes, it can prove to be too costly and time consuming. Furthermore, there is a noticeable shortage in the number of qualified CPD programme providers and instructors. It must also be recognised that Saudi culture does not permit mixing of different sexes, and females are not allowed to travel on their own. The online delivery of CPD programmes is envisaged to overcome many of these problems, since it will be available to all teachers, irrespective of geographical location or gender.

6.3 Contribution of the study

The findings of this study make several significant contributions, not only to Saudi Arabian educational theory and practice, but also to our understanding of teacher CPD globally. There are four key areas that the researcher has identified, in which this study has contributed to the literature.

Firstly, the core contribution of this study is in demonstrating that online CPD programmes can be as effective as f2f CPD programmes in delivering the same

materials, which in this case is the 5Es instructional model relating to science teachers in a large country such as Saudi Arabia. Online CPD programmes can save time and money in delivering CPD programmes, thus increasing the opportunity for teachers to participate in them, which should lead to higher standards in teaching if adopted in Saudi Arabia and across the world.

Secondly, one of the strengths of this study is that it is timely and topical; its focus is consistent with the King Abdullah Tatweer project's goals regarding the development of education in Saudi Arabia (Tatweer, 2012). The Ministry of Education is interested in using online CPD programmes in training and developing teachers via the Tatweer project (Tatweer, 2012), which was recently launched. The findings of this study will provide a clear impression to the stakeholders in the Tatweer project and the Ministry of Education in Saudi Arabia about the potential that online formats of CPD provision have in acting as effective training media which can be used to address some of the shortcomings in the current f2f programmes.

Thirdly, most CPD programmes in schools are evaluated according to Guskey's lower levels (teacher satisfaction and learning and skills outcomes) and the data for these evaluations is usually collected via survey methods, either on the day of training or immediately after the event (Goodall and Britain, 2005; Muijs and Lindsay, 2008). However, to achieve a more concrete evaluation of online professional development a deeper analysis is suggested (Lowden, 2005). Therefore, this study is one of the first to compare the evaluations about the impact of the online and the f2f CPD programmes using the higher levels of assessment criteria as well as organisational change and levels of support and the impact, particularly among science teachers, on classroom practices.

Fourthly, this study has made a methodological contribution. It achieved this by using both quantitative and qualitative methods to gather and apply a range of congruent but different approaches in analysis using Guskey's evaluation framework (Guskey, 2000). This triangulated methodological approach has contributed to the study's impact on scholarship by ensuring reliable and valid results from which provisional but evidence-based conclusions can be drawn. This study used the FIAC system (Flanders, 1966) to evaluate teaching practices. FIAC helped in recording teachers' verbal communication in the classroom, in particular in providing data to facilitate the comparison between the two CPD programmes, but is less useful in assessing practical activities. For this reason,

and as part of the researcher's mixed research methods, interviews were employed to validate the data and to cover any shortcomings of the method. Furthermore, using both interviews and observation (FIAC), the researcher was able to compare the respective results, thus strengthening the study's findings (see Table 5.2.3).

6.4 Implications of the Study

Based on the findings of the study, there are several major policy and practice implications that might be considered for improving science teachers' teaching and impact in Saudi Arabia, particularly since the Ministry of Education is in the process of reforming its science and maths educational provisions (Tatweer, 2012) initiative. Hence, the following sections discuss the implications of online CPD programmes as an alternative method for delivering training programmes in a large country like Saudi Arabia for the Ministry of Education (policy makers), CPD programme providers, schools administration and their science teachers.

6.4.1 Implications for the Ministry of Education in Saudi Arabia (Policy Makers)

This study implies several possibilities for the Ministry of Education, as it is responsible for setting policies and making decisions on the precise kinds of CPD programme that will be supported and implemented financially and in terms of infrastructure. It appears that, because there is no published research investigating the impact of online CPD programmes as compared to f2f CPD in Saudi Arabia, that the Ministry of Education possibly does not have a clear picture of the benefits that can be accrued by using online CPD programmes in training teachers. It is clear from the findings that Saudi science teachers were satisfied with the online CPD programme – even more so than with the f2f CPD programme. The findings also reported that the impact of the online CPD programme is no less than that of the f2f programme on teacher learning and on teaching practice. In certain areas the online programme is found to be more effective. Policy makers at the Ministry of Education and those involved in the Tatweer project might consider increasing the opportunities available for teachers to be trained via online programmes and may put this expansion of opportunity at the top of its agenda on teacher CPD programmes.

Policy makers at the Ministry of Education could use the data and findings of this study to further investigate the implementation of an online CPD programme, especially for training teachers in different and more innovative instructional models in order to change traditional approaches to achieve the widespread use of active learning models such as the 5Es instructional model. Policy makers might investigate the potential online CPD programme has for rolling out CPD to a wider teacher audience, because the findings suggests that the flexibility of this mode of training and learning was valued by the teachers.

The findings indicate that there is no conflict with school policies in terms of the online CPD programme, whereas, in the case of f2f CPD programme, a certain degree of co-ordination is required to cover teachers' absence when they attended the programme. In the online CPD programme, participants had no such issues with attendance and acknowledged the fact that they could engage in the programme anytime and anywhere.

6.4.2 Implications for CPD Programme Providers

The findings of this study confirmed that the online CPD programme produced no less impact than the f2f CPD programme – neither on teacher learning nor on actual practice. This result is significant for online CPD providers in Saudi Arabia and may well be of benefit to their counterparts in other countries, especially large developing countries.

It is reported that one of the advantages of the online CPD programmes compared to f2f was the additional time which the online programme allowed teachers, unlike the f2f course which for some respondents did not allow adequate time for the teachers to fully grapple with the information. Therefore, CPD programme providers could consider the duration of their programmes, as there might be need for an extension of those that currently exist. However, this dilemma encountered by CPD programme providers can be resolved by the introduction of online formats, as demonstrated by this study.

The findings also suggest that the levels of satisfaction towards the content of the online CPD programme was greater than the f2f CPD programme. This finding is unexpected as the content in the online and f2f programmes is identical, which leads to the conclusion that this result must be connected to other factors relating to the format, such as the quality of instruction, delivery of the material, the time spent on each topic and the time spent discussing a topic. The findings suggest that f2f CPD programme

providers may need to undergo training or a monitoring scheme to make sure that the delivery of the content is as effective as online CPD programmes. It also suggests that the online CPD programme be extensively evaluated and the advantages be adopted for the f2f CPD programmes.

Furthermore, the findings suggest that the discussion forum on the online CPD programmes is especially valued and mentioned favourably by the online group. Also, the teachers do not feel constrained by time, as is an instructor who has limited time to cover the material. Teachers who participated in the online CPD programme could also afford longer periods of time to ponder the course materials and reflect upon them during the discussions. Online CPD programme providers could ensure that their programmes facilitate a valuable degree of discussion among and between learners.

6.4.3 Implications for School Administrations and Teachers

The f2f CPD programmes can create organisational issues for school administrators. With regard to the teachers who participated in this study, the respective school administrations had to be informed and actively involved in finding replacement teachers to cover lessons that the science teachers were absent from due to their attendance at the CPD programme. With regard to the support received from the school, some teachers did mention that the administration was cooperative and positive towards the f2f CPD programme, its attendance and its application. This study suggests that the online programme did not create any demands on the administrative system of the participants' schools. Therefore school administrators should be made aware of the benefits which the online formats of CPD provisions can provide, and it is expected that this will be an attractive alternative to f2f methods of delivering CPD programmes as a result.

The study found that both online and f2f CPD programmes had no discernible impact on the organisational culture of the schools. It may be that if two or more teachers from each school participated in the CPD programme, the impact on school culture may have been very different because they would be able to support each other in the learning process. Furthermore, creating a learning network and/or facilitative CPD support groups in a school could perhaps help teachers to share best practice and to boost the impact of participation in CPD programmes. A number of teachers in this group claim that there is a need for more teachers from a single subject group to participate in online

CPD programmes and concomitantly for mechanisms to be in place for these teachers to share and discuss their learning and development with others.

The findings also suggest that when the online CPD programme was undertaken, the school administration was less engaged because it did not have to take any administrative measures, and the only way that the school would know the programme even existed was through the teachers participating in it informing them about it. This can lead to a lack of awareness and participation in the programmes. There is a need for the schools' head teachers to have a good degree of knowledge of the CPD programme, not only so the school administration can offer organisational support, but also so that the CPD programme is well-funded and a recognised component of the school's culture and norms. In this sense it is vital that head teachers be involved in some way in the CPD programmes.

The results also showed that teachers often lacked the time needed to share and discuss best practice. Some teachers found that the opportunity for online discussion with peers provided a valuable and needed experience of knowledge transfer. Head teachers might be able to give teachers enough time to share knowledge, best practice and overall experience with their professional peers.

The study also found that both programmes had a positive impact on providing effective training in the 5Es instructional model to the teachers, however there were external factors that negatively affected its implementation such as time constraints, class size issues and a lack of materials. Head teachers may consider these external and limiting factors and put necessary mitigations in place.

6.5 Limitations of the Study

As with all research projects, this study has a number of limitations which has affected the scope of the study. These reasons are due to the nature of the study, as well as cultural issues surrounding gender roles and expectations in Saudi Arabia. In this light, there are four main limitations to this study which have been perceived by the researcher.

Firstly, as explained in the methodology (section 4.7.1), because the study employs a mixed methods approach to answer the research questions, the sample of teachers who

participated were selected from a relatively small group and were chosen from only one geographical region (Al-Quwayiyah) in Saudi Arabia. This is because of time and funding limitations that arise as part of the PhD process. However, findings from a different region of Saudi Arabia are not anticipated to have a noticeable difference as Al-Quwayiyah is the largest and most populated province within the Riyadh district of Saudi Arabia with typified socio-cultural values and structures that prevail in other areas in Saudi Arabia.

Secondly, due to the prevalent cultural norms in Saudi Arabia, the researcher was unable to access female teachers to collect data from them, which has therefore limited the study to male teachers only. However, although only male teachers took part in this study, there is a possibility that a different, and perhaps more positive result in favour of the online approach, may be obtained in a study involving female teachers, for a number reasons. These include the fact that Saudi females work mostly at home due to family commitments and the additional fact that females do not drive, thus limiting their ability to attend the CPD course or additional costs of transport. Given these factors it is likely - although there is no evidence presented in this study - that female teachers would really appreciate the flexibility that online CPD programmes offer. This flexibility is also appreciated as some participants in this study indicated in their responses that online CPD programme are more flexible, giving them the opportunity to participate in CPD programme in the evenings or at night.

Thirdly, the evaluation framework used to assess the impact of the CPD programmes in this study was limited to Guskey's first four levels: (1) teacher satisfaction; (2) teacher learning; (3) organisational support and change; and (4) teacher practice and knowledge in the classroom. It does not include level 5 (student learning) as it is not considered possible to completely and accurately assess the improvement, or otherwise, of students' learning and understanding within the short time-frame of the study, because a comprehensive analysis would require the students to be rigorously tested and the results would need an in depth analysis, which may take years to come to fruition. Furthermore, including this level in another similar study would not necessarily add another dimension to the results on impact, as a number of studies have suggested that student learning does not necessarily suggest that any changes have come about as a result of CPD programmes (Fletcher and Barufaldi, 2002). In other words, it is difficult

to establish causality as there may be a number of alternative factors that can affect student performance.

A fourth limitation of this study is that it does not allow for laboratories, which facilitate practical work. The study does not address this issue, as recreating laboratory conditions online is potentially highly problematic. Laboratories can be used to train science teachers, especially in the field of chemistry, which may need teachers to know how to safely carry out practical work in the classroom. This kind of training is very different from other forms, as it necessitates close observation of learners' practical skills, who also need to see practical demonstrations for themselves. It was not within the scope of this work to address this issue, as it would need a specialized study that focuses on this facet specifically, to discover whether or not it is possible and practical to deliver this kind of training online using, for example, virtual laboratories.

Despite these limitations, this study remains relevant because the results have important implications for the decision making process regarding the implementation of new online CPD programmes in Saudi Arabia.

6.6 Recommendations for Further Studies

Based on the findings of the study, and bearing in mind its limitations, a number of viewpoints have been identified which could add more knowledge and recommendation to the current research. In light of this, the following foci of study are recommended to future researchers:

Firstly, as this study was only conducted on *male* teachers of science, it might be beneficial to conduct a similar study on female teachers in Saudi Arabia, even though it is anticipated that the online CPD programmes would be slightly more popular with women as a result of associated time pressure and family commitments. There may be hidden factors which could be brought to light through a study such as this which will help inform Saudi educational policy makers. Furthermore, it could be expanded to other disciplines, such as Languages, Mathematics, etc., to eliminate any subject specific biases that could be hidden to the researcher.

Secondly, more comparative studies on the impact of such phenomena as social media and the internet generally on teachers and students is needed because of the dramatic

growth in new technologies used by both, as well as by wider society. We still know little about the impact of these communication technologies on learning, training and professional development, and there may be scope to explore the utilization of these media to assist in the delivery of CPD programmes. Also more in-depth studies into the extent of IT literacy and online proficiency in Saudi Arabia should be conducted to identify possible challenges and provide necessary mitigations.

Thirdly, further studies that include more members of school staff in the evaluation, such as deputy head teachers and head teachers may be conducted. Fourthly, an international comparative study based on other countries could be carried out to examine the impact of online and f2f CPD programmes on science teachers' pedagogical practices for comparison and validation with the obtained results. Finally, other contexts such as higher education levels (secondary schools), other age brackets and different subjects (such as Mathematics, Languages, etc.) may also be studied to identify any difference between the impact of online CPD and f2f CPD programmes in those contexts.

It is anticipated that these suggested areas of research will add weight to the present research and further inform policy makers in deciding whether or not the implementation of online CPD programmes will have a positive impact on the quality of teaching in Saudi Arabia.

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Appendixes

Appendix 1: CPD Programmes outline

Programme details	
Programme name:	5Es Instructional Model
Subject:	Science
Target teacher:	Primary Science Teachers
Length of Programme:	5 hours

Summary of Programme Needs:

This course focuses on training teachers to the 5Es instructional model. It also teaches high-quality planning sessions based around the 5Es model.

Objectives of the programme:

It expected at the end of the course that teacher should be able to:

- Identify constructivism theory concepts.
- Understand the educational foundation of the 5Es instructional model.
- Appreciate the concept of the 5Es instructional model.
- Understand the different 5Es instructional levels.
- Understand and appreciate the knowledge of teacher and the student role in every level of the 5Es instructional model.
- Understand the skills that help teachers to design and plan lessons based on the 5Es instructional model.
- Apply a 5Es instructional model in a lesson.

Appendix 2: CPD programmes topics

Programme Topics		
Session	Topic	Time
First session	- The Constructivism approach. - Introduction to the 5Es instructional model. - The concept of the 5Es instructional model. - Phases of the 5Es instructional model.	90m
Second session	- The role of the teacher and the students in each level of the 5Es instructional model. - The relationship between the 5Es instructional model and other instructional models.	60m
Third session	- Designing and planning a 5Es instructional model lesson.	60m
Fourth session	- Applying the 5Es instructional model in the classroom.	90m

Appendix 3: Interface of the online CPD programme

Appendix 4: Ministry of Education's experts' letter.

Dear Mr.....

Please find enclosed a copy of the CPD course in the use of the Bybee 5Es instructional model. The course is a transformation of the face-to-face CPD course in current use for primary science teachers in Saudi Arabia. The course will then be staged online and further evaluated for effective CPD delivery as part of my PhD research.

You are, therefore, kindly requested to review this proposed course and compare it to the face-to-face CPD course with special reference to:

- Content
- Objectives
- Intended learning outcomes
- Assessment methods

Thank you for your anticipated cooperation.

Yours sincerely

Suliman Binmohsen
PhD in Education

Reply to the researcher (please tick as appropriate):
After reviewing the CPD course in using the 5Es model, I think that:

✓ The online CPD course is an exact replica of the face-to-face CPD course as are as content, objectives, intended learning outcomes and assessment methods are concerned.

☐ The online CPD course is not an exact replica o the face-to-face CPD course. The following amendments are required:

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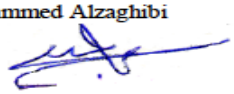
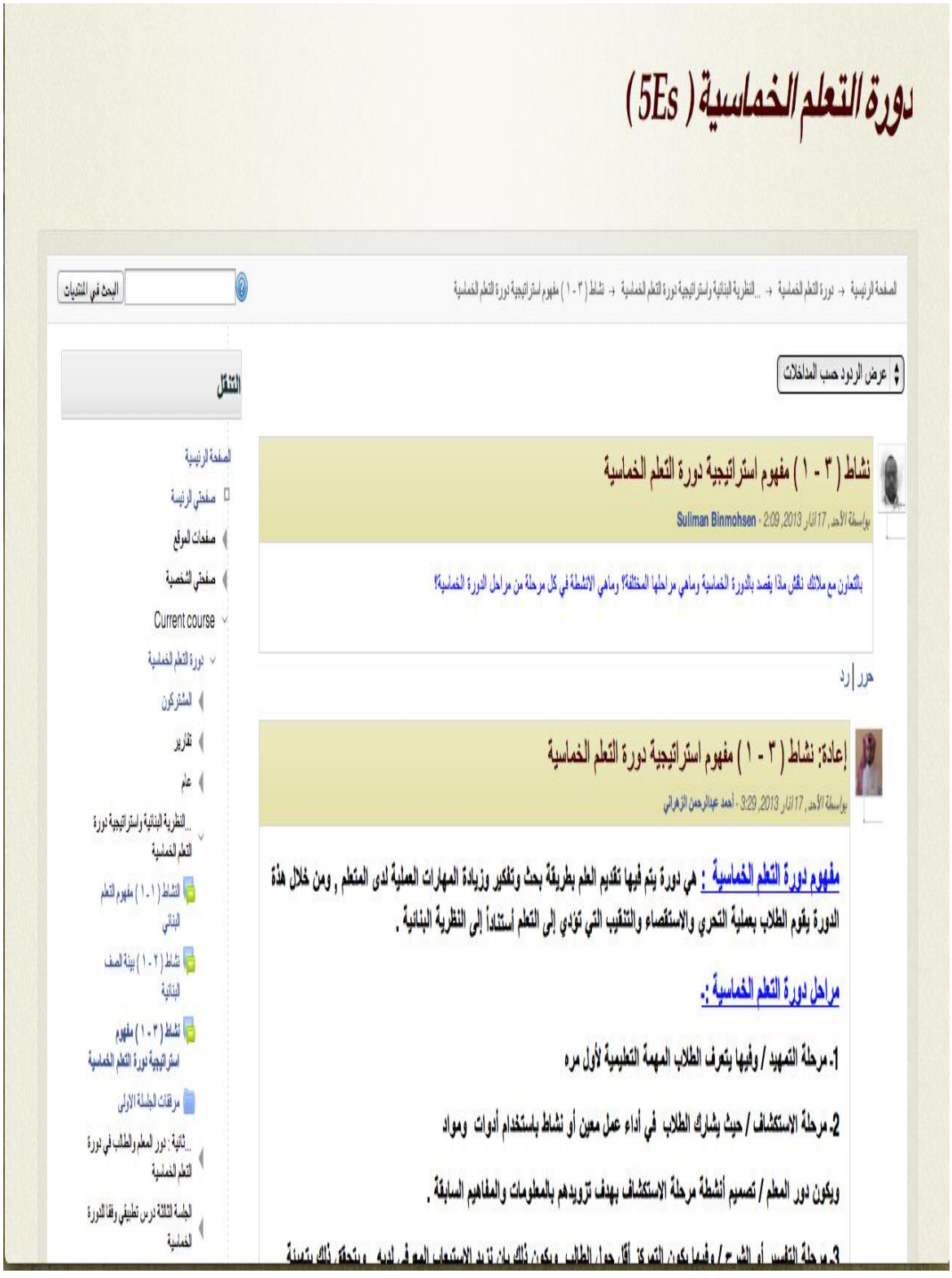
Name: Mohammed Alzaghibi
Signature: 

Occupation: Supervisor of Science and Math Project
Date: 14 Feb 2013

Appendix 5: An example of teacher post.



Appendix 6: Questionnaire of f2f CPD programme (English version)

Teacher Code:……. *Face to face CPD Programme*

How satisfied were you with the following aspects? Please rate your satisfaction as follows:

CPD Programme content: 1=Very dissatisfied 2= dissatisfied 3= unsure 4 = Satisfied 5 = Very Satisfied						
1. The programme was generally useful.	1	2	3	4	5
2. The aims of the programme were fully met.	1	2	3	4	5
3. The aims of the programme were appropriate to my needs.	1	2	3	4	5
4. The programme in general was clear and easy to understand.	1	2	3	4	5
5. All topics were covered in sufficient detail.	1	2	3	4	5
6. The content was arranged in a clear, logical manner.	1	2	3	4	5
7. The programme contained activities that helped me understand the 5Es model	1	2	3	4	5
8. The content was relevant to the 5Es instructional model.	1	2	3	4	5
CPD Programme Process: 1=Very dissatisfied 2= dissatisfied 3= unsure 4 = Satisfied 5 = Very Satisfied						
9. Explanation of the course aims and objectives.	1	2	3	4	5
10. Quality of the instruction	1	2	3	4	5
11. Quality of the activities	1	2	3	4	5
12. Quality of the materials	1	2	3	4	5
13. The programme time management.	1	2	3	4	5
14. Time spent on each topic of the programme.	1	2	3	4	5
15. The instructional process was motivated.	1	2	3	4	5
CPD Programme Context: 1=Very dissatisfied 2= dissatisfied 3= unsure 4 = Satisfied 5 = Very Satisfied						
16. Flexibility of the programme in terms of its time.	1	2	3	4	5
17. Flexibility of the programme in terms of location.	1	2	3	4	5
18. Flexibility of the programme in terms of access materials.	1	2	3	4	5
19. Cost-effectiveness of the programme.	1	2	3	4	5
20. Helpfulness of programmes facilitator.	1	2	3	4	5
21. The temperature of the room.	1	2	3	4	5
22. The comfort of the chair	1	2	3	4	5
23. The environment offers opportunity for interaction with your colleague during the discussions.	1	2	3	4	5
24. Satisfaction of the face-to-face mode – if compared with an online mode.	1	2	3	4	5

25. What part of the programme did you find most interesting?

……

……

……

……

26. Any additional information you wish to add?

……

……

……

Appendix 7: Questionnaire of online CPD programme (English version)

Teacher Code: ……. Online CPD programme

How satisfied were you with the following aspects? Please rate your satisfaction as follows:

CPD Programme content: 1=Very dissatisfied 2= dissatisfied 3= unsure 4 = Satisfied 5 = Very Satisfied						
1. The programme was generally useful.	1	2	3	4	5
2. The aims of the programme were fully met.	1	2	3	4	5
3. The aims of the programme were appropriate to my needs.	1	2	3	4	5
4. The programme in general was clear and easy to understand.	1	2	3	4	5
5. All topics were covered in sufficient detail.	1	2	3	4	5
6. The content was arranged in a clear, logical manner.	1	2	3	4	5
7. The programme contained activities that helped me understand the 5Es model.	1	2	3	4	5
8. The content was relevant to the 5Es instructional model.	1	2	3	4	5
CPD Programme Process: 1=Very dissatisfied 2= dissatisfied 3= unsure 4 = Satisfied 5 = Very Satisfied						
9. Explanation of course aims and objectives.	1	2	3	4	5
10. Quality of the instruction.	1	2	3	4	5
11. Quality of the activities.	1	2	3	4	5
12. Quality of the materials.	1	2	3	4	5
13. The programme time management.	1	2	3	4	5
14. Time spent on each topic of the programme.	1	2	3	4	5
15. The instructional process was motivated.	1	2	3	4	5
CPD Programme Context: 1=Very dissatisfied 2= dissatisfied 3= unsure 4 = Satisfied 5 = Very Satisfied						
16. Flexibility of the programme in terms of its time.	1	2	3	4	5
17. Flexibility of the programme in terms of location.	1	2	3	4	5
18. Flexibility of the programme in terms of access materials.	1	2	3	4	5
19. Cost-effectiveness of the programme.	1	2	3	4	5
20. Helpfulness of the programme facilitator.	1	2	3	4	5
21. Interactivity of the website.	1	2	3	4	5
22. The environment offers the opportunity for interact with other virtual students in group discussion.	1	2	3	4	5
23. Feeling of involvement with other students in class in an online community.	1	2	3	4	5
24. Satisfaction of the online training mode – as compared with face-to-face mode.	1	2	3	4	5

25. What part of the programme did you find most interesting?

……

……

……

……

26. Any additional information you wish to add?

……

……

……

……

Appendix 8: Questionnaire of f2f CPD programme Arabic version

ضع دائرة حول الاجابة المناسبة

٥= مرضي جد ٤= مرضي ٣= لا أعلم ٢=غير مرضي ١=غيرمرضي جدا محتويات البرنامج :

البرنامج بشكل عام مفيد.	١	٢	٣	٤	٥
البرنامج حقق اهدافه بشكل كامل.	١	٢	٣	٤	٥
أهداف البرنامج كانت مناسبة لاحتياجاتي التدريبية .	١	٢	٣	٤	٥
البرنامج بشكل عام كان واضحا وسهلا.	١	٢	٣	٤	٥
1. المواضيع كانت معروضة بشكل تفصيلي	١	٢	٣	٤	٥
2. الموضيع مرتبة بشكل واضح ومنطقي.	١	٢	٣	٤	٥
3. البرنامج احتوى على أنشطة ساعدت في فهم الدورة الخماسية	١	٢	٣	٤	٥
4. جميع محتويات البرنامج مرتبطة بالدورة الخماسية.	١	٢	٣	٤	٥

٥= مرضي جدا ٤= مرضي ٣= لا أعلم ٢=غير مرضي ١=غيرمرضي جدا اجراءات تنفيذ البرنامج :

5. أهداف البرنامج كانت واضحه.	١	٢	٣	٤	٥
6. اسلوب التدريب ذوجودة عالية.	١	٢	٣	٤	٥
7. أنشطة البرنامج كانت مناسبة.	١	٢	٣	٤	٥
8. ادوات البرنامج المصاحبةكانت ذا جودة.	١	٢	٣	٤	٥
9. ادارة الوقت كانت دقيقة.	١	٢	٣	٤	٥
10. جميع المواضيع اخذت ما يناسبها من الوقت.	١	٢	٣	٤	٥
11. عملية التدريب كانت محفزة.	١	٢	٣	٤	٥

٥= مرضي جدا ٤= مرضي ٣= لا أعلم ٢=غير مرضي ١=غيرمرضي جدا سياق البرنامج :

12. وقت البرنامج كان مرنا.	١	٢	٣	٤	٥
13. الوصول الى موقع البرنامج كان سهلا.	١	٢	٣	٤	٥
14. سهولة الحصول على المصادرأثناء الدورة كان ميسرا.	١	٢	٣	٤	٥
15. حضورالبرنامج غير مكلف ماديا.	١	٢	٣	٤	٥
16. المدرب كان متعاونا ومتفاعلا.	١	٢	٣	٤	٥
17. درجة حرارة الغرفة كانت مناسبة .	١	٢	٣	٤	٥
18. مقاعد قاعة التدريب كانت مريحة .	١	٢	٣	٤	٥
19. فرصةالتفاعل مع الزملاء في المناقشة كانت متاحة.	١	٢	٣	٤	٥
20. مدى رضاك عن التدريب من خلال التدريب التقليدي وجها وجها مقارنة الانترنت مقارن.	١	٢	٣	٤	٥

Appendix 9: Questionnaire of online CPD programme Arabic version

ضع دائرة حول الاجابة المناسبة

٥= مرضي جدا ٤= مرضي ٣= لا أعلم ٢=غير مرضي ١=غيرمرضي جدا محتويات البرنامج :

1. البرنامج بشكل عام مفيد.	١	٢	٣	٤	٥
2. البرنامج حقق اهدافه بشكل كامل.	١	٢	٣	٤	٥
3. أهداف البرنامج كانت مناسبة لاحتياجاتي التدريبية .	١	٢	٣	٤	٥
4. البرنامج بشكل عام كان واضحا وسهلا.	١	٢	٣	٤	٥
5. المواضيع كانت معروضة بشكل تفصيلي	١	٢	٣	٤	٥
6. المواضيع مرتبة بشكل واضح ومنطقي.	١	٢	٣	٤	٥
7. البرنامج احتوى على أنشطة ساعدت في فهم الدورة الخماسية	١	٢	٣	٤	٥
8. جميع محتويات البرنامج مرتبطة بالدورة الخماسية.	١	٢	٣	٤	٥

٥= مرضي جدا ٤= مرضي ٣= لا أعلم ٢=غير مرضي ١=غيرمرضي جدا اجراءات تنفيذ البرنامج :

9. أهداف البرنامج كانت واضحه.	١	٢	٣	٤	٥
10. اسلوب التدريب ذوجودة عالية.	١	٢	٣	٤	٥
11. أنشطة البرنامج كانت مناسبة.	١	٢	٣	٤	٥
12. ادوات البرنامج المصاحبةكانت ذا جودة.	١	٢	٣	٤	٥
13. ادارة الوقت كانت دقيقة.	١	٢	٣	٤	٥
14. جميع المواضيع اخذت ما يناسبها من الوقت.	١	٢	٣	٤	٥
15. عملية التدريب كانت محفزة.	١	٢	٣	٤	٥

٥= مرضي جدا ٤= مرضي ٣= لا أعلم ٢=غير مرضي ١=غيرمرضي جدا سياق البرنامج :

16. وقت البرنامج كان مرنا.	١	٢	٣	٤	٥
17. الوصول الى موقع البرنامج كان سهلا.	١	٢	٣	٤	٥
18. سهولة الحصول على المصادرأثناء الدورة كان ميسرا.	١	٢	٣	٤	٥
19. حضورالبرنامج غير مكلف ماديا.	١	٢	٣	٤	٥
20. المشرف على البرنامج كان متعاونا ومتفاعلا.	١	٢	٣	٤	٥
21. الموقع كان جذابا.	١	٢	٣	٤	٥
22. فرصةالتفاعل مع الزملاء في المناقشة كانت متاحة.	١	٢	٣	٤	٥
23. شعرت بالاندماج التام مع الزملاء على الموقع.	١	٢	٣	٤	٥

Appendix 10: Print screen of online questionnaire

بطاقة تقييم الدورة التدريبية

الاجابات المسلمة: 10
أسئلة: 27

وصف

بسم الله الرحمن الرحيم

عزيزي معلم العلوم المحترم

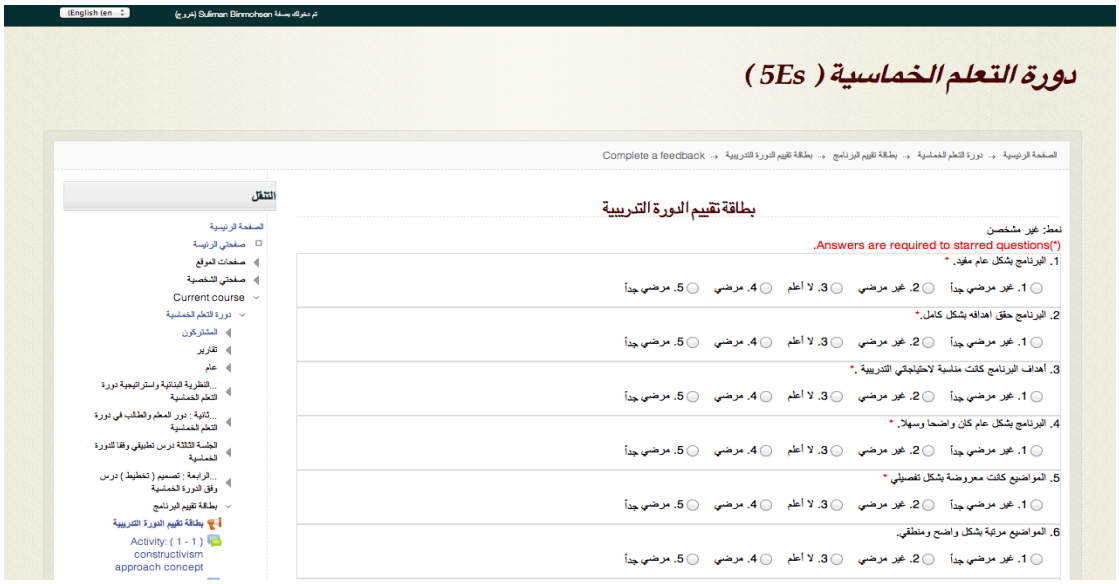
السلام عليكم ورحمة الله وبركاته وبعد :

أفيدكم بأني أقوم حاليا بدراسة الدكتوراه في التربية في جامعة يورك في المملكة المتحدة. دراستي تهدف إلى تقييم اثر التطوير المهني المستمر لمعلمي العلوم عن طريق الانترنت مقارنة بالتطوير التقليدي وجها لوجه على اداء المعلم داخل الصف. توجد استبانة علمية مرفقة، وهي إحدى ادوات جمع البيانات في هذه الدراسة والذي يحتوي على مجموعة من الأسئلة التي تهدف إلى قياس مدى رضاك عن البرنامج التدريبي الذي شاركت فيه، والذي كان بعنوان :استراتيجية دورة التعلم الخماسية. إن مشاركتك في الاستجابة لهذه الاستبانة هو من الأمور التي تعني الكثير للباحث والتي من المتوقع أن تسهم في إثراء البحث وبالتالي تعود بالنفع على العملية التعليمية ومنسوبيها. فارجو أن تمنح من وقتك عدة دقائق لاستكمال هذا الاستبيان. مع ملاحظة أن إجاباتك لن تؤثر على اداءك او وظيفتك حاليا او مستقبلا، وهنا ينبغي طمانة الجميع بانه سيتم مراعاة جميع اخلاقيات البحث العلمي عند الإشارة إلى الاستبيان او الإفادة منه او حفظه، وان جميع المعلومات التي تقدمونها لن تستخدم لغير اغراض هذه الدراسة.
إذا كان لديك اي استفسار عن كيفية تعبئة الاستبيان فارجو التواصل معي عن طريق الهاتف 0505412254
او من خلال الموقع او الايميل sulm54@hotmail.com

شاكرا ومقدرا تعاونكم

اخوكم الباحث : سليمان عبدالله المحسن

Page after submit

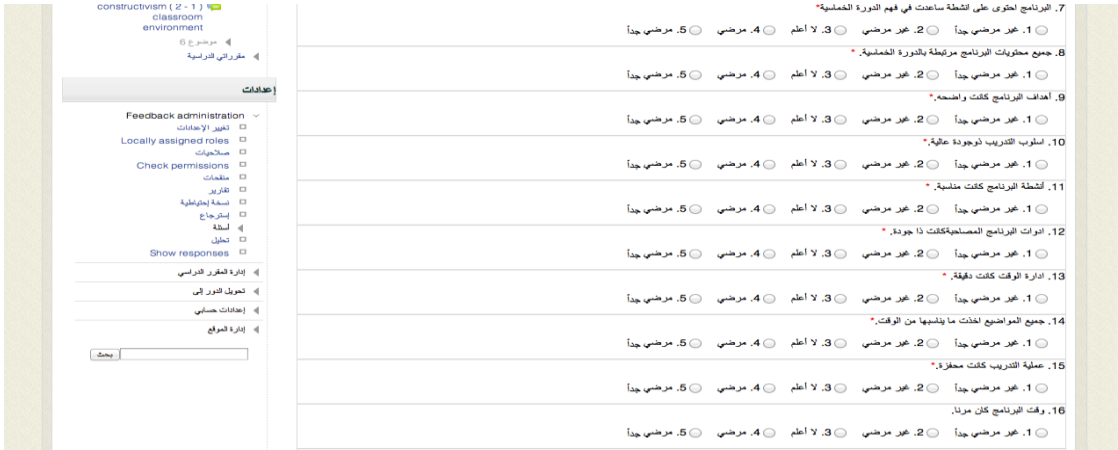


دورة التعلم الخماسية (5Es)

بطاقة تقييم الدورة التدريبية

نمط: غير مشخصن
(*)Answers are required to starred questions.

1. البرنامج بشكل عام مفيد. *
2. البرنامج حقق اهدافه بشكل كامل.*
3. أهداف البرنامج كانت مناسبة لاحتياجاتي التدريبية .*
4. البرنامج بشكل عام كان واضحا وسهلا. *
5. المواضيع كانت معروضة بشكل تفصيلي *
6. المواضيع مرتبة بشكل واضح ومنطقي.



7. البرنامج احتوى على انشطة ساعدت في فهم الدورة الخماسية*
8. جميع محتويات البرنامج مرتبطة بالدورة الخماسية. *
9. أهداف البرنامج كانت واضحه.*
10. أسلوب التدريب ذوجودة عالية.*
11. أنشطة البرنامج كانت مناسبة. *
12. ادوات البرنامج المصاحبةكانت ذا جودة. *
13. ادارة الوقت كانت دقيقة. *
14. جميع المواضيع اخذت ما يناسبها من الوقت.*
15. عملية التدريب كانت محفزة.*
16. وقت البرنامج كان مرنا.

Appendix 11: Questionnaire cover letter

عزيزي معلم العلوم المحترم

السلام عليكم ورحمة الله وبركاته وبعد :

أقوم حاليا بدراسة الدكتوراه في التربية في جامعة يورك في المملكة المتحدة. دراستي تهدف الى تقييم أثر التطوير المهني المستمر لمعلمي العلوم عن طريق الانترنت مقارنة بالتطوير التقليدي وجها لوجه على أداء المعلم داخل الصف.

توجد استبانة علمية مرفقة ، وهي إحدى أدوات جمع البيانات في هذه الدراسة والذي يحتوي على مجموعة من الاسئلة من التي تهدف الى قياس مدى رضاك عن البرنامج التدريبي الذي شاركت فيه والذي كان بعنوان :استراتيجية دورة التعلم الخماسية.

إن مشاركتك في الاستجابة لهذه الاستبانة من الامور التي تعني الكثير للباحث والتي من المتوقع أن تسهم في اثراء البحث وبالتالي تعود بالنفع على العملية التعليمية ومنسوبيها. فأرجو ان تمنح من وقتك عدة دقائق لا ستكمال هذا الاستبيان، مع ملاحظة أن إجاباتك لن تؤثر على أدائك أو وظيفتك حاليا او مستقبلا ،وهنا ينبغي طمأنة الجميع بأنه سيتم مراعاة جميع أخلاقيات البحث العلمي عند الاشارة الاستبيان او الافادة منه أو حفظه، وأن جميع المعلومات التي تقدمونها لن تستخدم لغير اغراض هذه الدراسة.

اذا لديك اي استفسار عن كيفية تغبئة الاستبيان فارجو الاتصال معي عن طريق لهاتف 0505412254

او من خلال الايميل sulm54@hotmail.com

شاكر ومقدر تعاونكم

الباحث / سليمان عبدالله المحسن

Appendix 12: Semi- structured interview. (English version)

Interview questions for the participant

I appreciate your participation in the CPD programme. I have some questions I'd like to ask you related to this programme. Do you mind if I tape the interview? It will help me stay focused on our conversation and will ensure that I have an accurate record of what was discussed.

Guskey Level 2: Teachers' learning

1. Have you learned something from the programme? If so, what specific outcomes have you achieved from the CPD programme? Please give an example. If not, could you please tell me the reason for your answer?
2. What instructional strategies do you use to promote student engagement?
3. Could you tell me what you understand by explanation?
4. Could you please explain what the teacher's role is at the explanation level? Give an example.
5. What is the student's role at the exploration level? Please give an example.

Guskey Level 3: Organizational Support & Change

6. Have you told your colleagues anything about the CPD programme?
7. Has the CPD programme affected your organizational climate or procedures? What has the impact of the CPD programme been, for example, on the school, administrations, head teacher, duty head teacher etc.)?
8. Were any organizational policies of the school in conflict with the programme or activity goals?

Guskey Level 4: Teachers' use of new knowledge

9. Has your practice changed in the classroom? If so, in what respect? Could you please give me an example?
10. Do you feel you can effectively apply the 5Es instructional model in your class? How? Could you give me an example?
11. Can you tell me which level of the 5Es you used in the lesson I observed today?

Guskey Level 5: Student' Learning outcome

12. What do you think the impact of CPD programme has been on your students?
13. Have you noticed any change in the students' learning? How? Could you give me an example?
14. To what extent has the students' confidence as learners developed?
15. Do you have any additional thoughts you want to add?

Appendix 13: Semi- structured interview (Arabic version)

بسم الله الرحمن الرحيم

عزيزي المعلم

السلام عليكم ورحمة الله وبركاته وبعد :

اقدر مشاركتك في البرنامج التدريبي . لدي بعض الأسئلة التي أريد أن أسئلك حول البرنامج.

هل لديك مانع أن أقوم بتسجيل المقابلة ؟. سوف تساعدني على التركيز على المحادثة والتسجيل الدقيق لما سيتم مناقشته.

المستوى الثاني : تطور المهارات والمعارف

1. هل تعلمت من البرنامج ؟ اذا كان نعم ؟ ماهي المخرجات بالتحديد التي حصلت عليها من هذا البرنامج ؟ ممكن تعطيني مثال على ذلك ؟ واذا كان لا ؟ ممكن تعطيني سبب لاجابتك؟

2. ماهي الاستراتيجيات التدريسية التي تستخدمها لاشراك الطالب في الدرس ؟

3. ممكن ان تذكر لي عن ما تعرفه عن مرحلة الشرح ؟

4. ممكن تشرح لي ماهو دور المعلم في مرحلة الشرح؟ اذكر مثال ؟

5. ماهو دور الطالب في مرحلة الاكتشاف؟ اذكر مثالا على ذلك ؟

المستوى الثالث : تأثير البرنامج على المنظمة التعليمية

6. هل تحدثت لأحد من زملائك أو لإدارة المدرسة عن البرنامج التدريبي ؟

7. هل البرنامج أثر على البيئة أوسياسيات المدزسية؟ ماهو التأثير على سبيل المثال (على المدرسة ، ادارة المدرسة، مدير المدرسة، وكيل المدرسة .. الخ)؟

8. هل هناك أي من سياسات المدرسة التي تتعارض مع البرنامج أوأهدافه؟

المستوى الرابع : استخدام المعلم للمهارات في الفصل

9. هل طريقة التدريس داخل الفصل تغيرت ؟اذا كان كذلك، إلي أي مدى ؟ ممكن تعطيني مثال ؟

10. هل انت تطبق الدورة الخماسية في الصف بشكل فعال؟كيف ؟ ممكن تعطي مثالا على ذلك ؟

11. ممكن تذكر لي في أي مرحلة من مراحل الدورة الخماسية استخدمت اليوم في الدرس الذي زرتك فيه ؟

المستوى الخامس : تحصيل الطلاب

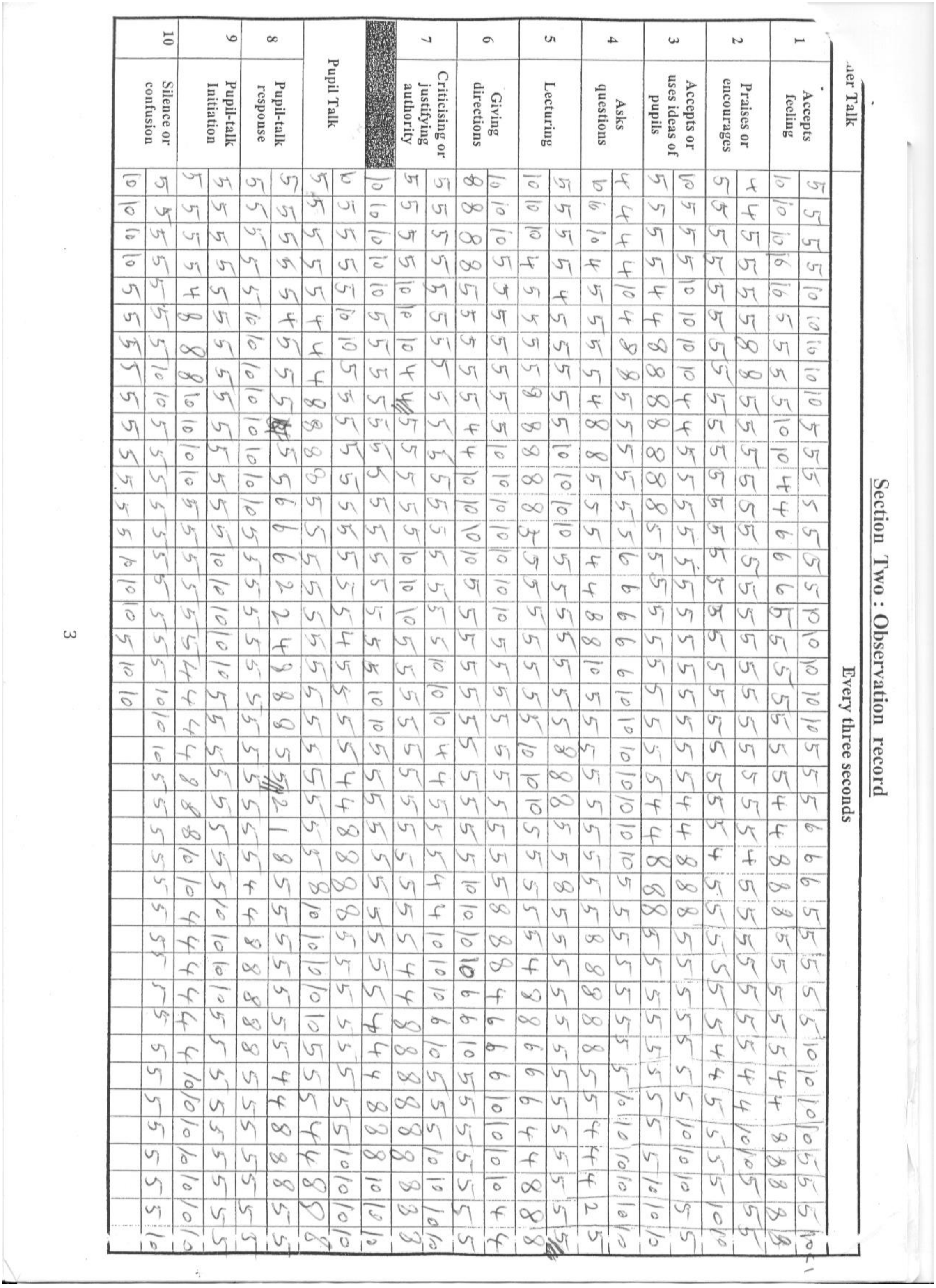
12. ماهو تأثير البرنامج على الطلاب ؟هل لاحظت أي تغيير في أداء الطلاب ؟

13. هل تتوقع ان المستوى التحصيلي للطلاب تحسن ؟كيف ؟ ماهو الدليل على تحسن أداء التلاميذ؟

14. إلى أي مدى تحسنت ثقة الطلاب كمتعلمين ؟

15. هل لديك أي معلومات تريد اضافتها ؟

Appendix 14: observation record sheet (FIAC system)



Appendix 15: The ethical issues audit form

Department of Education

Ethical Issues Audit Form

This questionnaire should be completed for each research study that you carry out as part of your degree. You should discuss it fully with your supervisor, who should also sign the completed form.

Surname / family name:	Binmohsen
First name / given name	Suliman
Programme:	PhD in science Education
Supervisor (of this research study):	Dr Ian Abrahams
Topic (or area) of the proposed research study:	online CPD
Where the research will be conducted:	In SaudiArabia
Methods that will be used to collect data:	observation, Interview

To be completed by the supervisor of the research study (after reviewing the form):

Please ☒ one of the following options.

q☑	I believe that this study, as planned, meets normal ethical guidelines
q	I am unsure if this study, as planned, meets normal ethical guidelines
q	I believe that this study, as planned, does not meet normal ethical guidelines and requires some modification

Signed: I. E. Abrahams Date: 26/3/12

To be completed by the programme leader or Chair of Education Ethics Committee (taught students) or TAG member (research students)

I agree with the supervisor's assessment of this project.

Signed: R M.u Date: 27/3/12

Data sources

1 Does your research involve collecting data from people, e.g. by observing or testing them, or from interviews or questionnaires. (YES)/NO

Note: The answer to this will normally be 'yes'. It would only be 'no', if the research was entirely based on documentary sources, or secondary data (already collected by someone else). If the answer is 'no', then please go straight to question 12.

Impact of research on the research subjects

For studies involving interviews, focus group discussions or questionnaires:

2 Is the amount of time you are asking research subjects to give reasonable? Is any disruption to their normal routines at an acceptable level? (YES)/NO

3 Are any of the questions to be asked, or areas to be probed, likely to cause anxiety or distress to research subjects? YES/(NO)

4 If the research subjects are under 16 years of age, have you taken steps to ensure that another adult is present during all interviews and focus group discussions, and that questions to be asked are appropriate? (YES)/NO N/A

For studies involving an intervention (i.e. a change to normal practices made for the purposes of the research):

5 Is the extent of the change within the range of changes that teachers would normally be able to make within their own discretion? (YES)/NO

6 Will the change be fully discussed with those directly involved (teachers, senior school managers, pupils, parents – as appropriate)? (YES)/NO

Informed consent

7 Will steps be taken to inform research subjects in advance about what their participation in the research will involve? (YES)/NO

8 Will steps be taken to inform research subjects of the purpose of the research? (YES)/NO

Note: For some research studies, the data might be seriously distorted by informing research subjects in advance of the purpose of the study. If this is the case (and your answer to question 8 is therefore 'no'), please explain briefly why.

9 Will steps be taken to inform research subjects of what will happen to the data they provide (how this will be stored, for how long, who will have access to it, how individuals' identities will be protected during this process)? (YES)/NO

10 In the case of studies involving interviews or focus groups, will steps be taken to allow research subjects to see and comment on your written record of the event? (YES)/NO

11 Who will be asked to sign a statement indicating their willingness to participate in this research? Please **tick all categories** that apply:

Category	*Tick if 'yes'*
Adult research subjects	
Research subjects under 16	
Teachers	✓
Parents	
Headteacher (or equivalent)	
Other (please explain)	

Reporting your research

12 In any reports that you write about your research, will you ensure that the identity of any individual research subject, or the institution which they attend or work for, cannot be deduced by a reader? (YES)/NO

If the answer to this is 'no', please explain why:

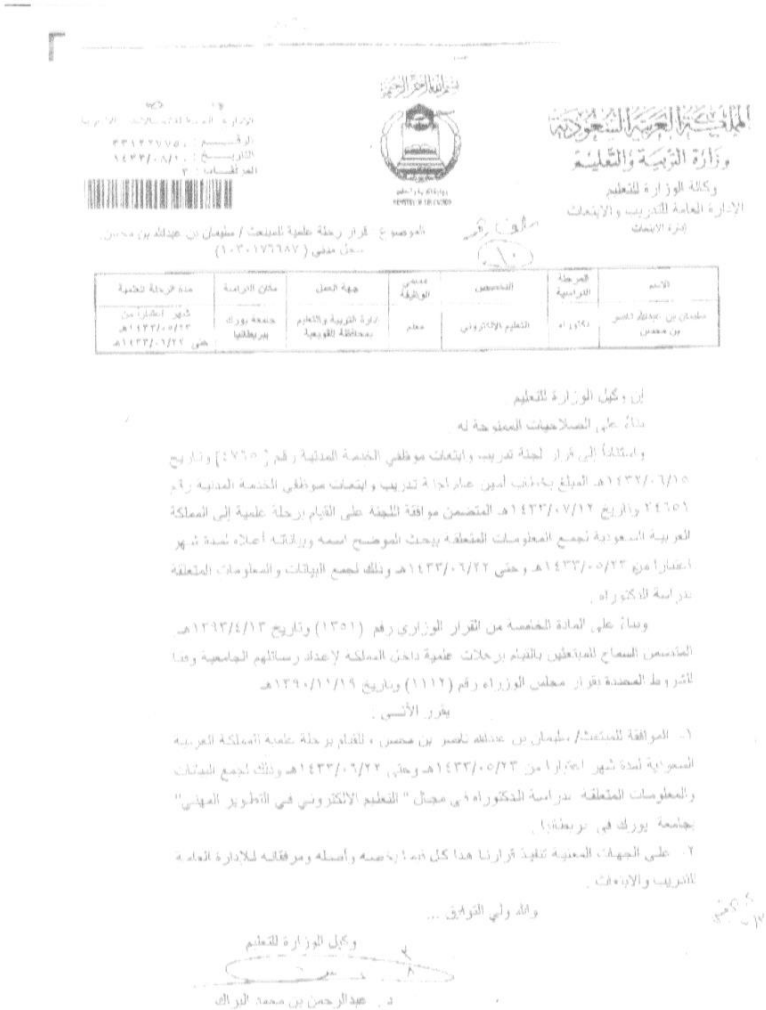
Signed: [signature]

Date: 12/03/2012

Please now give this form to your supervisor to complete the section on the first page.

NOTE:
If your plans change as you carry out the research study, you should discuss any changes you make with your supervisor. If the changes are significant, your supervisor may advise you to complete a new 'Ethical issues audit' form.

Appendix 16: Ministry of Education approval litter



المملكة العربية السعودية
وزارة التربية والتعليم
وكالة الوزارة للتعليم
الإدارة العامة للتدريب والابتعاث
إدارة الابتعاث

بسم الله الرحمن الرحيم

الموضوع : قرار رحلة علمية للمبتعث / سلمان بن عبدالله بن محسن
سجل مدني (١٠٣٠١٧٦٦٨٧)

الاسم	المرحلة الدراسية	التخصص	المسمى الوظيفي	جهة العمل	مكان الدراسة	مدة الرحلة العلمية
سلمان بن عبدالله المحسن بن محسن	دكتوراه	التعليم الالكتروني	معلم	وزارة التربية والتعليم بمحافظة القويعية	جامعة بورنموث ببريطانيا	شهرين اعتبارا من ١٤٣٣/٠٥/٢٣هـ حتى ١٤٣٣/٠٦/٢٤هـ

إن وكيل الوزارة للتعليم

بناءً على الصلاحيات الممنوحة له

وبالإشارة إلى قرار لجنة تدريب وابتعاث موظفي الخدمة المدنية رقم [٤٧٦٥] وتاريخ ١٤٣٢/٠٦/١٥هـ المبلغ بكتاب أمين عام لجنة تدريب وابتعاث موظفي الخدمة المدنية رقم ٢٤٦٥٤ وتاريخ ١٤٣٣/٠٧/١٢هـ المتضمن موافقة اللجنة على القيام برحلة علمية إلى المملكة العربية السعودية لجمع المعلومات المتعلقة ببحث الموضح اسمه وبياناته أعلاه لمدة شهر اعتبارا من ١٤٣٣/٠٥/٢٣هـ وحتى ١٤٣٣/٠٦/٢٤هـ وذلك لجمع البيانات والمعلومات المتعلقة بدراسة الدكتوراه .

وبناءً على المادة الخامسة من القرار الوزاري رقم (١٣٥١) وتاريخ ١٤١٣/٤/١٣هـ المتضمن السماح للمبتعثين بالقيام برحلات علمية داخل المملكة لإعداد رسائلهم الجامعية وفقا لشروط المحددة بقرار مجلس الوزراء رقم (١١١٢) وتاريخ ١٤١٠/١١/١٩هـ

يقرر الآتي :

١- الموافقة للمبتعث/ سلمان بن عبدالله بن محسن بن محسن ، للقيام برحلة علمية للمملكة العربية السعودية لمدة شهر اعتبارا من ١٤٣٣/٠٥/٢٣هـ وحتى ١٤٣٣/٠٦/٢٤هـ وذلك لجمع البيانات والمعلومات المتعلقة بدراسة الدكتوراه في مجال " التعليم الالكتروني في التطوير المهني" بجامعة بورنموث في بريطانيا .

٢- على الجهات المعنية تنفيذ قرارنا هذا كل فيما يخصه وأصله ومرفقاته للإدارة العامة للتدريب والابتعاث .

والله ولي التوفيق ...

وكيل الوزارة للتعليم

د. عبدالرحمن بن محمد الوراك

Appendix 17: Consent letter

A comparative study of the effectiveness of online inquiry-based and traditional face-to-face professional development of primary science teachers' pedagogical practice in Saudi Arabia

CONSENT FORM

I understand that:

- The aim of this study is to evaluate the effectiveness of online and face-to-face CPD of primary science teacher's pedagogical practice in S.A.
- My participation in this project will be in a classroom observation for at least three sessions in one day, which will take place before and after my participation in an intervention course.
- My participation in this project is entirely voluntary and that I have the right to withdraw any time with no obligation.
- The information that I provide as part of the study will be anonymous and will only be used for the purpose of the study.

Name:.....

Signed: .....Date.....

Appendix 18: Mann-Whitney U-test comparisons between perceived level of satisfaction of online and f2f group of science teachers about the CPD programme's content

Statements	Online CPD group (N=10)		F2f CPD group (N=10)		Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
	Mean Rank	Median	Mean Rank	Median			
The programme was generally useful.	14.4	5.0	6.6	4.0	11.0	-3.17	0.002
The aims of the programme were fully met.	13.6	4.0	7.5	3.0	19.5	-2.42	0.016
The aims of the programme were appropriate to my needs.	12.1	4.0	8.9	4.0	34.0	-1.29	0.199
The programme in general was clear and easy to understand.	15.1	5.0	6.0	3.0	4.5	-3.58	0.000
All topics were covered in sufficient detail.	15.1	5.0	6.0	2.5	4.5	-3.58	0.000
The content was arranged in a clear, logical manner.	14.1	5.0	7.0	4.0	14.5	-2.88	0.004
The programme contained activities that helped me understand the 5Es model.1	13.5	5.0	7.5	3.5	20.0	-2.38	0.018
The content was relevant to the 5Es instructional model.	13.6	5.0	7.4	4.0	19.0	-2.64	0.008

Appendix 19: Mann-Whitney U-test comparisons between perceived level of satisfaction of online and f2f group of science teachers about the CPD programme's procedure

Statements	Online CPD group (N=10)		F2f CPD group (N=10)		Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
	Mean Rank	Median	Mean Rank	Median			
Explanation of course aims and objectives.	12.2	5.0	8.9	4.0	33.5	-1.42	0.156
Quality of the instruction.	12.3	4.0	8.8	3.5	32.5	-1.41	0.160
Quality of the activities.	13.8	4.0	7.2	3.0	17	-2.64	0.008
Quality of the materials.	13.3	4.5	7.7	2.5	22	-2.20	0.028
The programme time management.	12.2	4.5	8.9	4.0	33.5	-1.32	0.187
Time spent on each topic of the programme.	13.6	5.0	7.4	3.0	19	-2.44	0.015
The instructional process was motivated.	12.9	4.0	8.1	4.0	26	-2.07	0.039

Appendix 20: Mann-Whitney U-test comparisons between perceived level of satisfaction of online and f2f group of science teachers about the CPD programme's context

Statements	Online CPD group (N=10)		F2f CPD group (N=10)		Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
	Mean Rank	Median	Mean Rank	Median			
16. Flexibility of the programme in terms of its time.	12.8	5.0	8.2	4.0	27	-1.87	0.062
17. Flexibility of the programme in terms of location.	11.1	5.0	9.9	5.0	44	-0.52	0.605
18. Flexibility of the programme in terms of access materials.	13.6	5.0	7.4	4.0	19	-2.49	0.013
19. Cost-effectiveness of the programme.	13.1	5.0	8.0	4.0	24.5	-2.30	0.021
20. Helpfulness of the programme facilitator.	12.5	5.0	8.5	5.0	30	-2.17	0.030

Appendix 21: Description nature of online pre-CPD programme's interaction

Teacher Code	Teacher 1			Teacher 2			Teacher 3			Teacher 4			Teacher 5			Teacher 6			Teacher 7			Teacher 8			Teacher 9			Teacher 10			Overall Statistic						
Scores	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Total Raw Scores	Standardised Scores					
Observation time in minutes	128	135		128	135		125	135		125	135		105	135		110	135		110	135		125	135		120	135		120	135			Total	%	Median	Mean	Max.	Min.
Teacher's Talk (TT)																																					
Indirect Teacher Talk (ITT)																																					
Accepts Feelings	16	17	0.6	16	17	0.6	3	3	0.1	15	16	0.6	8	10	0.4	2	2	0.1	7	8	0.3	4	4	0.1	3	3	0.1	3	3	0.1	**77**	**83**	**0.3**	**6**	**8.3**	**17**	**2**
Praise or Encouragement	114	120	4.5	112	117	4.3	33	36	1.3	54	58	2.2	34	44	1.6	12	15	0.5	57	69	2.5	10	11	0.4	28	31	1.2	24	27	1.0	**478**	**528**	**2.0**	**40**	**52.8**	**120**	**11**
Accepts or Uses ideas of Pupils	37	39	1.4	37	39	1.4	21	23	0.9	8	9	0.3	6	8	0.3	9	11	0.4	13	16	0.6	83	91	3.4	29	32	1.2	16	18	0.7	**259**	**286**	**1.1**	**21**	**28.6**	**91**	**8**
Asking Questions	383	404	15.0	385	404	15.0	278	300	11.1	122	131	4.9	117	151	5.6	74	91	3.4	196	236	8.7	240	263	9.7	135	150	5.6	153	173	6.4	**2083**	**2303**	**8.5**	**204**	**230.3**	**404**	**91**
Total ITT	550	580	21.5	550	577	21.4	335	362	13.4	199	214	7.9	165	213	7.9	97	119	4.4	273	328	12.2	337	369	13.7	195	217	8.0	196	221	8.2	**2897**	**3200**	**11.9**	**275**	**319.9**	**580**	**119**
Direct Teacher Talk (DTT)																																					
Lecture	458	483	17.9	450	472	17.5	1178	1272	47.1	1500	1614	59.8	1301	1682	62.3	1483	1821	67.4	1425	1714	63.5	1575	1727	64.0	1673	1864	69.0	1708	1930	71.5	**12751**	**14579**	**54.0**	**1698**	**1457.9**	**1930**	**472**
Giving Directions	117	123	4.6	117	123	4.5	39	42	1.6	55	59	2.2	50	65	2.4	56	69	2.5	30	36	1.3	56	61	2.3	70	78	2.9	20	23	0.8	**610**	**679**	**2.5**	**63**	**67.9**	**123**	**23**
Criticizing or Justifying Authority	25	26	1.0	25	26	1.0	3	3	0.1	0	0	0.0	0	0	0.0	16	20	0.7	0	0	0.0	0	0	0.0	1	1	0.0	1	1	0.0	**71**	**77**	**0.3**	**1**	**7.7**	**26**	**0**
Total DTT	600	632	23.4	592	621	23.0	1220	1317	48.8	1555	1673	62.0	1351	1747	64.7	1555	1909	70.7	1455	1750	64.8	1631	1788	66.2	1744	1943	72.0	1729	1954	72.4	**13432**	**15335**	**56.8**	**1749**	**1533.4**	**1954**	**621**
Total TT (ITT+DTT)	1150	1213	44.9	1142	1197	44.3	1555	1679	62.2	1754	1887	69.9	1516	1960	72.6	1652	2028	75.1	1728	2078	77.0	1968	2157	79.9	1939	2160	80.0	1925	2175	80.5	**16329**	**18535**	**68.6**	**1994**	**1853.4**	**2175**	**1197**
Pupil Talk (PT)																																					
Pupil Talk Response	641	676	25.0	647	678	25.1	515	556	20.6	199	214	7.9	146	189	7.0	223	274	10.1	233	280	10.4	195	214	7.9	224	250	9.2	188	212	7.9	**3211**	**3543**	**13.1**	**262**	**354.3**	**678**	**189**
Pupil Talk Initiation	63	66	2.5	63	66	2.4	6	6	0.2	0	0	0.0	0	0	0.0	9	11	0.4	9	11	0.4	0	0	0.0	3	3	0.1	0	0	0.0	**153**	**164**	**0.6**	**5**	**16.4**	**66**	**0**
Total PT	704	743	27.5	710	744	27.6	521	562	20.8	199	214	7.9	146	189	7.0	232	285	10.6	242	291	10.8	195	214	7.9	227	253	9.4	188	212	7.9	**3364**	**3707**	**13.7**	**269**	**370.7**	**744**	**189**
Silence (S)	706	745	27.6	723	758	28.1	425	459	17.0	557	599	22.2	426	551	20.4	315	387	14.3	275	331	12.3	300	329	12.2	257	286	10.6	277	313	11.6	**4261**	**4758**	**17.6**	**423**	**475.8**	**758**	**286**
Overall Total (TT+PT+S)	**2560**	**2700**	**100**	**2575**	**2700**	**100**	**2501**	**2700**	**100**	**2510**	**2700**	**100**	**2088**	**2700**	**100**	**2199**	**2700**	**100**	**2245**	**2700**	**100**	**2463**	**2700**	**100**	**2423**	**2700**	**100**	**2390**	**2700**	**100**	23954	27000	100	2700	2700	2700	2700
Direct to indirect teacher talk ratio (DTT/ITT)	1.1			1.1			3.6			7.8			8.2			16.1			5.3			4.8			9.0			8.8			**4.8**					

Appendix 22: Description nature of f2f pre-CPD programme's interaction

Teacher Code	Teacher 11			Teacher 12			Teacher 13			Teacher 14			Teacher 15			Teacher 16			Teacher 17			Teacher 18			Teacher 19			Teacher 20			Overall Statistic						
Scores	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Total Raw Scores	Standardised Scores					
Observation time in	123	135		135	135		135	135		117	135		102	135		125	135		102	135		101	135		121	135		120	135			Total	%	Median	Mean	Max	Min
Teacher's Talk (TT)																																				
Indirect Teacher Talk (ITT)																																				
Accepts Feelings	3	3	0.1	14	14	0.5	2	2	0.1	10	12	0.4	2	3	0.1	7	8	0.3	3	4	0.1	4	5	0.2	1	1	0.0	1	1	0.0	**47**	**53**	**0.2**	**4**	**5.3**	**14**	**1**
Praise or Encouragement	11	12	0.4	35	35	1.3	39	39	1.4	10	12	0.4	7	9	0.3	7	8	0.3	32	42	1.6	30	40	1.5	3	4	0.1	35	39	1.5	**209**	**240**	**0.9**	**24**	**24.0**	**42**	**4**
Accepts or Uses ideas of Pupils	13	14	0.5	1	1	0.0	19	19	0.7	5	6	0.2	1	1	0.0	8	9	0.3	18	24	0.9	59	78	2.9	7	8	0.3	42	47	1.8	**173**	**207**	**0.8**	**11**	**20.7**	**78**	**1**
Asking Questions	118	129	4.8	201	201	7.4	155	155	5.7	188	218	8.1	74	97	3.6	102	111	4.1	156	206	7.6	88	117	4.3	44	53	2.0	136	152	5.6	**1262**	**1439**	**5.3**	**141**	**143.9**	**218**	**53**
Total ITT	145	159	5.9	251	251	9.3	215	215	8.0	213	247	9.1	84	110	4.1	124	135	5.0	209	276	10.2	181	240	8.9	55	66	2.4	214	240	8.9	**1691**	**1939**	**7.2**	**227**	**193.9**	**276**	**66**
Direct Teacher Talk (DTT)																																				
Lecture	1455	1596	59.1	1508	1508	55.9	1629	1629	60.3	1460	1692	62.7	1440	1891	70.0	1777	1930	71.5	1348	1782	66.0	1345	1783	66.0	1719	2058	76.2	1734	1940	71.9	**15415**	**17809**	**66.0**	**1783**	**1780.9**	**2058**	**1508**
Giving Directions	62	68	2.5	56	56	2.1	21	21	0.8	33	38	1.4	51	67	2.5	13	14	0.5	40	53	2.0	68	90	3.3	44	53	2.0	10	11	0.4	**398**	**471**	**1.7**	**53**	**47.1**	**90**	**11**
Criticizing or Justifying Authority	3	3	0.1	17	17	0.6	5	5	0.2	0	0	0.0	5	7	0.2	3	3	0.1	0	0	0.0	0	0	0.0	1	1	0.0	0	0	0.0	**34**	**36**	**0.1**	**2**	**3.6**	**17**	**0**
Total DTT	1520	1667	61.7	1581	1581	58.6	1655	1655	61.3	1493	1730	64.1	1496	1965	72.8	1793	1947	72.1	1388	1835	68.0	1413	1873	69.4	1764	2112	78.2	1744	1951	72.3	**15847**	**18316**	**67.8**	**1854**	**1831.6**	**2112**	**1581**
Total TT (ITT+DTT)	1665	1826	67.6	1832	1832	67.9	1870	1870	69.3	1706	1977	73.2	1580	2075	76.8	1917	2082	77.1	1597	2112	78.2	1594	2113	78.3	1819	2178	80.7	1958	2191	81.1	**17538**	**20255**	**75.0**	**2079**	**2025.5**	**2191**	**1826**
Pupil Talk (PT)																																				
Pupil Talk Response	342	375	13.9	256	256	9.5	358	358	13.3	342	396	14.7	86	113	4.2	164	178	6.6	143	189	7.0	187	248	9.2	103	123	4.6	149	167	6.2	**2130**	**2403**	**8.9**	**218**	**240.3**	**396**	**113**
Pupil Talk Initiation	0	0	0.0	15	15	0.6	0	0	0.0	0	0	0.0	2	3	0.1	2	2	0.1	0	0	0.0	1	1	0.0	0	0	0.0	0	0	0.0	**20**	**21**	**0.1**	**0**	**2.1**	**15**	**0**
Total PT	342	375	13.9	271	271	10.0	358	358	13.3	342	396	14.7	88	116	4.3	166	180	6.7	143	189	7.0	188	249	9.2	103	123	4.6	149	167	6.2	**2150**	**2424**	**9.0**	**219**	**242.4**	**396**	**116**
Silence (S)	455	499	18.5	597	597	22.1	472	472	17.5	282	327	12.1	388	510	18.9	403	438	16.2	302	399	14.8	255	338	12.5	333	399	14.8	306	342	12.7	**3793**	**4320**	**16.0**	**419**	**432.0**	**597**	**327**
Overall Total (TT+PT+S)	**2462**	**2700**	**100**	**2700**	**2700**	**100**	**2700**	**2700**	**100**	**2330**	**2700**	**100**	**2056**	**2700**	**100**	**2486**	**2700**	**100**	**2042**	**2700**	**100**	**2037**	**2700**	**100**	**2255**	**2700**	**100**	**2413**	**2700**	**100**	**23481**	**27000**	**100**	**2700**	**2700.0**	**2700**	**2700**
Direct to indirect teacher talk ratio (DTT/ITT)	10.5			6.3			7.7			7.0			17.8			14.4			6.6			7.8			32.0			8.1			9.4					

Appendix 23: Descriptive nature of online post - CPD programme's interaction

Teacher Code	Teacher 1			Teacher 2			Teacher 3			Teacher 4			Teacher 5			Teacher 6			Teacher 7			Teacher 8			Teacher 9			Teacher 10			**Overall Statistic**						
Scores	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	**Total Raw Scores**	**Standardised Scores**					
Observation time in minutes	90	135		95	135		92	135		85	135		90	135		95	135		129	135		107	135		95	135		106	135			**Total**	**%**	**Median**	**Mean**	**Max.**	**Min.**
Teacher's Talk (TT)																																					
Indirect Teacher Talk (ITT)																																					
Accepts Feelings	19	28	1.0	12	17	0.6	5	7	0.3	9	15	0.5	6	9	0.3	7	10	0.4	5	5	0.2	3	4	0.1	1	1	0.0	0	0	0.0	**67**	**96**	**0.4**	**8**	**9.6**	**28**	**0**
Praise or Encouragement	99	147	5.4	70	100	3.7	19	28	1.0	9	15	0.5	10	15	0.6	12	18	0.7	19	20	0.7	7	9	0.3	5	7	0.3	1	1	0.0	**251**	**360**	**1.3**	**16**	**36.0**	**147**	**1**
Accepts or Uses ideas of Pupils	11	16	0.6	37	53	2.0	18	26	1.0	9	15	0.5	5	7	0.3	46	68	2.5	45	47	1.7	29	36	1.3	56	80	3.0	43	55	2.0	**299**	**403**	**1.5**	**42**	**40.3**	**80**	**7**
Asking Questions	335	498	18.4	318	455	16.8	262	384	14.2	164	266	9.9	83	124	4.6	190	282	10.4	878	916	33.9	178	224	8.3	175	251	9.3	170	216	8.0	**2753**	**3616**	**13.4**	**274**	**361.6**	**916**	**124**
Total ITT	464	689	26	437	625	23	304	445	16	191	310	11	104	155	6	255	378	14	947	988	37	217	273	10	237	339	13	214	272	10	**3370**	**4475**	**16.6**	**359**	**447.5**	**988**	**155**
Direct Teacher Talk (DTT)																																					
Lecture	262	389	14.4	300	429	15.9	673	986	36.5	825	1340	49.6	1102	1651	61.1	868	1287	47.7	1074	1120	41.5	1301	1636	60.6	1148	1644	60.9	1287	1636	60.6	**8840**	**12118**	**44.9**	**1314**	**1211.8**	**1651**	**389**
Giving Directions	65	97	3.6	67	96	3.5	28	41	1.5	18	29	1.1	24	36	1.3	51	76	2.8	22	23	0.8	34	43	1.6	68	97	3.6	64	81	3.0	**441**	**619**	**2.3**	**59**	**61.9**	**97**	**23**
Criticizing or Justifying Authority	4	6	0.2	19	27	1.0	2	3	0.1	3	5	0.2	0	0	0.0	9	13	0.5	0	0	0.0	2	3	0.1	11	16	0.6	6	8	0.3	**56**	**81**	**0.3**	**6**	**8.1**	**27**	**0**
Total DTT	331	492	18	386	552	20	703	1030	38	846	1374	51	1126	1687	62	928	1376	51	1096	1143	42	1337	1682	62	1227	1758	65	1357	1725	64	**9337**	**12818**	**47.5**	**1375**	**1281.8**	**1758**	**492**
Total TT (ITT+DTT)	795	1181	44	823	1176	44	1007	1475	55	1037	1685	62	1230	1842	68	1183	1753	65	2043	2131	79	1554	1955	72	1464	2097	78	1571	1997	74	**12707**	**17292**	**64.0**	**1798**	**1729.2**	**2131**	**1176**
Pupil Talk (PT)																																					
Pupil Talk Response	602	894	33.1	491	702	26.0	371	544	20.1	188	305	11.3	108	162	6.0	152	225	8.3	146	152	5.6	136	171	6.3	87	125	4.6	82	104	3.9	**2363**	**3384**	**12.5**	**198**	**338.4**	**894**	**104**
Pupil Talk Initiation	40	59	2.2	14	20	0.7	5	7	0.3	0	0	0.0	2	3	0.1	6	9	0.3	0	0	0.0	13	16	0.6	0	0	0.0	1	1	0.0	**81**	**116**	**0.4**	**5**	**11.6**	**59**	**0**
Total PT	642	953	35	505	722	27	376	551	20	188	305	11	110	165	6	158	234	9	146	152	6	149	187	7	87	125	5	83	106	4	**2444**	**3500**	**13.0**	**211**	**350.0**	**953**	**106**
Silence (S)	381	566	21.0	561	802	29.7	460	674	25.0	437	710	26.3	462	692	25.6	480	712	26.4	400	417	15.4	444	558	20.7	334	478	17.7	470	597	22.1	**4429**	**6207**	**23.0**	**636**	**620.7**	**802**	**417**
Overall Total (TT+PT+S)	**1818**	**2700**	**100**	**1889**	**2700**	**100**	**1843**	**2700**	**100**	**1662**	**2700**	**100**	**1802**	**2699**	**100**	**1821**	**2699**	**100**	**2589**	**2700**	**100**	**2147**	**2700**	**100**	**1885**	**2700**	**100**	**2124**	**2700**	**100**	**19580**	**27000**	**100.0**	**2700**	**2700.0**	**2700**	**2699**
Direct to indirect teacher talk ratio (DTT/ITT)	0.7			0.9			2.3			4.4			10.9			3.6			1.2			6.2			5.2			6.3			2.9						

Appendix 24: Description nature of f2f post-CPD programme's interaction

Teacher Code	Teacher 11			Teacher 12			Teacher 13			Teacher 14			Teacher 15			Teacher 16			Teacher 17			Teacher 18			Overall Statistic						
Scores	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Raw Scores	Standardised Scores	%	Total Raw Scores	Standardised Scores					
Observation time in	102	135		56	135		108	135		117	135		121	135		122	135		115	135		79	135			Total	%	Median	Mean	Max	Min
Teacher's Talk (TT)																															
Indirect Teacher Talk (ITT)																															
Accepts Feelings	0	0	0.0	0	0	0.0	1	1	0.0	0	0	0.0	2	2	0.1	0	0	0.0	0	0	0.0	15	25	0.9	**18**	**28**	**0.1**	**0**	**3.5**	**25**	**0**
Praise or Encouragement	2	3	0.1	3	7	0.3	6	7	0.3	0	0	0.0	3	3	0.1	5	6	0.2	10	12	0.4	15	25	0.9	**44**	**63**	**0.2**	**6**	**7.9**	**25**	**0**
Accepts or Uses ideas of Pupils	25	33	1.2	34	81	3.0	57	71	2.6	48	56	2.1	13	14	0.5	67	74	2.7	61	73	2.7	54	91	3.4	**359**	**493**	**1.8**	**72**	**61.6**	**91**	**14**
Asking Questions	113	149	5.5	114	271	10.0	258	321	11.9	291	338	12.5	200	222	8.2	326	360	13.3	202	241	8.9	125	211	7.8	**1629**	**2113**	**7.8**	**256**	**264.1**	**360**	**149**
Total ITT	140	184	6.8	151	359	13.3	322	400	14.8	339	394	14.6	218	242	9.0	398	440	16.3	273	326	12.1	209	353	13.1	**2050**	**2697**	**10.0**	**356**	**337.1**	**440**	**184**
Direct Teacher Talk (DTT)																															
Lecture	1177	1547	57.3	565	1344	49.8	1042	1297	48.0	1038	1201	44.5	1474	1633	60.5	1438	1589	58.8	1360	1621	60.0	921	1559	57.7	**9015**	**11791**	**43.7**	**1553**	**1473.9**	**1633**	**1201**
Giving Directions	41	54	2.0	40	95	3.5	78	97	3.6	133	154	5.7	86	95	3.5	87	96	3.6	91	108	4.0	64	108	4.0	**620**	**807**	**3.0**	**97**	**100.9**	**154**	**54**
Criticizing or Justifying Authority	1	1	0.0	0	0	0.0	3	4	0.1	0	0	0.0	1	1	0.0	0	0	0.0	1	1	0.0	9	15	0.6	**15**	**22**	**0.1**	**1**	**2.8**	**15**	**0**
Total DTT	1219	1602	59.4	605	1439	53.3	1123	1398	51.8	1171	1355	50.2	1561	1729	64.0	1525	1685	62.4	1452	1730	64.1	994	1682	62.3	**9650**	**12621**	**46.7**	**1642**	**1577.6**	**1730**	**1355**
Total TT (ITT+DTT)	1359	1787	66.2	756	1798	66.6	1445	1799	66.6	1510	1748	64.8	1779	1971	73.0	1923	2124	78.7	1725	2056	76.1	1203	2035	75.4	**11700**	**15318**	**56.7**	**1885**	**1914.7**	**2124**	**1748**
Pupil Talk (PT)																															
Pupil Talk Response	108	142	5.3	111	264	9.8	189	235	8.7	304	352	13.0	192	213	7.9	168	186	6.9	140	167	6.2	78	132	4.9	**1290**	**1691**	**6.3**	**199**	**211.3**	**352**	**132**
Pupil Talk Initiation	2	3	0.1	0	0	0.0	5	6	0.2	3	3	0.1	0	0	0.0	0	0	0.0	0	0	0.0	9	15	0.6	**19**	**27**	**0.1**	**1**	**3.4**	**15**	**0**
Total PT	110	145	5.4	111	264	9.8	194	241	8.9	307	355	13.2	192	213	7.9	168	186	6.9	140	167	6.2	87	147	5.4	**1309**	**1718**	**6.4**	**199**	**214.8**	**355**	**145**
Silence (S)	585	769	28.5	268	638	23.6	530	660	24.4	517	598	22.2	466	516	19.1	353	390	14.4	400	477	17.7	305	516	19.1	**3424**	**4564**	**16.9**	**557**	**570.5**	**769**	**390**
Overall Total (TT+PT+S)	2054	2701	100.0	1135	2700	100.0	2169	2700	100.0	2334	2702	100.1	2437	2700	100.0	2444	2700	100.0	2265	2700	100.0	1595	2699	99.9	**16433**	**21600**	**80.0**	**2700**	**2700.0**	**2702**	**2699**
Direct to indirect teacher talk ratio (DTT/ITT)	8.7			4.0			3.5			3.4			7.2			3.8			5.3			4.8			4.7						

Appendix 25: Test Statistics of Wilcoxon Signed Ranks Test for online CPD programme

	Mean negative rank (Post < Pre)	Sum of Negative Ranks (Post < Pre)	Mean positive rank (Post > Pre)	Sum of positive Ranks (Post > Pre)	Z	p (2-tailed)	Effect size
Teacher's Talk (TT)							
Indirect Teacher Talk (ITT)							
Accepts Feelings	3.00	15.00	7.00	21.00	-0.421	0.67	-0.133
Praise or Encouragement	5.75	46.00	4.50	9.00	-1.886	0.06	-0.596
Accepts or Uses ideas of Pupils	5.00	15.00	5.71	40.00	-1.274	0.20	-0.403
Asking Questions	1.50	3.00	6.50	52.00	-2.497	0.01*	-0.790
Total ITT	4.25	8.50	5.81	46.50	-1.938	0.05	-0.613
Direct Teacher Talk (DTT)							
Lecture	5.50	55.00	0.00	0.00	-2.803	0.01*	-0.886
Giving Directions	5.43	38.00	5.67	17.00	-1.07	0.28	-0.338
Criticizing or Justifying Authority	5.75	11.50	3.30	16.50	-0.423	0.67	-0.134
Total DTT	5.50	55.00	0.00	0.00	-2.803	0.01*	-0.886
Total TT (ITT+DTT)	5.78	52.00	3.00	3.00	-2.497	0.01*	-0.790
Student Talk (ST)							
Student Talk Response	5.29	37.00	6.00	18.00	-0.968	0.33	-0.306
Student Talk Initiation	5.90	29.50	3.88	15.50	-0.831	0.41	-0.263
Total ST	4.88	39.00	8.00	16.00	-1.172	0.24	-0.371
Silence (S)	5.00	5.00	5.56	50.00	-2.293	0.02*	-0.725

$p<0.05$

Appendix 26: Test Statistics of Wilcoxon Signed Ranks Test for f2f CPD programme

	Mean negative rank (Post < Pre)	Sum of Negative Ranks (Post < Pre)	Mean positive rank (Post > Pre)	Sum of positive Ranks (Post > Pre)	Z	p (2-tailed)	Effect size
Teacher's Talk (TT)							
Indirect Teacher Talk (ITT)							
Accepts Feelings	4.00	28.00	8.00	8.00	-1.402	0.16	-0.50
Praise or Encouragement	4.50	36.00	0.00	0.00	-2.521	0.01*	-0.89
Accepts or Uses ideas of Pupils	0.00	0.00	4.50	36.00	-2.524	0.01*	-0.89
Asking Questions	0.00	0.00	4.50	36.00	-2.521	0.01*	-0.89
Total ITT	0.00	0.00	4.50	36.00	-2.521	0.01*	-0.89
Direct Teacher Talk (DTT)							
Lecture	4.50	36.00	0.00	0.00	-2.521	0.01*	-0.89
Giving Directions	1.00	1.00	5.00	35.00	-2.38	0.02*	-0.84
Criticizing or Justifying Authority	4.10	20.50	3.75	7.50	-1.101	0.27	-0.39
Total DTT	4.50	36.00	0.00	0.00	-2.521	0.01*	-0.89
Total TT (ITT+DTT)	4.71	33.00	3.00	3.00	-2.1	0.04*	-0.74
Student Talk (ST)							
Student Talk Response	5.60	28.00	2.67	8.00	-1.402	0.16	-0.50
Student Talk Initiation	3.67	11.00	4.25	17.00	-0.511	0.61	-0.18
Total ST	5.00	30.00	3.00	6.00	-1.68	0.09	-0.59
Silence (S)	3.00	3.00	4.71	33.00	-2.1	0.04*	-0.74

p<05