

**The Importance of Teachers in Integrating ICT into Science
Teaching in Intermediate Schools in Saudi Arabia:
A Mixed Methods Study**

A thesis submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy

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Abstract

Curriculum reform is central to the aspirations of many developing countries as they strive to deliver a quality education to their citizens. In Saudi Arabia, with its remarkable achievement of a high literacy rate in a few decades, the next step is bringing its resources to bear on providing a quality education so that Saudis may take their places in the global labour force.

This study concerns the integration of information and communications technologies (ICT) into the science curriculum of intermediate schools for boys and girls in the educational district of Jeddah, and the training and development requirements of science teachers in this regard. A mixed methodology was employed to obtain qualitative data from six policymakers within the Ministry of Education in Riyadh and Jeddah, and quantitative data from a questionnaire for which 311 replies were received from intermediate schools' science teachers in Jeddah.

The findings confirm those reported in the literature that inefficient central project management and inadequate resources influence the integration of ICT in the science curriculum. Further, qualitative and quantitative findings confirm that teachers' access to training is affected by time constraints, ineffective ICT course material, and in the specialised case of an Islamic country, inadequate access of women teachers to external training. However, this study does not support the majority of researchers which finds teachers' negative attitude to ICT. Whilst the policy makers interviewed in this study perceived the teachers as having a negative attitude toward ICT integration in the science curriculum, quantitative data from the teachers pointed to a high interest (90 per cent) in ICT integration, and their willingness to pursue further professional development in the effective use of ICT in the intermediate science curriculum.

Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

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Abdullellah Abdullah Al-Sulaimani

22 March 2010

Dedication

To the souls of my mother and father who cared for me and encouraged me to learn;

To my lovely wife, Abeer, who stands by me, and gives me unlimited encouragement, time, endeavour, support, and her prayers;

To my children, Abdulgader, Ammar, Zakeiah, and Hala, who stood by me strongly during times of trial;

To all my brothers and sisters, who cared for me after the death of my father, especially to my brother Alshihk Abdulaziz;

To all my family and friends who wish me success in my life, especially to my uncle Alshihk Abdulgader Habani who I think of as a father, and my nephew Omar Alsulaimani

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I wish to dedicate this thesis to these people with my sincere thanks and appreciation

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Chapter 1 Introduction

Merely a means of distance communication a generation ago, information and communication technology (ICT) may now be considered as part of modern society. As the technology proliferates, new applications appear and ICT increasingly pervades everyday life. Consequently, the knowledge and skills necessary to embrace the emerging ICT are becoming priorities for education authorities around the world (Tatto, 2006). In emerging economies such as the Kingdom of Saudi Arabia, education strategies by policymakers are expected to include ICT to prepare school leavers to seek jobs in the labour force and in the global economy. Researchers argue that, to gain advantages from this technology, curricula should incorporate computer-based programs and other ICT applications (Semenov, 2005). Education authorities in Saudi Arabia provide these ICT through hardware and software infrastructure, and promote pedagogical programs which incorporate ICT (Ministry of Education, 2004a). This study investigates integration of ICT in the Saudi intermediate schools' science curriculum and teachers' professional development.

This chapter begins with a contextual explanation. Next, there is an introduction to the issues of teachers' knowledge and skills in relation to ICT, followed by a statement of the problem, with the research aims and research questions then being presented. The significance of the study is discussed, followed by the research methodology including the sources for data collection; the analyses employed and last, the organisation of the thesis.

1.1 Research Background

This section defines the nature of the study and places it in a traditionalist context of the Saudi Arabian educational experience, emphasising the government's desire to achieve high standard outcomes for its school leavers in achieving jobs or moving to tertiary education.

Whilst the term "ICT" can broadly define any tool or process (Resnick, Pontecorvo, & Saeljoe, 1997), educational technology traditionally involved books, writing materials, blackboards; and in this instance, materials and equipment in a science laboratory. "New" ICT can therefore include computers and ancillary equipment that can calculate data and present communications in different media (Woolsey & Bellamy, 1997). ICT is an

emerging force in education, as it is in other socio-economic environments, and its potential effects in teaching and learning practices are fundamental to this thesis. For the purposes of this educational research, a combination of the following definitions of ICT will be adopted. Elston (2007, p.5) defines ICT globally as “the technology used to manage information and aid communication”; whilst UNESCO (2002) earlier identified ICT as computer-based elements of technology: ICT comprises computer hardware and software and communication networks (the internet). Whilst the UNESCO explanation relates to the elements of the system, Elston’s definition goes beyond this, as it also incorporates the notion of a process. Curriculum reform is an ongoing process; as is ICT itself.

Over the last decade ICT diverged to meet the requirements of various disciplines or industries; examples are public services such as health and education, and private sector areas such as finance and construction. Due to the pressures of globalisation and the increasing mobility of an international workforce, information and communications technology is now a priority for national education systems (Cuban, Kirkpatrick, & Peck, 2001; Harrison et al., 2002; Higgins & Packard, 2004). Ottestade and Quale (2009) find a positive connection between deployment of ICT and pedagogy outcomes and Semenov (2005), Vrasidas and Glass(2005), and Roblyer (2006) provide evidence that integrating ICT into curricula improves productivity and student results and provides superior teaching and learning experiences. The authors state that, with effective integration of ICT into curricula, educational institutions may deliver higher quality education.

ICT can be used in opening the classroom to the larger world, according to UNESCO (cited in Charp, 2000), so that students can experience ideas beyond the classroom. Teachers may benefit through widening and deepening understanding of their relevant fields of expertise and perhaps be encouraged to vary their teaching styles. The integration of ICT into the curriculum can contribute to change; Blackmore, Hardcastle, Bamblett, and Owens (2003) argue that ICT contributes to both the teaching and learning processes, creating independent and self-motivated learners, and encouraging the use of multiple teaching methods. Roblyer and Edwards (2000) posit that ICT in teaching saves time and facilitates flexible learning delivery that extends learning experiences. Through ICT, teachers can simulate environments and physical characteristics (Capron & Johnson, 2004).

ICT, however, has its limitations, and Semenov (2005) and Zimmerman (2001) identify essential learning skills that cannot be attained through ICT: students must learn

handwriting, manual calculations, and to undertake discussion to solve problems. Zimmerman (p. 108) declares that “ICT is not . . . a panacea for all educational problems”. Further, there are inequalities in the learning process using computers based on students’ access to computers at home, thus students who are not experienced in assessing internet information may find it overwhelming and are thus unable to cope (Reid, 2002).

The integration of technology into a curriculum is complex. Akbaba-Altun (2006) and Reid (2002) warn that the successful integration of ICT depends on interlinking variables, such as teachers’ knowledge and skills and attitude to ICT, adequacy of ICT infrastructure, curriculum strategy, and school management’s attitude. In an international study, Pelgrum (2001, p. 173) found that “teachers did not have sufficient knowledge and skills regarding ICT”. The potential for ICT is in its software applications that can gather, process, and communicate information, thus the successful deployment of technology depends on the quality of teaching (Pea, 2000; Shelly, Cashman, Gunter, & Gunter, 2006; Elston, 2007).

Whilst ICT is increasingly adopted by education policymakers for a variety of reasons, teachers deliver the curriculum (Charp, 2000). Researchers such as Hasselbring et al. (2000), and Glennan and Melmed (2000) claim that improving the quality of an education system depends upon teachers’ training and development. Valente (2003) argues that teachers should be trained to view ICT as a resource and to use technology in classroom activities, whilst earlier Ortega (2000) added that education authorities are responsible for teacher training. However, there are substantial issues, both generic and particular to Saudi Arabia, in teachers acquiring skills with rapidly changing ICT hardware and software, and in integrating the new ICT tools into the science curriculum. This study investigates integration of ICT into science teaching and the professional development needs of science teachers in Saudi Arabia.

In the next section, the narrative moves to the context of this study. Over the last few years, the Kingdom has moved rapidly to integrate ICT into its education portfolio. However, due to a range of extant and emerging issues, the projects had marginal success. The antecedents for ICT integration into the schools’ curricula are discussed below.

1.2 Study Context

The development of education in Saudi Arabia in the last century saw the rapid establishment of schools, colleges and universities staffed by expatriates, generally from Arab countries. The contractors, under direction, tended to follow traditionalist principles of pedagogy, using texts and examination by memorisation. Under a policy of Saudiisation, graduates replaced the temporary staff and assumed teaching positions; however, these Saudi teachers were products of an unsatisfactory educational process and thus lacked the rigour of recruitment competition or performance testing (Al-Rasheed & Vitalis, 2004). The Ministry of Education, with complete control of primary, intermediate, and secondary schools has a policy of integrating ICT into its curricula as it seeks to improve the educational system and address quality standards through pedagogical reform (Al-Moussa, 2004, Ministry of Education, 2004a). The Saudi government historically expends significant resources to this end; however, structural and operational issues arise which militate against the full exploitation of potential ICT advantages. Whilst there are inherent advantages and challenges in educational ICT, such as technology and pedagogical evolution, cost, and skills acquisition, Saudi society presents further issues in its traditional stance towards its educational ideal (Bingimlas, 2009). In this study, those tensions and the Ministry's approaches to their resolution are identified and explored. The purpose of this thesis is therefore to consider the Saudi Ministry of Education's policy and practices in integrating ICT in one particular group, intermediate science students, in the Jeddah educational district. Part of the study includes an investigation of intermediate science teachers' training and development needs regarding the use of ICT.

This research concerns urban and regional schools in Jeddah and its surrounds. Jeddah, on the Red Sea, is a large port with a population of some 3.5 million, and it is the entry point for the annual Muslim *hajj* (pilgrimage), when the population in the surrounding provinces doubles. The Ministry of Education manages almost 2000 schools for boys and girls in the city and its provinces, with half a million students, and more than 40,000 teachers (see table 1.1). The selection of this area for study was based on accessibility to potential study participants and information through this researcher's prior employment. The Jeddah education administration is second only to Riyadh, so that there is an expectation that the study findings may be applicable throughout the country, and are relevant to other Arab countries.

Table 1.1
Students, teachers, and schools in Jeddah Province 2007- 2008

Item	Boys' schools	Girls' schools	Total
Students	251,072	256,670	507,742
Teachers	17,161	23,434	40,595
Schools	758	1,190	1,948

Source Ministry of Education, 2008

This study investigates integration of ICT in the Saudi intermediate schools' science curriculum, and teachers' professional development. The next section considers the characteristics of intermediate science teachers and the challenges they meet undertaking their professional and societal obligations to their students.

1.3 Teaching in Saudi Arabia

Schools in Saudi Arabia are divided by gender; this results in two administrations within the Ministry of Education, with minimal shared resources and intermittent communications between the two bureaucracies for planning. For legal reasons, women teachers are constrained in travel and in their access to workplaces; indeed older female teachers may represent the first generation of Saudi women to teach. Nevertheless, they share with their male counterparts the perennial issues of teachers: lack of time, little opportunity for professional development, inadequate resources, and the pressure to fulfil the demands of the centralised curriculum (Mustafa & Cullingford, 2008). In common with other Arab teachers, they also are directed to teach science according to the Koran, and, particularly with the use of ICT, they have difficulty in sourcing science material in Arabic. Translation issues are therefore constant (Haider, 1998).

As they are directed by Ministry policy to integrate ICT into the curriculum, teachers require at least basic operational skills to use the available equipment. In this study, teacher ICT skills refer to teachers' various abilities in computer usage, together with its ancillary equipment: printers, scanners, cameras, and projectors; user knowledge of computer functions including operating installed and software programs such as Microsoft Windows and Office, and familiarity with email and internet protocols. Such skills are then deployed in a student-centred pedagogy. Together with skills acquisition, professional development is required to permit teachers to transform a text-based curriculum into a

virtual science classroom (Haider, 1998). However, access to training and development for teachers is problematic: researchers cite insufficient facilities, inadequate educators, and inappropriate times for courses, especially for women (Schwille & Dembélé, 2007). Teachers also require an environment of constant encouragement and opportunities to undertake such professional development and to continue pursuing skills acquisition for evolving ICT (Rodrigues, 2005).

In the acquisition of ICT skills, the range of equipment and software available requires diligence on the part of the teacher to assess a given resource, determine its effectiveness in the science curriculum, then to gain operational skill for delivery. For example, Jones (2003, p. 66) expects teachers to have the following ICT competencies:

- to operate a computer and its basic applications;
- utilise desktop publishing and presentation software;
- familiarity with multimedia and communication technologies; and
- to apply learning technologies in key learning areas.

As the Saudi government subscribes to the integration of ICT through the education system, it supports this aim through successive and substantial budgets to achieve a world-class educational system (Al-Moussa, 2004; Lal & Al-Jondy, 2004). In 2004, the Ministry of Education introduced a 10-year plan to restructure its education system, introducing national projects for ICT in schools, together with teacher training and development to attain the necessary skills (Al-Omran, 2007; Ministry of Education, 2004a). However, during this researcher's visits to schools in Jeddah and regional areas of the Kingdom, there was little evidence of technology-based teaching practised in intermediate school. This observation is supported by the literature relating to teachers' ICT perceptions. Variables associated with a deficiency in ICT usage in the curriculum include resistance to change, skills training, limited knowledge of ICT; and other issues pertaining to the school itself, with perhaps limited ICT infrastructure or poor program implementation (Corbin, 2003; Schrum, 1999).

This study investigates integration of ICT in the Saudi intermediate schools' science curriculum, and teachers' professional development. Its objectives, discussed below, are to investigate national integration issues with ICT, particularly at the intermediate school level with its entry into empirical study of theoretical science, and to identify knowledge and skills issues for teachers which can be addressed by professional development.

1.4 Objectives of this Study

This study's purpose is to investigate and assess the Saudi Ministry of Education's integration of ICT into the educational system; includes ICT development programs for science teachers in both boys' and girls' schools. In 2003, girls' schools came under the jurisdiction of the Ministry and this is a point of interest: there may be variations in ICT knowledge and skills evident in the gender-based teacher groups. Once the ICT programs for deployment of ICT in science education in intermediate schools¹ are defined, teachers' knowledge and attitudes regarding ICT may be assessed in light of their training. In case of a shortfall in standards, systemic and local barriers to further training and development can be identified. As this investigation has national repercussions, the study is approached from both a policymaking perspective, and a teacher's perspective. Many implications may emerge from these findings, including in relation to the teachers' skills, attitudes, and needs; leading to recommendations for future systemic change and teachers' professional development.

1.5 Research Questions

As the research concerns the integration of ICT into the science curriculum at intermediate schools in Saudi Arabia; the competencies of Saudi science teachers in implementing ICT and their professional development needs in this regard are the bases of the research questions.

1. What actions have been taken by the Saudi Ministry of Education to integrate ICT into teaching and learning particularly for the intermediate science curriculum?
2. What programs has the Ministry introduced to provide professional development for male and female teachers to employ ICT in their classes?
3. What are the skills, beliefs and attitudes of intermediate male and female science teachers regarding ICT?
4. What are the professional development needs of science teachers regarding ICT use in the intermediate science curriculum?

¹ Grades 7, 8, and 9; student ages between 13 and 15 years.

1.6 Significance of this Study

The significance of this research is that it is a study of a traditionalist education system and the issues encountered in the government's adoption of a new pedagogical model based on technology. In this instance, the focus of research is intermediate science classes for boys and girls in Jeddah and its surrounds. This empirical study investigates teachers' perspectives on their competencies regarding computer technology, and access to ICT training and development. Their views on barriers to and issues around attaining these competencies are also identified, and the interest they may have in pursuing pedagogical change. Further, perceptions of Ministry policymakers on the study questions are sought to enrich the study and provide an understanding of the Ministry's experiences integrating ICT into Saudi public education. Whilst the focus is on Saudi science teachers, the findings of this research may have significance in educational change in all developing economies, especially Arab.

This study of science teachers is the first since the Ministry assumed administration of girls' schools in 2003, and the first to evaluate ICT competency in intermediate school science teachers and assess their access to ICT training and development programs. Further, it may also assist the Ministry with findings on the outcomes of ICT integration in education, and the teachers' perceptions of ICT integration into the intermediate science curriculum. It has an overarching aim to identify barriers to technological reform in education.

1.7 Research Design

For this study, a research strategy integrating different methods is likely to produce better results in terms of quality and scope. The research design selected for this study is a "triangulation mixed methods" approach that can better inform the study, increase the quality of the final results and provide a more comprehensive understanding of analysed phenomena (Creswell, 2009; Sydenstricker-Neto, 1997). A triangulation mixed method approach can therefore extend the analysis, findings, and conclusions for this study to better inform its results and create a stronger path towards a critical evaluation of ICT integration into the intermediate science curriculum, and therefore becomes more useful and

accountable to a wider audience. The triangulation mixed method approach uses qualitative and quantitative analyses: qualitative research as a means for exploring and understanding the meaning ascribed to a problem, and quantitative research through the collection of data, and then testing objective theories by examining the relationship among the variables (Creswell, 2009; Johnson & Christensen, 2004). The purpose of combining these arguably disparate approaches is to minimise the weaknesses inherent in a singular method to gain a contextual understanding through collecting qualitative data, and a more rigorous approach through exploring quantitative data (Johnson & Onwuegbuzie, 2004). Thus two sample groups were selected to gather the requisite data for each type of analysis, Ministry policymakers for the selected qualitative approach of interviews, and intermediate science teachers for boys' and girls' schools in the region of Jeddah for a large paper-based survey by questionnaire.

As this is social research, qualitative research is appropriate for gathering and interpreting data by using an open-ended semi-structured interview procedure from representatives from the Ministry of Education who can influence Saudi education policies. Participants in this study include members of the Central Committee for the Development of Education, those involved with the ICT implementation program, and representatives from teacher development. Whilst a comprehensive literature survey was undertaken, secondary data collection included documents and information from the Ministry regarding its plans, programs and projects to integrate technology into the Saudi educational system.

Further, this research requires specific data through quantitative analysis, in particular, descriptive analysis. A self-administered questionnaire, distributed to intermediate science teachers in urban and rural boys' and girls' schools in the Jeddah area, was constructed to determine the ICT awareness and usage in the science curriculum. The questionnaire also sought information on the teachers' perceived issues in accessing ICT training and development.

Data were examined to identify policies and programs to educate and inform teachers regarding the new technology. This analysis sought information on the Ministry's ICT policy, and its ICT systems provision; teacher training for various ICT hardware and software systems, techniques introduced by the Ministry for combining technology with classroom activities, the availability of ongoing support for teachers from the schools' knowledge centres (libraries), and supervision and mentoring for teachers when incorporating ICT into their classroom activities. Issues that impeded the introduction of

ICT into the classroom were examined, taking regard of access to equipment and information, quality of support, and pedagogical issues. These results were then differentiated for boys' school science teachers and girls' school science teachers, and the results compared.

In summary, data collected comprised:

- the literature survey to inform the study,
- collection of government documents that explain the current integration of ICT into education,
- conducting semi-structured interviews with six policymakers from the Ministry of Education and the educational administration for boys' and girls' education in Jeddah, and
- a self-administered questionnaire with the male and the female science teachers at intermediate schools in Jeddah Province.

As this section introduces the research support, the context, and the research design of the thesis, the following section shows the organisation of the study.

1.8 Organisation of the Thesis

This study investigates integration of ICT in the Saudi intermediate schools' science curriculum, and teachers' professional development. This thesis is divided into eight chapters.

Chapter Two is contextual, an overview of Saudi Arabia and its challenges in educating youth to meet the needs of the labour force. A brief summary of the development of its education system is presented, followed by the characteristics of its schools. A review of teachers in Saudi Arabia concludes this chapter, noting particular elements of male and female science teachers in intermediate schools. The third chapter, the literature review, presents extant research in relation to integration of ICT into education, especially school science education. The conceptualisation and development of educational ICT is presented, then an account of its influence on teaching and learning processes, again with a focus on science. Integration of ICT into the Saudi education system is reviewed, explaining the nature of the Saudi science curriculum. Issues regarding ICT integration for teachers and their professional development are also discussed in this chapter.

The research methodology in the fourth chapter is selected as a mixed methods approach, explaining procedures for preparing the instruments and collecting data. Interviewing as a qualitative technique is discussed, together with the nature of the semi-structured questions for the policymakers' interviews. Further, there is a summary of benefits and issues with quantitative data collection by survey, followed by the process of constructing the self-administered science teachers' questionnaire. Finally, the data collection is detailed. The fifth chapter explores the themes and subthemes that emerge from the analysis of interviews with participant policymakers.

The first five chapters explain the preparation of the research and the collection and analysis of the data which inform the findings. The outcomes from this analysis are then explored to inform the study. The sixth chapter presents the results from the quantitative survey: demographic data on the respondents, self-reports on attendance at ICT training, skills assessments and their attitudes to ICT integration into the science curriculum. A summary of perceived factors impeding ICT integration finalises the chapter.

The seventh chapter discusses the results of the study and is based on findings from interviews with policymakers, and from an analysis of the science teachers' questionnaire data in relation to the research questions. These are presented in comparison with those of other researchers in the literature survey. The last chapter presents a review of the study and its findings, some methodological reflections, brief reflections on the challenges of the study, its limitations, and implications noted relating to the integration of ICT into science teaching and the professional development needs of male and female science teachers at intermediate schools in Saudi Arabia.

1.9 Summary

This chapter introduces the study, providing an overview of the research which concerns the integration of ICT into the science curriculum of intermediate boys' and girls' schools in and around Jeddah. The research also takes cognisance of the training and professional development needs of the science teachers and their various perceptions of ICT integration into the classroom and science laboratories. There is an explanation and short discussion of pedagogical trends of ICT integration and the operational skills required by teachers in this regard. Next, data on schooling in Saudi Arabia is briefly mentioned and an explanation of the role for teachers in this country.

The introduction to the subject matters of the research is followed by the thesis itself: its objectives in assessing the Ministry's commitment to ICT integration and its success in these endeavours; the research questions which inform the study. The significance of the research is explained and the research design and implementation briefly discussed. This is followed by a description of the thesis.

The following chapter, the contextual chapter, discusses the environment for science teaching in Saudi Arabia, and, through secondary data, explores the role of the Ministry as the government's agent in educating its citizens.

Chapter 2 Context of the Study

This thesis explores the Saudi Ministry of Education's integration of ICT into the educational system through a study of science pedagogical practices and teachers' training programs in gender-specific public schools. It is thus important to place the study in context, as the Kingdom of Saudi Arabia's educational experience differs culturally from the school environments generally depicted in the literature. Whilst it is an ancient civilization, Saudi Arabia in the 21st century is markedly different to its socioeconomic status of a generation past. Oil fortunes and a rapid increase in population facilitated the development of cities and infrastructure that are world-class. However, the pace of change brings its own issues, where social and economic priorities compete for financial resources, and national skills and knowledge capabilities are perennially inadequate to the task ahead. This requires labour imports, and the concomitant exposure of nationals to global markets, therefore if the next generation is to fulfil its potential, the standard of education should reflect the profiles of similar nations at this socioeconomic level.

The purpose of this chapter is to present the Saudi environment for school science programs; its geography, cultural and religious traditions, and the status of its indigenous labour market, the purpose of this form of education. The antecedents to the current educational system in Saudi Arabia are briefly examined for context, including the centralisation of the Ministry of Education with its policies and practices. Of particular note is the important position of the teacher in Saudi society; and teacher characteristics, the working conditions they encounter and the gender division are discussed.

2.1 Environment and Labour Force

To identify the factors relevant to education on the Arabian Peninsula, this section considers the physical and social environment, particularly in relation to the structure of the labour force. The Peninsula may be viewed as an ancient civilisation in juxtaposition with robust modern economies. This somewhat precarious balance shapes all matters in this deeply religious region and none more so than for Saudi Arabia. The relatively new economy's predominance in wealth, population, and Peninsula land area is an imperative for it to adopt international trade, finance, and jurisdictional standards. This course of action

brings with it a national social and economic infrastructure of health, education, security, commerce, and transport. As the largest supplier of oil into the global market and a significant world state, the Kingdom requires a skilled and knowledgeable workforce to maintain its economy and status. However, such a national workforce is not yet available and the Kingdom contracts its substantial resource requirements to experienced expatriate labour. The antecedents for this situation are briefly described below, first the environment of Saudi Arabia, then the structure of the labour force.

2.1.1 Environment

The Kingdom of Saudi Arabia occupies the majority of the Arabian Peninsula, ranked 14th largest country by size; and with less than two per cent of the country arable, it is a desert with great extremes of temperature (Kingdom of Saudi Arabia, n.d.). Habitation is concentrated in cities (82%), with Riyadh as the capital, and the second largest city, Jeddah, on the Red Sea (figure 2.1).



Source: (Ministry of Economy and Planning 2010)

Figure 2.1 Map of the Kingdom of Saudi Arabia

The modern history of the Kingdom of Saudi Arabia began in 1902 when King Abdulaziz bin Abdurrahman Al Saud reunited the greater part of the Arabian Peninsula,

which had been divided between various leaders. The Kingdom was declared in 1932 (US State Department, 2009).

Traditionally, Saudi Arabia's environment and society were influenced by two factors, desert life and the Shari'a, the religious and moral laws of Islam (Al-Sadan, 2000). Before the discovery of oil in 1937, the Kingdom was a subsistence economy, relying on farming, trading, pearl fishing, and pilgrimage dues. Oil production commenced after World War 2 and the wealth was used initially on developing the oilfields and socio-economic infrastructure. Increasingly, Saudi Arabia's mineral riches were employed on a massive national development program (OPEC, 2007). However, the Global Human Development Report classifies Saudi Arabia as a developing country, ranking it 71st in the world; however, it is expected that the country will enjoy a position of higher socio-economic development (UNDP, 2007). The Saudi Ministry of Economy and Planning is focused on job creation and raising per capita income as part of its rapid growth (UNDP, 2007, McKinsey Consultants, 2007).

2.1.2 Labour Force

The population, according to the latest census conducted in 2004, is 22,673,538, of which 16,529,302 (72.9%) are Saudi and 6,144,236 (27.1%) are non-Saudi (Kapiszewski, 2006), the birth rate, where the Kingdom was ranked 52nd, was in the top quartile of countries; literacy was earlier estimated in 2003 at 79 per cent; for women it was 71 per cent (Kingdom of Saudi Arabia, n.d., referencing World Factbook, 2009); although the World Bank (2007) estimated Saudi literacy at 93 per cent in 2007. Economically, the country in 2008 ranked 60th by gross domestic product per capita, with a labour force of less than seven million, although 80 per cent of these were claimed to be expatriates (Kingdom of Saudi Arabia, n.d.; World Factbook, 2009). However, a report from the newsagency Zawya placed expatriates at 47 per cent of the national workforce, whilst another news source using similar data, nominated Saudis as 73 per cent of the national workforce (Zawya, 2009; Times of Oman, 2009). Again, the International Labour Organisation claimed nearly eight million in Saudi Arabia in employment in 2008, with an active workforce of 8.4 million: 7.1 million men and 1.3 million women. The majority of men work in retail and wholesale trade, public administration and defence; whilst the majority of women work in gender-segregated education, and as household service workers (these are generally expatriates). Unemployment of 0.4 million represents a rate of 3 per cent for men and 13 per cent for women; with the

majority of both genders, 47 per cent of unemployed, aged from 20 to 24 years. Three-quarters of unemployed women have a 'first stage' tertiary qualification (ILO, 2008).

To summarise the Saudi work force: in a population of some 28 million, with over 8 million in employment and seeking jobs, this researcher is estimating expatriate labour at a conservative 30 per cent, or 2.4 million (including about 350,000 women). Therefore there are arguably some 6 million Saudis in the workforce or seeking work. To this are added some 700,000 Saudis attaining the age of 15 each year, bound for further education or the workforce: traditionally women marry young and do not work after marriage. Note is also made that the higher educated female graduates are unable to find work to meet their career expectations. There are therefore in the vicinity of 500,000 new workers arriving on the labour force each year. This is the task of the Saudi education system: to produce skilled workers to take over the plentiful expatriates' positions in a highly charged economy. The next section follows this thread and briefly explains the Saudi education system.

2.2 Evolution of Education

Education developed over the centuries in the region and is presented in this summary. The antecedents of schooling on the Arabian Peninsula can be traced back to traders and early Islamic teachings centred on the Qur'an; an Islamic system of education with characteristics which remain extant (Anzar, 2003; Rugh, 2002). Mosques were therefore the principal places for male learning, especially in the holy cities and thus near Jeddah; otherwise, primary schools supplied basic religious training and literacy for trading, and vocational instruction supplied the various needs of communities (Nawwab, 2001). Traditional teaching methods were rudimentary: listening to the teacher, memorising the lesson and repeating it. Sometimes students wrote on small wooden plates which, after committing the lesson to memory, were cleaned and reused; these plates were the extent of teaching aids available. Nevertheless, this system was sufficient for the bulk of the nomadic and urban population at that time (Bedawi, 1998). In relation to this study, the religious nature of learning the Qu'ran by rote presaged the traditionalist teaching techniques practised today; that of teachers lecturing to classes of students, and examinations based largely on memory rather than understanding.

In 1952, the United Nations reported that although Saudi Arabia had 306 elementary schools, illiteracy in the country was between 92 and 95 per cent. The Ministry of Education

was formed in 1953 to provide public education for boys, and to establish programs for adult literacy and skills acquisition. It later took control of private sector education. The Ministry was directed to instil Islamic culture in boys, and provide them with work skills for the labour market (Ramadan, 1994). In 1958, a six-year compulsory primary education was proclaimed, plus an optional three years each for an intermediate education and a secondary education for boys (12 years) which led to the labour force or higher education (Lal & Al-Jondy, 2004; Ramadan, 1994). Against considerable resistance in 1960, the General Directorate for Girls' Education was established to supervise all public girls' schools and education. By 1970 there were 16 primary girls' schools with 148 staff members teaching over 5,000 girls (Al-Hakami, 2000). In 2003, the separate education systems for boys and girls were brought under the Ministry of Education (2003b) with a Deputy Minister for each of the boys' and girls' schools' administrations. The Ministry of Education presides over 42 districts, providing public schools with all educational resources, curricula plans, national examinations, teacher recruitment and selection. Currently, the Ministry controls all aspects of public education, and sets standards for the growing private sector, the preferred source of girls' education.

A general education in Saudi Arabia has four stages, three of which are pre-school, a small sector limited to larger cities; a six-grade primary school for children six years of age; and a three-grade intermediate school for children aged 12 years. Promotion to each level is by examination. The fourth stage, secondary (high) school, at 15 years, is three years and provides specialised studies; it also prepares students for entering university. Schools, as noted, are physically separated by gender and sometimes by stages, which arguably require administrative and functional duplication and wasted resources, especially in the matter of ICT facilities: provision of cabling, equipment, and user training. The school year for all stages consists of two semesters, each of which is fifteen weeks long. The number of classes for student varies by stage from 28 to 36 per week, each for 45 minutes, giving an indication of the high workload for Saudi teachers and impacting their ability to seek training (Al-Hakami, 2000).

In summary, education in Saudi Arabia emerged according to the highly structured Islamic tenets which instruct devout Muslims on all aspects of life, especially learning. Oral learning through memorising the Qur'an is fundamental to Saudis; secular learning naturally followed the same pedagogical practices. Once the Kingdom was united under an absolute ruler, education through skills and knowledge acquisition proceeded relatively quickly so that all Saudi children are now compelled to have at least a basic education. The Saudi

government sources advice and knowledge from international and regional organisations, including UNESCO; the Arabic Organisation for Education, Culture and Science; and the Arabic Education Office for the Gulf States. In particular, UNESCO provides advisers and consultants to enhance teacher performance, and pedagogy conferences and workshops which Saudi teachers and supervisors frequently attend.

Determining to adopt international standards, the Saudi government is pursuing to bring ICT into the classroom. This study investigates the government's experience in integrating ICT in the Saudi intermediate schools' science curriculum, and the perceptions of teachers in this regard. In the next section, the evolution of government education policy is examined.

2.3 Characteristics of Schools

This section explores the means employed by the Saudi government to introduce world-class education outcomes for its citizens and its world positioning in this regard.

For the last half-century, substantial resources were applied to education in the six GCC monarchies (Saudi Arabia, Bahrain, Kuwait, Oman, Qatar, United Arab Emirates) and the governments frequently issued policy statements of their intentions to achieve world standards in education, and economic development aspirations. High birth rates challenged the various Ministries of Education in their attempts to educate every child, and the initial developments in education were merely accommodating and resourcing ever-increasing numbers of students. This was achieved through intense building programs, renting buildings to accommodate new students and employing expatriate Arabic teachers. Over the years, discrepancies emerged over the quality of education and that the school leavers (and later graduates) did not meet the needs of Gulf societies. Issues endemic in these educational systems were, and remain, continuation of traditional teaching practices, the higher standards of qualifications of the expatriates, and the dual gender education systems (Bahgat, 1999).

Quality was also at issue. In a recent assessment of the Middle East and North Africa (MENA) education systems, the World Bank (2007) reported that Algeria and Saudi Arabia, both with relatively high per capita income, performed less well in their educational

outcomes (age of school leavers, and TIMSS² results) than Jordan or Tunisia, with lower per capita incomes. The conclusion of the World Bank report is that the better performing MENA countries of Jordan, Kuwait, and Lebanon have relatively better evaluation, monitoring, and reward systems in public schools, and their private education sectors are more robust. However, there is a challenging environment for Saudi education, both from the educational reform movement and from the system itself. As the Ministry of Education Report (2004b) indicates, a prime consideration is the increasing number of students entering the educational system in high population growth countries such as Saudi Arabia. Another challenge is that of preparing graduates for the future economic and social needs of the country and its world position, which requires greater emphasis on mathematics, science, and ICT, as well as the adjustments educational reform demands (Ministry of Education).

There is little doubt that the Saudi government applies all available financial resources to its education portfolio. Besides free education, the Saudi government provides its students with free learning tools, health services, and living expenses if required. There are also monthly financial rewards for college and university students, and institutes and training centres. The 2010 budget allocated SR 137 billion (\$AU39.6 b.), over 25 per cent, for Education and Manpower Development:

to increase both the quality and quantity of the Kingdom's human resource base among the Saudi Arabia's population, of which two-thirds are under the age of 30. The budget includes . . . four new universities . . . and the establishment of new polytechnic colleges and vocational institutes. In addition, more than 5,000 Saudi students will receive scholarships to study abroad . . . with a particular emphasis on technical training. New projects for primary education will include the addition of 1,200 new schools to the 3,112 schools currently under construction and the more than 770 schools completed in 2009. Two thousand existing schools are scheduled for renovation. The government will continue to place a large emphasis on implementing its national plan for science and technology (US-Saudi Business Council, 2010).

As a result of the focus on education over the decades, the number of children at school increased from 547,000 students in 1970 to more than five million students in 2007, the majority of whom attend nearly 32,000 public schools (table 2.1) (Lal & Al-Jondy, 2004; Ministry of Education, 2008).

² Trends in International Mathematics and Science Study, .see Chapter Three

Table 2.1
Schools and students 1970-2007

Year	Schools Number	Girls Thousands	Boys Thousands	Students Thousands
1970	3,282	135	412	547
1975	5,634	311	673	984
1980	11,070	511	951	1,462
1985	15,079	876	1,273	2,149
1990	16,609	1,310	1,624	2,934
1995	21,284	1,912	2,022	3,934
2000	22,770	2,369	2,405	4,774
2004	29,807	2,403	2,379	4,783
2007*	31,798	2,496	2,522	5,019

Sources Lal & Aljondy, 2004, p. 162; *Ministry of Education, 2008

This rapid increase in education facilities necessitated an equally large rise in the number of teachers, increasing from 23,100 teachers in 1969 to more than 450,000 teachers in 2006 (Ministry of Economy & Planning, 2008). As noted, this continual increase in students and the resources required for their education places considerable strains on an education system which is still relatively new and which requires substantial upgrading in its standards to meet the needs of economic growth, a civil society, and international expectations. The objective of this study is the integration of ICT into science education, and science teacher training to meet those needs, and the teaching environment is introduced below.

2.4 Teachers

In their positions of ICT users and receivers of training, characteristics of intermediate science teachers in Saudi Arabia are fundamental to the information required for this study. In this section, discussion includes the extension of responsibilities of Saudi teachers to ensure that learning must be imparted within the tenets of the Qur'an. An imported curriculum, or tools such as ICT, must be adapted and used within an Islamic framework, so that curriculum standards are derived from different criteria to countries with a secular education system. An instance of these tenets is the position of women in society; segregated

education systems diminish the opportunity of teachers to a variety of resources, collegiate support, flexible professional development, and to pursue more varied careers.

For all Saudi teachers, pre-service training, recruitment, performance assessment, career prospects, and financial rewards are factors that impinge on the quality of teaching (Moon, 2007). However, the quality of facilities, equipment, supervision, and administration; and workloads and time constraints are also elements in teacher performance and student outcomes and these factors are explored in the following paragraphs.

2.4.1 Religion and Culture

The cultural impact of Arabic society on teachers is introduced in this section. As noted (see section 2.2), Islam permeates all aspects of Saudi life, thus faith is a criterion of a teacher's worth (Sharpe, 1986). All educational matters must conform to Shari'a laws and the Qur'an, and traditional gender roles shape the teaching careers for both men and women. Nevertheless, the absence of teacher accreditation and objective evaluation is being questioned, and the government is considering reform measures (Rugh, 2002). In a comparison between South African and Saudi teaching experiences, Arnolds (2006) found that values that were part of education policy: respect for others, equality, acceptance of other languages besides Arabic, and respect for the environment; were not practised in Saudi classrooms. Teachers preferred social norms and were not always open to foreign values. Schools' administrations appeared inflexible to innovative ideas or expatriate teaching practices. Although most teachers were unhappy with lesson plans, weekly plans, and the curriculum, school principals rarely deviated from that prescribed, preferring rote results. To Arnolds, responsibility, accountability, and promotion of critical thinking in Saudi schools appeared to be of little significance. Nevertheless, Arnolds' expatriate study participants welcomed Saudi parental involvement, private tutoring, a good working environment, and adult education aspects of their Peninsula teaching experience.

Arnolds (2006) findings of rigid teacher attitudes may influence the outcomes of this research if teachers respond within a limited frame of reference. Further, Arnolds' recommendations for the Saudi government's consideration are of particular interest to this study and summarised from a more extensive list:

- the Ministry should reconsider its teacher qualifications and require at least a teacher's diploma;
- traditional learning practices should be addressed;

- teachers' unions should be formed to coordinate and advocate teachers' needs;
- the system of teacher promotions should be addressed to reflect merit; and
- administration of lesson plans should be streamlined to save time (p.124).

2.4.2 Teacher Conditions

This part explains the nature of a teaching career in Saudi Arabia. The assessments from Arnolds' study were echoed by the World Bank (Wahab, 2008) in an annual update following its 2007 report (see section 2.3). The bank noted that there remained a weak relationship between education and economic growth in the region, with no improvement in education quality, thus employment prospects remained low. The bank posited that development of education in the region followed 'engineering' practices: building schools, hiring teachers, and writing curricula and that the underlying practices of the key personnel: teachers, administrators, and also the educational authorities remained unchanged. Teacher salaries were at poverty level, given the economic development and its attendant rise in expectations and accessibility so that teachers engaged in private tuition to supplement their wages. The bank also recommended a policy that school principals within defined limits could choose teaching staff and offer performance-based salaries. Similarly, in a study of issues concerning Saudi secondary school principals, Alzaida (2008), stated that there was dissatisfaction with a lack of authority to transfer underperforming teachers, lack of financial resources to improve school buildings, salary levels and lack of financial reward.

2.4.3 Gender

The issue of gender is fundamental to the Saudi experience. Women teachers may only work with girl students and their movements are highly restricted.

Women have a special place in Islam, one which militates against choice in employment. Al-Sheik (2001) nominated the following aspects of life for Saudi teachers:

- policy initiatives for working women are relatively new and have yet to gain credence in a traditionalist and religious male-dominated society
- a negative attitude toward working women in general, together with overt and covert restrictions imposed by the government and society
- knowledge and skill issues allied with working women and cultural restrictions; training to gain entry into male-dominated professions is difficult to access

- employer requirements for secured work places and restrictive working conditions, especially regarding women's travel, working away from the family home, and staying away overnight.

Education in a female-only working environment is one career open to Saudi women. Al-Sheikh (2001) estimated that at the time, two-thirds of working Saudi women were in the public sector; some 90 per cent of those were in education; with the remainder in health and a few women (1%) in the services industry. However, there is a recent Saudi Employment Strategy which seeks full employment for all school leavers and graduates, and increased employee productivity:

the short-term goal (two years) of the employment strategy is to bring the unemployment rate among Saudis under control through adoption of policies aiming at employing numbers of the Saudi male and female citizens equal to the new workforce that enters the labour market (Ministry of Labour, 2009).

This new emphasis on finding work for women graduates and female school-leavers is arguably aimed at reducing the number of women out of work; however, the overhang of past cohorts of graduates remains.

This study investigates integration of ICT in the Saudi intermediate schools' science curriculum, and teachers' professional development. The objective of the study is to investigate and assess the Saudi Ministry of Education's integration of ICT into the educational system, and to assess ICT development programs for science teachers in both boys' and girls' schools. As girls' schools in recent times became a responsibility of the Ministry there may be variations in ICT knowledge and skills evident in the gender-based teacher groups. Once the deployment of ICT in science education are determined, teachers' knowledge and attitudes regarding ICT may be assessed, and if there are deficiencies, further training and development can be identified. As this investigation has national repercussions, the study is approached from both a policymaking perspective, and a teacher's perspective.

2.5 Summary

This chapter presents the social, cultural, and economic context of the study. In its aim "Education for all", the Saudi government allocates some 25 per cent of its annual budget to education, one of the highest percentages in the world. The educational system has rapidly expanded over the last few decades, with over 32,000 schools, 450,000 teachers, and more than five million students.

The objectives of Saudi educational policy are also to ensure that education becomes more efficient in meeting the social needs of the country. Saudi Arabia is still a developing country, intent on improving the standard of education for its high proportion of young people to assist them to compete in the global labour market. Further, the majority of Saudi families do not have computers and children have little access to ICT (World Bank, 2007). The Ministry continually seeks to enhance the educational system to improve the quality of outcomes for its students; each national plan is directed to this end, providing ICT at all schools to facilitate teaching and learning processes and to prepare both teachers and students for the demands of the 21st century.

The rapid population increase challenges the Saudi government in the quality of its schools accommodation and teaching staff. Despite its copious resources allocated to education, there are strains on a system which is still developing standards to meet the needs of economic growth, a civil society, and international expectations.

Teachers reflect their society's expectations. In a traditional society, teachers are expected to follow religious tenets and deliver a conservative curriculum. However, pedagogical theory dictates a new paradigm, where students can use ICT to broaden their study and access new forms of learning. Nevertheless, teachers receive low remuneration, infrequent access to training due to time and gender constraints, and large classes. The science curriculum lacks flexibility, is copious, and all teaching and learning materials are supplied as text-based directions. Teachers adhere to the curriculum and teach students for recall-based examinations.

These and other issues are investigated in the following chapters, which comprise a review of the literature, the primary research which consists of semi-structured interviews with Ministry policy makers and a questionnaire answered by male and female science teachers, and analyses and conclusions.

Chapter 3 Literature Review

The aim of this study is to investigate integration of ICT in the Saudi intermediate schools' science curriculum, grades seven to nine, and teachers' professional development in this regard. This chapter provides the theoretical framework that supports the research aims concerning the professional development of Saudi science teachers using ICT within the science curricula. This is an exploration of the literature in the related fields of science pedagogy and technology to develop a logical framework for this study. Due to the differential position of Saudi Arabia as a developing economy, with considerable economic resources yet without an established body of literature in the field, secondary and factual sources are confined to the contextual chapter, 2. Referenced material is presented and discussed in this chapter.

Integrating ICT into education, particularly science curricula, includes conceptualisation of ICT media, and thus its educational applications and approaches. Of interest to this study is the research findings regarding the purpose and expected outcomes of ICT integration into learning environments and issues encountered concerning the use of ICT in education in principle, and particularly in the science curricula. The discussion in this chapter first considers the nature of computer-based technologies in education, and their antecedents, and the adoption of ITC in research over the last decades as educators explore its potential. The arguments for and against improving the classroom experiences for students and teachers are presented, and the structural and pedagogical issues set out. The discussion then turns to the science curriculum, the purpose for learning science and the outcomes expected from this knowledge. The particular case of science knowledge in Saudi Arabia is presented, its content and delivery by teachers who are responsible to their society for inculcating Islamic values through students' learning.

The next section turns to issues regarding teachers that impact ICT integration into education, again in respect of Saudi Arabia; however from a secular view. These factors are intrinsic and extrinsic and their interconnectedness is explored. The final discussion turns to teachers' professional development, including the necessity for continual upgrading of teachers' ICT standards, particularly in the sciences, and the various systems and approaches

adopted for training and development. The relationship of this literature review to the research problem and the attendant questions is illustrated at table 3.1.

Table 3.1
Literature Review: Relationship to Research Questions

Field of Literature	Research Question/s	Explanation
3.1 Overview of ICT in Education	1,2,3,&4	Section 3.1 introduces all research questions comprising the overarching research problem, reviewing the literature regarding ICT in education, against which the Saudi Ministry of Education introduced policies and programs relevant to the science curriculum and professional development of science teachers. It further informs the study of the relevant attitudes, beliefs and skills that are extant for intermediate science teachers, and their needs relating to ICT training.
3.2 Integration of ICT into Saudi Education System	1 and 2	Section 3.2 explains the development of the Ministry of Education's ICT policies and programs, and the existing pedagogical and resource environment.
3.3 Science Curriculum and ICT	1, 3 and 4	Section 3.3 moves forward to the integration of ICT into the science curriculum, highlighting Saudi cultural and belief systems regarding science policies and practices which may affect science teachers' attitudes and pedagogical skills. This informs the quality and quantity of ICT training that may be required by the teachers.
3.4 Issues with ICT Integration	3 and 4	Section 3.4 discusses the theory and effects of change, and barriers to science teachers' ability to engage with ICT systems in the classroom. The narrative touches on Arabic performances on the global science education rankings.
3.5 Training and Development for Teachers	2 and 4	Section 3.5 explores the field of professional development for teachers, in particular ICT. Whilst the discussion includes both ICT skills and professional development in an ICT-enhanced curriculum, this study emphasises the skill aspects of teacher training.

3.1 Overview of ICT in Education

This part introduces the conceptualisation of ICT within education. Research attention is increasingly directed at the interface of the arguably merging fields of education and ICT, and this attention is encouraged by educational authorities (Abuzaid & Singh, 2008; Al-Jarf, 2007; Bauer & Kenton, 2005). There is inherent potential for improved student outcomes when ICT is integrated into teaching and learning; consequently teachers are expected to explore means by which they may incorporate ICT into their professional practice (Fitzallen, 2004). Whilst the trend to ICT integration continues, researchers identify issues such as inadequate technology, insufficient teacher training; inadequate curriculum, technical, and administrative support; limited time for planning for teachers; computer access issues; budgetary constraints, and a general resistance of teachers to change (Roblyer, 2004). In this section, the characteristics of ICT are explored through definition, and the underlying factors of the computer in ICT are described. The antecedents of ICT integration education are discussed, together with its implementation into various curricula to improve learning outcomes through adapting teaching styles. Media, including ICT, as curricula resources are noted, and the potential learning and teaching outcomes from such integration are explored. Next, structural issues which may impact ICT integration are discussed, and this part ends with a summary of potential approaches for integrating ICT into education.

3.1.1 Definition for ICT

For the purposes of this study, the term ICT, whilst superficially all-encompassing, requires some bounds. The concept of ICT as information-based technology which can be coordinated with other technologies including communications has acquired the status of a structural unit of society (National Council for Accreditation of Teacher Education 2002; UNESCO, 2002). Elston (2007, see section 1.1) identifies ICT as technology to manage information and communication, whilst Blurton (2002) broadens this to define ICT as a “diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information” (Blurton, p.1). In education as elsewhere, the term ICT is usually connected with the notions of computer-based hardware and software. The National Council for the Accreditation of Teacher Education (2002, p. 54) defines ICT as “computer hardware and software; voice, data, network, satellite and other telecommunications technologies; and multimedia and application development tools; these technologies are used for the input, storage, processing, and communication of information”.

In teaching and learning, ICT is expected to include the organisation's computer networks through the internet, and dedicated personal computers and associated equipment such as printers, scanners, digital cameras, video and audio software programs, various ICT-enhanced laboratory equipment, and interactive whiteboards in classrooms and laboratories (Haddad, n.d.).

However, many educational researchers view the computer as the basis of ICT. Ortega (2000), Shelly et al. (2006), and Elston (2007) are researchers who state that the potential for computer-based ICT is in the software applications that can gather, process, and communicate information. With developments in technology equipment and communications systems, many studies conceptualise ICT as the computer and the internet. For example, UNESCO (2002) refers to ICT as computer-based equipment including hardware and software, communication networks such as the internet, and communication hardware and software. Shelly, Cashman, Gunter, and Gunter (2006), and Davis and Naumann (1997) concur, adding externalities such as input and output devices and visual display devices. The internet is defined as a computer network that transmits data from one computer or from one network to another via modems, telephone lines, and other communication devices and media (Norton & Sprague, 2001; Shelly et al.).

In this study, as noted, the overarching Elston (2007) ICT definition is adopted. One intention of this study (see section 1.4) is to explore the competencies of Saudi science teachers in implementing computer-based technology at intermediate schools in Jeddah city in Saudi Arabia. To ground the Saudi experience in integrating ICT into the science curriculum, the following discussion relates to the development of ICT in education, and the effects of technology on educational principles over time.

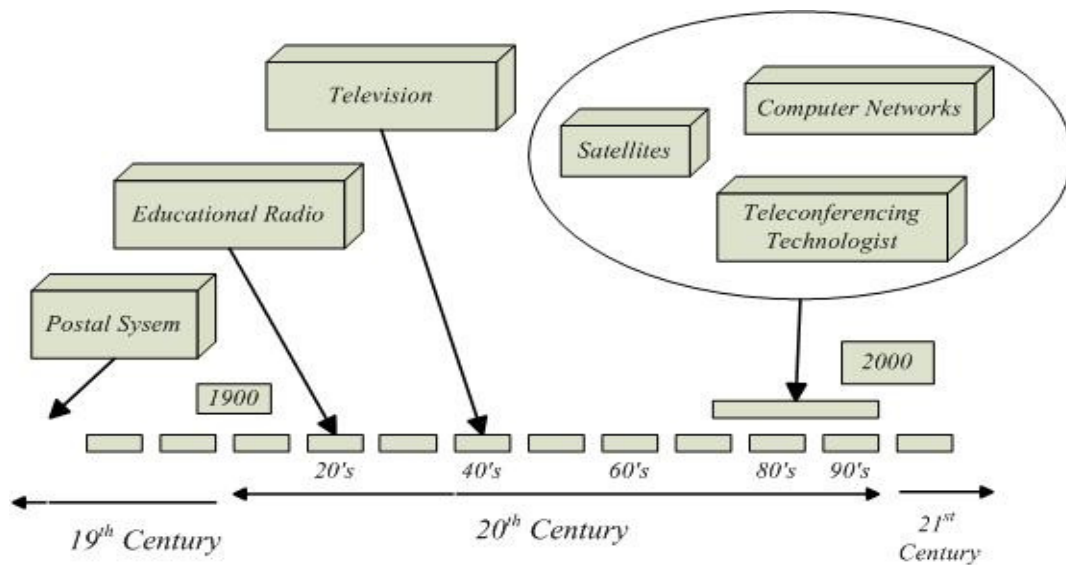
3.1.2 Background

This section explores the rise of computer-based technologies in education and discusses factors which impinge on ICT adoption. Factors which may contribute to the successful integration of ICT into schools are also discussed.

It is useful to consider extant systems and past events to identify trends which may guide the future with regard to experiences in countries which earlier adopted ICT practices in their pedagogy. Developing economies such as Saudi Arabia can use these experiences and studies described in the literature to build their capacities in ICT, and into its integration into the teaching and learning practices. Roblyer (2006, p. 11) states that "knowing the history of

information and communications technology in education is useful only if we apply what we know about the past to future decisions”.

Researchers record the evolution of ICT from its introduction in the classrooms of technologically advanced countries. Prior to this, Taylor (1999) and Shelly et al. (2006) state that the first use of ICT in schools was in the form of print technology, duplicating textbooks; second, technology became a multimedia model based on print, also using audio and video technologies; the third model was based on opportunities ITC provides for synchronised communication; and fourth, the flexible learning model is based on online delivery of instruction through the internet. The evolution of information and communication based technologies is described by the Ministry of Education in the following figure (3.1).



Source: Ministry of Education, 2003c

Figure 3.1 Stages of ICT Development

Technological development in electronics contributed to the development of computers, enabling the production of quality machines at low cost and in compact sizes suitable for home use by individuals. The use of microcomputers in education started in 1976 with the first-generation Apple computer, replaced soon after by the Apple II computer. In the following decade, it became the most widely-used computer in American public schools because it was considered the first user-friendly computer (Roblyer, 2006; Waugh, 2006).

The advent of the world wide web (www) in the mid 1990s resulted in a proliferation of systems and applications, particularly in education (Roblyer, 2006; Shelly et al., 2006). Internet users at the time, according to Elston (2007, p.10), are “about 30 million people in

the UK and about 600 million worldwide (who) now use the internet to search for information and send e-mails”. The Australian Bureau of Statistics (2002) reported that internet users in Australia increased from 260,000 in 1996 (when data was first collected) to 2.7 million in 2000, and at the time, almost half of children aged five to fourteen years had accessed the internet, with just over a quarter of all children accessing it from home and almost a third using the internet at school. In Australia, the majority of schools give a high budget priority to the provision of ICT for students and for teachers (Australian Bureau of Statistics, 2000). In 2004, for the Arabic ITC adoption rates, there were more than 16.4 million internet users in eighteen Arab countries; by 2005 this rose to 26.3 million (Mader Research Group, n.d.). In Saudi Arabia, the internet was used by government agencies from the inception of the world wide web about 1994; however, it was not made available to the general public until 1999. By 2005, there were 2.54 million users in the Kingdom, which was then one of the fastest-growing internet markets (Government of Saudi Arabia, 2007).

The development of computer technology and the internet in the educational field may be divided into three periods: the pre-microcomputer era, microcomputer era, and internet era (table 3.1) (Roblyer, 2006).

Table 3.2
ICT Timelines in Education

Era	Years	Statement
Pre-microcomputer era	1950	First computer used for instruction
	1959	First computer used with schoolchildren
	Early 1970s	Computer-assisted instruction (CAI) movement emerges
	Mid 1970s	Mainframe and minicomputer applications dominate
	Late 1970s	CAI movement declines; computer literacy movement begins
Microcomputer era	1977	First microcomputers in schools
	1980s	Microcomputer applications proliferate
	Mid 1980s-1990s	Integrated learning systems emerge
Internet era	1994	World Wide Web appears
	1998	International society for technology in education creates standards
	2000 >	Internet use propagates across higher education, then into schools (online and distance learning).

Source: Roblyer, 2006, pp. 10-11

As applications and usage evolved, ICT became integrated with education as authorities pursued more intensive programs and projects to bring ICT technologies into the reach of every student (Harrison et al., 2002; Higgins & Packard, 2004). ICT thus has penetrated educational systems, forming new databases and linkages to allow students access to knowledge repositories across the world (Semenov, 2005; UNESCO, 2002).

The successful integration of ICT is a complex development, as it depends on interlinking variables, such as overcoming issues concerning teachers' professional development, financial and technical resources, curriculum, teachers' and principals' attitudes (Akbaba-Altun, 2006). Earlier, Hoffman (1996) had success factors for ICT integration: ICT strategy and planning, project management, technical support and assessment; particularly staff development which provided the skills and knowledge that teachers need to use ICT. These factors are inherent in project development; more so when technological change is involved.

Integration of ICT into teaching and learning processes requires human factors, such as teachers; and technical factors, such as the availability of hardware and software (Lawson & Comber, 1999; Reid 2002). Hasselbring et al. (2000), Ortega (2000), and Blackmore et al. (2003) state the successful integration and use of ICT in education depends upon teachers and their capacities, and noted that teachers needed confidence in their ability to employ ICT into their teaching style. Teachers' professional development is viewed as more important than hardware and software availability (Hasselbring et al.). Education authorities in developed countries, such as the United States and Australia, note the importance of teacher training and development. Finger et al. (1999) indicate that "while schools are obtaining increased levels of ICT infrastructure and increasing the number of computers, state education systems in Australia and the United States have also highlighted the importance of the professional development of teachers". Also, Blackmore et al. note that teacher training should precede the integration of ICT into classrooms, citing four elements necessary for the effective integration:

- teachers first: teacher professional development comes before integrating ICT into programs
- complementarity: skills taught at the same time technology is introduced;
- workability: assessing whether the new technology improves teaching and learning and whether it will work for teachers and students; and

- equity: ICT leads to a re-allocation of resources, and this should produce an equitable result (Blackmore et al. p.83).

However, any planning for integration of ICT into education has to include two factors: teachers' professional development and ICT infrastructure, and a considered response to the issue of teachers' resistance to change is further training (Pan, 1999). Such programs can assist teachers in acquiring new skills, knowledge, and support, and help them integrate ICT into their teaching (Pan).

3.1.3 ICT Media as Curriculum Resource

This study investigates integration of ICT in the Saudi intermediate schools' science curriculum, and teachers' professional development. This discussion follows the nature of online learning, and expected outcomes and issues pertaining to the introduction of ICT in the classroom. In introducing ICT as a curriculum resource, interlinking factors need to be considered. Researchers show interest in ICT in education, describing the potential for improved student outcomes (Mitra & Steffensmeier, 2000). To employ these ICT in science education, it is necessary first to identify the precise objectives of that education and then to match the appropriate use of such resources to the achievement of those objectives (McFarlane & Sakellariou, 2002). Richmond (2002) summarises the use of ICT in education through three approaches: first, learning about the computer with ICT literacy as the goal; second, learning by the computer, in which this form of technology facilitates learning across the curriculum; and the third approach is learning through the computer, integrating ICT into the curriculum. Using these approaches requires substantial professional development for teachers and corresponds to the second aim of this research. Developing this theme in a US study, Lawless and Pellegrino (2007) emphasise the need for a systematic study of the manner by which ICT integration occurs within schools, factors that increase its adoption by teachers, and the long-term impacts that these investments have on both teachers and students.

Noting its social and economic implications, Kozma (2005) nominates four types of approach to using ICT:

- as delivery: ICT can improve the way that instructional methods are delivered without involving fundamental change;
- as the goal: ICT is the focus of learning new skills;

- for student understanding: ICT can support students' deep understanding of subjects, as teams of students engage in solving complex, real-world problems;
- as knowledge creation: knowledge creation and technological innovativeness can contribute to the transformation of the education system and to sustained economic growth and social development (Kozma, p.142).

These aspirations are grounded in ICT-based methodologies in use today. Online learning, used frequently by educators and students for out-of-hours communications or distance learning, is generally classified into two types: synchronous and asynchronous learning (Sparnon, 2004). In synchronous online learning, students and their instructors meet over the internet at given times to communicate; whereas with asynchronous online learning students and teachers do not interact live but access the 'virtual' classes from any location at their convenience (Sparnon). Educators such as McKenna, Avery, and Schuchardt (2000); Norton and Sprague (2001); and Semenov (2005) confirm that both types of online learning are powerful tools for teaching and learning. However, there are issues with online instruction; it can have limited capability to engage students unless learners are self-motivated and well-organised in their learning habits (Lim, Morris, & Kupritz, 2006). In Lim's study, online learners also reported that ICT learning lacked the immediacy of group interchange and lacked empathy between learners and instructors. This factor influences learner satisfaction and learning absorption. Fontaine (2002) agrees, argues that delivering vivid learning experiences to online learners requires a sense of belonging, of immediacy, and a strong learning environment.

The ICT supporting online learning delivers a custom-built learning environment designed for online learning. These environments, such as *Blackboard*³ and *Moodle*, typically provide the software tools required for online learning, including communication and file sharing facilities (Elliott, 2008). To enhance the online experience, these environments are often modelled around the traditional school structure, providing "virtual staff rooms" and "online student common rooms". Internet portfolios provide the digital equivalent to the traditional paper exercise books and portfolios; providing online storage for a range of student materials such as text, drawings, photos and videos. These applications extend to

³ Blackboard is learning management software partially owned by Microsoft; Moodle is open-source learning management software free to use; Questionmark Secure is free product provides a secure environment for delivering high-stakes assessments such as tests and exams.

assessment systems, such as *Questionmark*, and they facilitate large-scale online testing, providing many of the question types that are familiar to teachers (Elliott).

There is a distinct difference between ICT-based learning opportunities in the developed countries and those of Saudi Arabia (Al-Reeise, 2004). Internet services are sparse in Arabic countries due to the government monopolies over the telecommunications sector, resulting in higher prices (Ahmad, Härdle, & Klinke, 2007). The authors contend that only 0.5 per cent of internet users come from the Arab world, even though the Arab population is 5 per cent of the world population. Another example of ICT penetration is the number of personal computers: 20 per thousand in Arab countries, compared with 200 per thousand in more developed economies (Ahmad, et al.). Further, English is generally used for e-learning and most Arab users are not fluent in English, and do not have sufficient familiarity with the language to decipher discipline-based terms and acronyms, or to communicate using English; these factors distance them from e-learning sources and educational courses. Lastly, social and cultural problems are reflected in varying levels of censorship by Arab governments, as the internet contains opinions that violate Islamic traditions and cultural values (Ahmad et al.).

Contributing to this debate, Al-Jarf (2007) identified instances of on-line training in Saudi universities for teachers. The researcher found that only six universities (43%) were offering online courses and their technology was inappropriate for the task. Lack of motivation, below standard online skills and training, inadequate infrastructure and funds contribute to the inadequate use of online courses. This indicates that there is little leadership from the universities to employ ICT in pedagogy, a position that Al-Jarf considered was not viable (also Ali & Bailur, 2007).

Pertinent to this study is the important role for science teachers in adapting their conceptions toward ICT and the Ministry's aim, inherent in its government directives, for them to gain ICT literacy. In a UNESCO report, BouJaoude (2003) notes that the concept of lifelong learning is slowly progressing for Saudi teachers as they attempt to manage the great changes to their pedagogy, curricula, and subjects. Professional development for teachers necessarily includes technology and updated, flexible, and rigorous curricula that emphasise thinking and problem-solving (BouJaoude). Science curricula elements that attach importance to breadth (facts) rather than depth (understanding) are inappropriate. For students to think

effectively, they require a deep and coherent knowledge base, the skill to think, and evaluation systems that reflect the desired outcomes (BouJaoude).

In these approaches, ICT integration into teaching and learning experiences is generally considered to contribute to change and permits students flexibility in exploring resources to find their own route to answers (Elliott, 2008; McKenna et al. 2000; Semenov, 2005). However, ICT can also be introduced into the curricula through the Learning Resource Centres' computer laboratories, and this option is being pursued by the Ministry of Education. Abuzaid and Singh (2008) proposed a network model for a Jeddah girls' school to connect teacher, Resource Centre and student. They coordinated the stakeholders' needs for a science subject and implemented an agreed pilot system. The authors then examined the learners' satisfaction with the availability, variety, and accessibility of resources through the Resource Centre. The majority (89%) of students were enthusiastic about the use of the Resource Centre in their work; whilst 98 per cent wanted the system used on all school subjects (Abuzaid & Singh).

Nevertheless, there are contrary opinions to unfettered use of ICT in the classroom. In a recent Korean study, Park, Khan, and Petrina (2009) investigated the results of a national School Curriculum Reform introduced in 2000 to prepare school-aged Koreans for an information and knowledge-based society. Whilst the results were generally inconclusive, the researchers found some evidence that ICT assists low-achieving students and may encourage later enrolment in science. Of consequence, Cox and Marshall (2007) query the underlying assumptions of the literature. The researchers argue that decades after the introduction of ICT into classrooms, there were unanswered questions about the impact of technology on students' learning, and the manner by which it affects simple and complex learning tasks. In relation to the outcomes and recommendations for this study, Cox and Marshall highlight the absence of rigorous studies as impacting (a) government policies; (b) teacher education programs; (c) advancing national curricula; (d) designing or reforming classroom implementation, and (e) analysing costs and benefits. They ask: "Does the way in which ICT is implemented have a major/minor impact on students' knowledge and understanding?" and "Does the impact affect the surface or deep structure of students' thinking and acting?" Further research is required to address these factors.

Therefore, ICT integration into the Saudi curricula, whilst proliferating, has inherent issues to be addressed. These include assessing ITC effectiveness as media for learning,

possible alienation of students with excessive online study, and the previously mentioned aspects of finance, software of computer incompatibility, and resource support. The next subsection considers the effects of ICT curriculum delivery for students.

3.1.4 Learning Outcomes

The effects of ICT integration on learning outcomes are examined in this section, describing pedagogy, teaching and learning techniques, and research findings to support these factors.

Student characteristics affect acceptance of the science curriculum. The UNESCO report (BouJaoude, 2003) concludes that students' understanding of the nature of science and including a conceptualisation of science in the curricula by using technology may be of advantage in a deeply religious society such as Saudi Arabia. If science is offered as a means of knowing and understanding the natural world, students may feel less threatened by it and consequently may pursue careers in science (BouJaoude). However, language is also important. To gain the advantage of ICT, internet access basically requires English at a high degree of fluency, plus the ability to understand discipline-based terminology, acronyms, assumptions, and references. Scientific English, scientific and technological terminology, is a further aspect of the science curriculum to provide students with the necessary tools to access information (BouJaoude).

Reviewing an expert UNESCO publication, "Education via the Internet", Charp (2000) noted that educational researchers find a positive connection between the integration of ICT and the successful curricula outcomes when ICT is properly deployed. Following this outcome, Semenov (2005), Vrasidas and Glass (2005), and Roblyer (2006) state that integrating ICT into education may provide opportunities for successful pedagogic outcomes through facilitating both the teaching and learning processes, and providing authentic and engaging teaching and learning experiences. Brown, Fluck, Wilson, and Fitzallen (2007) offered a framework for improved student outcomes, whilst Higgins and Packard (2004) add that ICT should be an important part of education, and suggest that educational institutions cannot deliver high quality education without the integration of ICT. To illustrate this stance, and in a reversal of the usual progressive and incremental nature of the ICT advance, Beauchamp and Parkinson (2009) studied a group of science students from a technology-rich primary school who moved to a less ICT-oriented secondary school in rural UK. They found

that the lack of ICT in the secondary school caused some frustration; however, the group remained predominantly enthusiastic about science. The students particularly enjoyed the practical aspects of science lessons, something that they had not experienced in the primary school, and which they reported compensated for the relative lack of ICT in science teaching. Further, Busacco (2001), Castellani (2000), and Cox, Preston, and Cox (1999b) state that ICT provides both teachers and students with increased access to further subject-based resources. Charp (2000) agrees, stating that ICT facilitates opportunities for both teachers and students to share their experiences and ideas with others external to the classroom, and this can improve teaching standards.

There is research evidence to show that the use of ICT in teaching has a positive effect on learning; however, the majority of the research is based on individual students using a computer (Harrison et al., 2002). Widening the concept of ICT, Beauchamp and Parkinson (2005) studied a collaborative form, that of interactive whiteboards, setting up a lesson sequence to illustrate teaching and learning practices (figure 3.2).

ICT (Interactive Whiteboard) Fostering Interactivity in Science Lesson Sequence			
Teacher input	Group Discussion	Group Presentations	Confirmation of correct science
The class observes a solid (e.g. stearic acid) being heated either as a simulation or using a data-logger. Running alongside the image of the heated substance is a table and graph plotting temperature against time. The changing phase of the substance is also recorded	Groups are asked to explain what is happening to the particles as the temperature is increased. They are asked to prepare particle diagrams with a few words of explanation.	Each group presents its conclusions to the rest of the class using the ICT pen. Teacher and other pupils ask questions to clarify any points. No comment is made on the correctness of the information until all the presentations have been completed.	Teacher uses simulation software to explain particle movement at the various stages of heating and compares this with the pupils' suggestions. Where appropriate, the teacher discusses why the pupils' model is incorrect.

Source Beauchamp & Parkinson, 2005, p.100.

Figure 3.2 *Example of ICT-based Lesson Sequence*

Beauchamp and Parkinson (2005) state that the ICT tool described at figure 3.2 can assist learners to reason and think through scientific explanations as a group with their teacher and fellow students, using a student-centred learning focus where co-learning is the prevailing force. In agreeing with the findings of Harrison et al. (2002), Beauchamp and Parkinson see this as a complex area for teacher development: as well as ICT literacy,

teachers' role changes in relation to classroom interactions; however, the teacher must also support the student in migrating to the new environment.

The use of ICT in education may contribute to the changing nature of both the teaching and learning processes, creating more independent and self-motivated learners and encouraging the use of multiple teaching methods (Blackmore et al., 2003). ICT in teaching is variously described as time efficient, supporting teaching and learning processes to improve outcomes, increasing motivation through improving students' self-esteem and perseverance; and inculcating greater learner autonomy (Roblyer & Edwards, 2000; Wheeler, 2000; Wellington & Ireson, 2008). In a large UK study, Hennessey et al. (2007) examined pedagogical approaches using ICT tools such as multimedia simulations, data logging tools, and interactive whiteboards, and the means by which they may be adapted to the cognitive and structuring resources available in the classroom setting. The researchers found that teachers were moving away from only using practical experiments towards "What if" explorations where the outcomes of ICT-based experiments can be immediately accessed; for example through the use of simulations to demonstrate scientific concepts and physical processes; thereby bridging the gap between scientific and students' informal knowledge. ICT was also integrated with other practical activities to support incremental knowledge building, consolidation, and application (Hennessey et al.).

The integration of ICT into the curricula has the potential to change learning pathways (Harris, 2008; Pittard, Bannister, & Dunn, 2003). Traditional teaching techniques are text-based learning and lecturing; in contrast, with ICT-based learning, students can become researchers for the information from different media and the focus of the educational process, rather than the teachers (Semenov, 2005; Shelly et al., 2006). Blackmore et al. (2003), and Ertmer, Addison, Lane, Ross, and Woods (1999) find that using ICT in learning offers advantages and opportunities to increase students' motivation, helps students to solve problems, and increases students' attention span. However, there is little research guidance for effectively integrating computer-based learning tools in science teaching and learning. In a rare example of assessment, Papadouris and Constantinou (2009) offer a form of systematic analysis to identify the capabilities of particular software tools, and to formulate a series of competencies that could be developed relevant to physical science.

To accommodate students' diversity in learning styles, particularly those from cultures which have less exposure to technology, Semenov (2005) reports that ICT provides opportunities

to facilitate learning for students who have different learning styles and abilities; make learning environments more useful, with more senses in a multimedia context and more connections in a hypermedia context; provide a broader international context for approaching problems, as well as being more sensitive to local needs (p.161).

In an earlier study (2000) on students' perspectives of ICT in their classrooms, Deaney, Ruthven and Hennessey (2003) found that students viewed ICT resources as helpful in tasks and presentations, and also useful in refining project reports and trial options. They associated ICT with change in the study environment and classroom relations; ICT applications raised interest and increased motivation on their part. Nevertheless, whilst the participants valued independent study and the challenge of ICT, they were concerned that this reshaping of learning might be displacing valuable teaching (Deaney et al.). Bahr and Bahr (2009) concur, finding that the complex ICT environments may adversely impact on student learning. Learning is enhanced when integrating pedagogies are employed to soften the sometimes high-load information environments of ICT. Further, a framework for ICT in education needs to consider the professional capacities of teachers in their differing abilities to effectively design and integrate technologies for learning (Bahr & Bahr).

In 2006, the International Association for the Evaluation of Educational Achievement held its Second Information Technology in Education Study, an international comparative study of pedagogy and ICT use in schools in 22 countries (Law, Pelgrum, & Plomp, 2008). The study focused on the role of ICT in teaching and learning in mathematics and science classes, and examined the extent to which practices conducive to the development of "21st century skills" were present, in comparison to traditionally important practices. The study found that the impact of ICT use on students was highly dependent on the teaching approaches adopted (Law et.al.). Greater student gains in 21st century skills were reported by teachers who provided more student-centred guidance and feedback and who engaged more frequently in advising students on group work and enquiry projects. On the other hand, the study found that higher levels of reported ICT usage did not necessarily equate with higher levels of learning gains. No significant correlation was found between using ICT in traditional instructional activities and perceived students' learning outcomes (Law et al.).

Whilst these findings postulate the potential of ICT on the curricula, the following table (3.2) conceptualises the various findings of the learning-based researchers regarding advantageous ICT factors.

Table 3.3
Summary of Research Findings on the Effect of ICT on Learning

Advantages of ICT in learning	Literature Source
Increases motivation and opportunities for students to learn	Ertmer et al., 1999; Busacco, 2001; Castellani, 2000; Blackmore et al., 2003
Prepares students for using ICT in the future	Ertmer et al., 1999
Helps students to solve problems	Ertmer et al., 1999; Blackmore et al., 2003; Deaney et al., 2003
Improves students understanding	Charp, 2000; Blackmore et al., 2003
Encourages team-oriented inquiry	Blackmore et al., 2003
Facilitates learning for students who have different learning styles and abilities	Semenov, 2005
Makes learning environments more useful, with more senses, in a multimedia and a hypermedia context	Semenov, 2005; Shelly et al., 2006
Provides students with rich resources,	Castellan, 2000; Busacco, 2001; Shelly et al., 2006
Helps students to develop their independent learning and communication skills	Charp, 2000, Deaney et al., 2003.

The following section takes regard of the role of the teachers, and their experiences using ICT in the science classroom and the science laboratory.

3.1.5 Teaching Outcomes

There are claimed advantages for ICT in the teaching process; with its potential influence on teaching style and classroom management (Charp, 2000). Cox et al.(1999a) and Shelly et al. (2006) concur in that ICT helps teachers vary their teaching styles through the use of media to enrich and facilitate the teaching process. However, the success rate remains low; most teachers are just coping with the new demands of ICT integration and sustainability (Cuban, 2001; Tearle, 2003). McDonald (2008) explains this continuing situation as a consequence of inadequate professional development, suggesting that few teachers integrate ICT in ways that enrich students' learning (citing Harrison et al., 2002, Hennessey et al., 2005).

There are also ICT integration issues with the curricula, which resonate with this study of a similar situation in Saudi Arabia. Leach and Moon (2000) identified the spasmodic use of ICT in the UK curricula and contrasted this outcome against the government rhetoric that required coherent planning and integration of ICT within all aspects of teaching and learning. The researchers argue that the inherent contradiction between aspiration and reality could be overcome if a stronger conceptualisation of teachers' professional knowledge is embraced. To address this factor of disconnect between policy and practice in a Europe-wide e-learning program context, Granić, Mifsud, and Ćukušić (2009) introduced a pedagogical framework for online learning in secondary schools from static (e-learning) and mobile (m-learning) approaches. They found that successful integration required administrative support, adequate resources and appropriate continuing professional development; however, with experience, the teachers' knowledge improved and their opinion of the program's effectiveness increased. The researchers note that effective implementation of the ICT framework offered scope for both collaborative and autonomous learning which improved teaching and learning performance in the Europe-wide network of schools (Granić et al.).

Practical outcomes concerning ICT-based science learning were reported by Rogers and Finlayson (2003) in an analysis of 350 lesson reports submitted by secondary schools engaged in a UK Science Consortium program. An interesting feature of these data is the dominance of "normal" science teaching objectives, suggesting that, in general, ICT facilitates science learning rather than displacing it. Further, teachers rated 92 per cent of their lessons with ICT as having successfully fulfilled their objectives. The researchers also reported that successful outcomes were influenced by the following teaching practices:

- Lesson objectives are clearly identified and tasks are clearly defined.
- The "time bonus" is used creatively, often involving interventions to encourage discussion and investigative approaches ICT activities are explicitly linked to other activities before, during and after the ICT lesson.
- Teachers plan a greater emphasis on interpretation of results and thinking about science.
- Teachers recognise and build upon the technical skill already acquired by pupils (Rogers & Finlayson, p.111).

Whilst there are findings that consider ICT an advantage in the science classroom as it fulfils the criteria of broadening the availability of media to deliver the curriculum, that is, a useful tool, there are indications that teachers are unable to adequately follow the changes in technology which require not only competency in the various media, but also exploration of new pedagogical practices to employ ICT (cf. Charp, 2000; Rogers & Finlayson, 2003). There is evidence that this need for professional development is being recognised and addressed and that a successful integration of ICT into the science curriculum may gradually occur as teachers become familiar with the changing technology (Granić et al., 2009; Rogers & Finlayson, 2003). This could lead to a further issue, if teachers adopt ICT not as a tool, but as pedagogy in itself. This is discussed in the next part.

3.1.6 Relationship Between ICT and Curricula Delivery

Central to the assumptions inherent in this thesis is the notion that evolving technology permeates the social experiences of teaching and learning; however, the nature of the relationship is controversial. In an extreme view, Bogost and Montfort (2009) discuss the premise that technology follows a path of its own, influencing society directly without social mediation. They note that this “technological determinism” describes any theoretical or sociological approach which holds that technologies exert an effect on human society and behaviour. Most contemporary usages, the authors continue, make an important modification: technological determinism suggests that social change is more affected by technology than by other sources. They cite Marshall McLuhan and his argument that media are “extensions of the physical human body or the mind,” that is, they affect the ways that people perceive, understand, and relate to the world (McLuhan & McLuhan, 1988, p. 93.):

This idea is best known through the aphorism “the medium is the message”, a phrase meant to clarify that the properties of a medium, not its “payload”, ought to be the object of study (Bogost & Montfort, p. 2).

The implications for education of McLuhans’ position are that pedagogy may come to reflect ICT development in other disciplines and industries. As educational technologies change and adapt to encompass ICT, directed perhaps through government policy and thus funding, school administrations and thus teaching and learning are bound to evolve (Charp, 2000). As a learning technology, ICT has issues which have yet to be resolved in the literature. Arguably, elements such as accessibility, price, speed, security, reliability, and configurations are all aspects of ICT which must be in place before the pedagogical aspects

can be addressed. Accessibility of ICT in Saudi Arabia is dependent on factors such as perceived usefulness, service quality, age of client, usage, type of connection, and even the type of residential accommodation (Dwivedi & Weerakkody, 2007).

It is not only financial or technical issues that contribute to the less than enthusiastic adoption of technology-based learning in developing countries. Cultural issues also play a major role. Mohamed, Abuzaid, and Benladen (2008) refer to Chaula, Yngstrom, and Kowalski (2006) who posited that the reluctance of developing countries to adopt computer-based learning was due to the nature of the software and the program content of the imported material from countries whose cultures differ significantly from those of the developing world. Mohamed et al. stated that this issue also applied to Saudi Arabia where, according to Wurm (2008), the fundamental feature of Saudi society is the dichotomy between technological modernity and conservative religious values.

Security is indeed a fundamental issue in the Kingdom. The internet, the mainstay of computer-based or e-learning, was introduced in Saudi Arabia in 1999 only after extensive debate regarding perceived social risks associated with unfettered access (Mohamed et al., 2008). According to Al-Saggaf and Weckert (2004), the Saudi government was reluctant to adopt internet technology because it had serious concerns regarding undesirable material; cultural, religious, and political, within private homes. In concert with many other traditionalist countries, the Saudi government developed high security to prevent citizen access to a large number of websites deemed offensive (United Nations Development Program, 2007). However, broadband connectivity for schools may be further filtered (Underwood et al., 2004). For example, the UK Schools Broadband Network operates a web filtering service for schools and libraries, among other users. Websites accessed on the Schools Broadband Network are filtered to ensure that inappropriate sites are excluded. Despite having some 30 million websites categorised in 2009, new sites can be readily added by the school or access prevented (National Centre for Technology in Education, Eire, n.d.). Similar filtering programs are deployed in school systems around the world.

Overall, teaching practices change slowly and it is argued that the traditional pedagogies should not be subject technological change. The proponents for ICT argue that the learning environment is now different from the classical model and that pedagogy must evolve to reflect this (cf. Elliott, 2008). ICT-supported collaborative learning, according to this view, will be the dominant pedagogical model, as contemporary learning models

encourage interaction between students, and students and their teacher. Nevertheless, as noted in Saudi Arabia's example, although computer-based technologies facilitate knowledge sharing, the prevailing culture may not promote a move from individual-based learning (Lindvall & Rus, 2003).

The proliferation of new uses for the internet in education, according to Elliott (2008) may result in an evolution from paper-based methodologies and perhaps science laboratory experiences toward keyboard ICT models and beyond. This in turn moves pedagogy from a focus on an individual's need to recall factual material that is now readily available, towards a new focus for learning, that is, knowledge creation, through a social process (Choi & Hanafin, 1995; Elliott). The literature defines a common set of characteristics for this form of learning (Elliott, pp.8 -9).

- skilled use of tools;
- active learning rather than passive receiving of knowledge;
- authentic learning experiences rather than contrived tasks;
- construction rather than instruction;
- task (not process) oriented;
- just in time learning;
- search not memorise;
- does not know answer but knows where to find answer;
- search engines, not libraries; and
- collaborate, not compete.

Given that ICT can be adapted and that users can adequately address coping issues of adequate resources, time, and user competency, the structural issues that may emerge are to find a balance for its integration into curricula and to generate improved outcomes for students and teachers. By finding a balance between ICT and traditional classroom models, science teachers and students in Saudi Arabia could benefit from part delivery of their curriculum by ICT, as the Ministry of Education (2003c) confirms. The next section considers the teacher's role in ICT integration into the science curriculum.

3.1.7 Potential for ICT-based Approaches

ICT is not only perceived as a catalyst for change, but also for change in learning approaches, change in access to information, change in teaching style, and change in the role of teachers (UNESCO, 2002). Semenov (2005) and Shelly et al. (2006) argue that students

are now the focus of the classroom experience, rather than the teachers. Graham and Martin (1998) state that the integration of ICT contributes to changing a teacher's role from that of an authoritative transmitter of knowledge in the learning process to that of a facilitator or co-learner. Scheffler and Logan (1999) and Singh and Means (1997) state that teachers play the role of the facilitator in setting project goals and providing guidelines and resources, working in collaboration with students, while providing suggestions and support for student activity. This is in contrast with traditional teaching methods, teachers are the ultimate source of information, which they then transmit to students who passively receive and record this knowledge in their memory.

In this new role of teachers as facilitators, students need teachers who can use ICT effectively and employ ICT in the classroom to direct and facilitate their learning process when using ICT. Selinger (2001) and Semenov (2005) agree that the teacher's role is to support students to learn; teachers, therefore, create the conditions for students to learn using a range of resources, including ICT. If this is the case, then teachers should attain adequate skills to effectively use ICT in their classrooms. Jones (2003) notes that the Victorian Department of Education and Training states that, with the changing roles of teachers, teachers are expected to have good computer skills including skills for using

- basic computer applications;
- multimedia, desktop publishing and presentation software; and
- communication and learning technologies in key areas (Jones, p.66).

These points are of consequence in the primary research associated with this study. If the Saudi Ministry of Education wishes to integrate ICT in to the schools' curricula, then these skills will be relevant to Saudi teachers as well.

Whilst the basic skill levels can be used to operate ICT in the classroom or laboratory, teachers may find that further skills are acquired through discovery and practice. In an interesting study, Fleming, Montamedi, and May (2007) surveyed 79 pre-service teachers on their training experience and computer technology skills. Results suggest that the more extensively pre-service teachers observe computer technology being used and the more they use ICT in and out of the student teaching classroom, the more likely they were to report competence in the computer technology skills. Pre-service teacher gender, important in the Saudi context, was unrelated to perception of skill. Thus the findings suggest that the more

exposure teachers have to ICT models, and the more hands-on experience they undertake, the greater is the proficiency they claim (Fleming et al.).

Need for skills acquisition, especially for teachers, may accelerate, especially if a curriculum moves from the classroom to online. Koehler, Punya, and Yahya (2005) introduce a framework for conceptualising technological pedagogical content knowledge (TPCK) during a design seminar to develop online courses. Participants moved from considering technology, pedagogy, and content as being independent constructs towards a more complex concept that explored interactions between the three knowledge bases. The researchers suggest that developing TPCK is a multigenerational process, involving deeper understandings of the complex web of relationships between content, pedagogy and technology, and the contexts in which they function (Koehler et al.). This observation meets the conclusion in section 3.1.6 above, that is, teachers can over time find a structural balance between the three classroom elements.

3.1.8 Summary

In this part, the use of ICT in teaching and learning is considered. For a decade or more past, ICT changed from basically computer-based text to today's proliferation of programs, applications and equipment that establishes person to person communications across the world and any factual material required at the touch of a few buttons. Nevertheless, the ICT phenomena produce unlimited information and infinite choice. This can be used by the teacher in possibly numerous combinations to illustrate anything from the beat of a butterfly's wing to a supernova. The pressure on teachers to perform in this environment is intense, and no more so than for teachers in a devout Muslim country as it copes with massive development, high population growth, and technological change.

ICT permeates the educational sector as it permeates all other sectors and social intercourse. There is discussion regarding the purpose of ICT; however, that is defined by the Ministry of Education (2003c) as serving the science curriculum and considerable educational resources are directed to this end. Teacher adoption of ICT to integrate it into the science curriculum is, however, a barrier identified in the literature (Hennessey et al., 2005). This barrier may be temporary, as Rogers and Finlayson (2003) found in their study that teachers were already exploring the boundaries of pedagogy, content, and technology to find synergies for use in the curricula. Whilst ICT delivery, that is, seamless platforms, networks, hardware and software elements were not yet available in Saudi Arabia, there is precedent in

the literature that with adequate ICT resources and well trained teachers the Ministry may successfully move to integrate ICT into the science curriculum, as discussed under.

3.2 Integration of ICT into Saudi Education System

This study investigates integration of ICT in the Saudi intermediate schools' science curriculum, and teachers' professional development. The overarching research objective at section 1.5 relates to Saudi Ministry of Education's performance record in introducing computer-based technologies into schools, and this section describes the directives, finances and projects directed by the Ministry in pursuing the government's commitment to raising awareness of ICT in the population. To a large extent, this was planned through a process of exposing Saudi children to computer-based equipment in their school environment. The next part discusses this process, first with the Ministry's ICT-based policies and then a short summary of indicative ICT integration programs.

3.2.1 Directives and Policies

The Ministry first considered the introduction of computers, as the forerunner of ICT, in its Second Educational Development Plan in 1975-1980; however, the matter was not pursued until the Fourth Development Plan when the General Administration for Educational Technology was formed in 1991. This organisation was directed to enhance the quality of education through the integration of ICT into the teaching and learning environment for all schools (Ministry of Economy & Planning, 2006).

Introduction of a computer literacy course boys' secondary schools (that is, the senior grades of 10 to 12) was attempted at different times (Al-Hakami, 2000). First, in 1985, selected boys' secondary schools were designated 'Developed High Schools', with, among other initiatives, computer courses 'Introduction to Computers' and 'Basic Programming Languages' (the BASIC language). This was unsuccessful due to insufficient computer laboratories in the majority of the schools. Next, the Ministry introduced another general computer course into boys' secondary schools; the new course was theoretical and access to a computer was not required. In 1994, a third computer curriculum was offered to assist male students to become familiar with computer technology, with improved access to computers (Al-Hakami, 2000). Meanwhile in 1999, the General Presidency of Girls' Education issued a curriculum of computer literacy for selected girls' secondary schools. In 2000, the Ministry launched an ambitious program to make computers available in every classroom for boys and

girls, with computer science introduced in all secondary schools (Al-Mayoof, 2003). Computer literacy through the integration of ICT in pedagogy across the curricula remains an unrealised goal of the Saudi education system (Ministry of Education, 2003c).

3.2.2 Projects and Programs

In its drive toward computer literacy for Saudi citizens, the government introduced a succession of programs and initiatives to establish an ICT framework to serve the nation, and in particular, education (Ministry of Education, 2003c). However, the efficacy of these programs tends to disperse over time due to the perennial issues of funding, internet capacity, and available skills. Whilst the initial project usually included user training, this was frequently specific to the ICT equipment and restricted to the project installation period; thus subsequent users were not trained on the equipment, and there was little support for users in the case of failure (Al-Mayoof, 2003). Further, although international ICT computer platforms and software programs were often accepted for immediate use, more complex equipment and systems were subjected to testing, such as the Prince Abdullah bin Abdulaziz Computer Project (National Project), Learning Resource Centres, and educational information and communication technology centres (Ministry of Education). As useful adjuncts to the educational ICT infrastructure, these are presented below.

The National Project Otherwise known as the Watani project, this initiative commenced in 2000, promoting computer literacy through word processing and the internet. The project goal was to connect all Saudi schools and educational directorate districts by means of a wide area network covering the Kingdom, and local area networks for every educational directorate and school. This project was supported by the then Prince Abdullah bin Abdulaziz and staged over a number of years (Ministry of Education, 2000). The goals of this project were directed to computer literacy:

- to develop student skills by exploiting and using ICT within education;
- to enhance teachers' potential by employing computers in all educational activities;
- to provide an information environment, research-based content, and direct educational resources for students and teachers; and
- to create a comprehensive awareness of the benefits of ICT in education and to disseminate knowledge of ICT throughout society (Watani, 2006).

The Ministry planned to complete the connection of all school computer networks and infrastructure by 2003 and then to maintain and continue to upgrade its ICT resources (Ministry of Education, 2000). However, in 2005 there was a change of Minister and priorities for education moved away from the extension of the ICT infrastructure under this program. Nevertheless, less ambitious funded programs are continually introduced. Technology developments, changes of priorities in education (for instance, toward vocational training), and economic development impinge on these plans (cf. Ministry of Education, 2006a). Further, given the proliferation of new ICT concepts in the form of internet and user platforms, the intent or direction of such programs dissipates over the years.

Learning Resource Centres Project Learning resources centres were formed by development of school libraries into central resource centres for teachers and students (Al-Omran, 2007). They provide “information and ideas that are fundamental to . . . equip students with life-long learning skills and develop the imagination, enabling them to live as responsible citizens” (UNESCO, n.d.). Further, the Australian Library and Information Association (1999) states “when librarians and teachers work together, students achieve higher levels of literacy, reading, learning, problem-solving, and information and communication technology skills”.

Commenced in 1997, the Saudi Resource Centres project was introduced in selected schools to integrate ICT into learning and teaching (Ministry of Education, 2004). The project aims were to provide alternative learning environments to classrooms using ICT to assist teachers with lesson planning, and enhance students’ research skills. Both students and teachers can benefit from such resources and access academic curricula, electronic books and internet services (Ministry of Education, 2004c). The project was set to achieve 4,000 centres in schools by 2002, and 5,500 by 2006. The Learning Centres project is symptomatic of project implementation in the country, as there was no follow-up published by the Ministry, yet the Learning Centres are undoubtedly resourced and extended with the establishment of each new school. In Jeddah, to this writer’s knowledge, a pilot program, Technical Halls, was established to provide the infrastructure for ICT in rented schools where an LRC is not appropriate. To date, 108 Technical Halls have been provided and this successful project is being adopted in other parts of the Kingdom.

Education ICT Centres The Education ICT Centre project provides teacher training facilities to develop pedagogical practices (Ministry of Education, 2006a). The centres

comprise multimedia instruction, teacher supervision, and technological support. The Jeddah centre, where this author was involved, was the first centre established and, as a result of its success, the Ministry implemented the centre concept throughout the Kingdom, with 24 such centres established by 2005. Madon (2000), in examining the internet's role in education in developing countries, concluded that it is important to link local experiences to the global environment; these centres set ICT as a discipline as well as a general tool. As ICT administrative centres for schools, they provide a full range of resources to enable teachers to access training, equipment and software, and they can promote a cooperative workshop approach for those seeking to integrate ICT into the curricula, particularly science. Further, the centres have a quality-enhancing role through ICT education supervisors, who can both monitor schools' ICT courses, and assist teachers to utilise ICT in their classrooms and science laboratories (Madon).

Other Initiatives The Ministry fully resources schools in Saudi Arabia. As well as infrastructure, systems, and equipment, the Ministry provides administration, curricula, and teaching and training aids (Arnolds, 2009). Examples of national projects for science-based or inclusive teaching materials are the “20 million means project”, referring to curricula including ICT; the “SIMANOR Explorer”, curricula for all class levels in CD format which includes a scientific encyclopaedia if the internet is not available, and also links to scientific websites (Ministry of Education, 2006a).

In 2001 the Ministry's General Administration for Educational Technology established a committee to integrate ICT and multimedia into the curricula, with this author as a committee member from 2001 to 2003. This committee designed many curricula for ICT delivery: religion and mathematics for primary students, and science and mathematics for intermediate students; and distributed them throughout the public education system. Since that time, the Ministry has implemented many measures to further improve the quality of education: an ambitious project to equip each student with a computer and internet, and to establish a network that connects all schools and universities to facilitate teaching and research (Ministry of Education, 2006a).

A science and mathematics curricula project aims to raise Saudi Arabia's international standing in the TIMSS tests (see section 3.4.3), especially in chemistry and the cognitive domains of knowing and reasoning (Al-Sadaawi, 2008). The new curricula are being developed by the Ministry to international standards in collaboration with the Al-Obaikan Company. The curricula cover primary, intermediate and secondary students for both boys'

and girls' schools, with learning and teaching materials delivered in multimedia formats: books and supporting educational materials using the internet, interactive tapes, and ICT delivery. In its objective of promoting the use of ICT in schools, the Ministry also publishes a series of ICT usage guides, the Ministry's aims and goals, and explanation of ICT usage. However, these are not necessarily directed to the science curriculum, although they are inclusive.

Partners in Education The Ministry remains committed to ITC integration into education. Commencing in 2007, a substantial Ministry program in partnership with the international ICT organisation, Intel, aimed to train 30,000 teachers to integrate ICT into public education. At September 2009, 11,000 Saudi teachers had participated in the program to be more effective educators, integrate technology into their lessons, and promote 21st century skills of problem solving, critical thinking, and collaboration among students (Global Arab Network, 2009).

3.2.3 Summary

Whilst the Ministry has pursued ICT integration into schools for a considerable period of time, funding constraints, overlapping programs, technological change, and cultural distrust and unfamiliarity with ICT have frustrated its intention to integrate ICT into the science curriculum. As representatives of society as well as employees of the Ministry, teachers pursue their traditional role of dispensers of knowledge. Students learn their lessons and are examined on the technology of rote instruction; the importance of ICT as a resource for learning, and as media for delivery of education is not apparent.

3.3 Science Curriculum and ICT

The science curriculum is perhaps less dependent on text-based learning than many subjects, due to its reliance on students' interactions and observations, which places the topic in good stead for the use of multimedia such as ICT. Nevertheless, as McFarlane and Sakellariou (2002) state, it must first be established that ICT has a role in science inasmuch as it can improve outcomes for the students and teachers.

This section seeks to ground the science curriculum, and ICT integration from the literature into the particular experience of Saudi Arabia. The discussion begins with the goal for learning science, whether a student wishes to pursue a science career, or more generally, requires basic science knowledge to perform daily tasks safely and effectively. Next, the

manner in which the Ministry fulfils its role to produce school leavers with adequate knowledge and skill in science is considered, followed by the dominant pedagogical practices employed to this end, and further approaches that could be considered by the Ministry.

3.3.1 Objectives of Science Curriculum

There is an on-going debate regarding the purpose of school science. The original intention appears to be to expose children to science to engender interest in scientific and engineering careers (Osborne & Dillon, 2008). Science educational researchers argue, however, that a general science education should be of universal value, not simply as an introduction to a career, and thus the goal of science education must be to develop students' understanding both of scientific knowledge, and the manner by which science functions.

In the United States, the National Science Education Standards espouses the aim for science competencies:

- to educate all students to experience the richness and excitement of knowing about and understanding the natural world;
- use appropriate scientific processes and principles in making personal decisions;
- engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers (Krajcik, Czerniak, & Berger, 2003, p. 22).

Therefore, science is a complex subject; it contains strands of biology, chemistry, earth science and physics and concerns understanding attitudes, communication skills, and the place of science and technology in society.

Science is often practical and while it is not essential, ICT can be deployed to good effect in these activities: observing, measuring, communicating and discussing, experimenting, investigating, and recording results (Wellington & Ireson, 2008; Krajcik et al., 2003). Moreover, studies show that the use of ICT in science classes provides tools to facilitate the learning process. Science classes were among the first users of ICT, as it can offer features to facilitate science activities (Corbin, 2003; Schrum, 1999).

It appears that science teachers can employ a range of media to expand the curriculum beyond that offered by textbooks. Wellington and Ireson (2008) note the range of ICT elements: collecting, processing and storing quantities of data, complex calculations, and presentation and communication options. Wellington and Ireson, and Osborne and Hennessy (2006) find the potential role of ICT in science includes:

- data capture, processing and interpretation, data logging systems, databases and spreadsheets, graphing tools, and modelling environments;
- multimedia software for simulation of processes and experimentation;
- publishing and presentation tools;
- digital recording equipment;
- computer projection technology; and
- computer-controlled microscopes (Wellington & Ireson, p. 6).

ICT in science class can open the science environment through simulation software; programs which model an artificial or natural system or process that allows learners to interact with, make various decisions, and reflect upon the results of their actions (Capron & Johnson, 2004; Cheong & Kim, 2009). Osborne and Hennessy (2006) confirm that simulation software can improve students' understanding through practical applications; such as using graphics to simulate science experiments. Thus science education gains the benefit of visual impact, whilst reducing the requirements for laboratory equipment, and enhancing safety (Wellington & Ireson, 2008).

Through ICT applications, Cox et al. (1999b) explain that students develop problem-solving skills, hypothesise scientific relationships and processes, and improve scientific reasoning and explanations. Harrison et al. (2002) concur: ICT facilitates practical work, exploring ideas, motivation, expanding pedagogical approaches to science, and enhancing flexibility. Osborne and Collins (2001) also argue for an increase of student motivation through the individual's ability to control their learning experiences, and to study topics related to the student's environment. Students can access data on the internet and interact with others through networks, gather data, and employ graphing and visualisation tools to analyse data. Wellington and Ireson (2008, p.261) give the example of data-logging to analyse and store data, creating tables and graphs. These actions employ "higher order" skills such as interpreting, discussing and hypothesising. Databases on topics such as birds and

mammals, the planets or the periodic table can allow students to quickly search for information, for connections and for comparisons, e.g. wing span and speed of flight.

ICT competency standards necessarily should be adequate to the tasks required by the ICT available for the science curriculum. Lavoie (2001) offers the recommendations that:

- trainee teachers should gain competency in ICT skills and usage in the science curriculum;
- science teachers should receive adequate training to gain ICT competency with available equipment;
- standards should include the collection and processing of data, and the operation of available peripheral sensing devices; and
- science teachers should incorporate multimedia and audio-visual ICT into the classroom activities, and should involve their students (Lavoie, p. 166).

National science teacher education standards in the USA emphasise the relationship between science, ICT, and society. Lavoie (2001, p. 166) states:

a common thread of agreement running through all the standards and recommendations is that pre-service and in-service science-teacher preparation programs incorporate ICT in a variety of ways and that doing so should enhance teaching and learning in the science classroom.

In their assessments of the literature, Harrison et al. (2002) and Osborne and Hennessy (2006) state that using ICT effectively in science education should be well planned and implemented with care:

- ensuring that ICT use is appropriate and ‘adds value’ to learning activities;
- building on teachers’ existing practices and on pupils’ prior conceptions;
- structuring activity while offering pupils some responsibility, choices and opportunities for active participation;
- prompting pupils to think about underlying concepts and relationships; creating time for discussion, reasoning, analysis and reflection;
- focusing research tasks and developing skills for finding and critically analysing information;
- linking ICT use to ongoing teaching and learning activities; and

- exploiting the potential of whole-class interactive teaching and encouraging pupils to share ideas and findings.

It should be noted that this review takes in over a decade of ICT introduction and integration into pedagogy and, to an extent, the science curricula around the world. As the pace of technological innovation is increasing, the findings and reflections of researchers are necessarily grounded in time and place. Although similar in genre, studies carried out in different settings refer to issues which may or may not be relevant in Saudi Arabia, or indeed, the centralised science curriculum in Saudi Arabia.

3.3.2 Saudi Science Curriculum

The objectives of the science curricula in Saudi Arabia were determined in the 1970s by the Higher Committee for Education Policy and remaining unchanged (Al-Mohaissin, 2002). The principles are based, as noted, on Islamic principles and values. The objectives of science knowledge and skills are aspirational: to take a sound approach in teaching science; to develop Islamic values in the student through direction towards creation and wonders, and observing the amazing precision of things and events; for purposes of moral education; to build confidence in students through knowledge; to show that there is no contradiction between science and religion; and to train students to be objective and impartial. Further, teachers should be trained in research through scientific experiments, displaying in their analyses honesty and integrity. These unchanging principles inform the existing curricula, filtering science pedagogical research to reflect cultural and religious aims (Al-Mohaissin).

As with all Saudi curricula, the science curriculum is set with relevant material sourced from the Ministry of Education; science teachers have no role in curriculum development. All education regions and science teachers deliver the set curriculum, use specified publications, and cannot alter or change any topic or subject. The science curriculum in intermediate schools focuses on the quanta of science facts (table 3.3).

Table 3.4
Intermediate School Science Curriculum: 3 Years

Unit	Title	Contents
1.1	Matter: composition and characteristics	Why study science? Characteristics of matter, composition of matter, mass and density
1.2	Change as a part of God's law of natural law in the universe	Physical changes, biological changes, chemical and bio-chemical changes. Change: an overview
1.3	Living things: classification, composition, functions	Cells: structural unit of a living thing, classification of living things, common functions of living things, composition and functional integration in some kinds of mammals, composition of plants and their functions.
1.4	Force and equilibrium.	Force: examples, measuring force, equilibrium
2.1	Human body.	Composition and integration, digestive system, system of motion, system of planning and organisation
2.2	Motion.	Motion, sound and nature of light
2.3	Interaction, change and continuity in environment.	Environment and its constituents, environmental systems, natural environments in Saudi Arabia, environment and the human being
2.4	Geology	Earth and its place in the universe, Earth's layers
3.1	Heredity	Cells and heredity, science of heredity, hereditary transmission of characteristics in humans, heredity and improvement in animals and plants
3.2	Essentials of chemical matter	Composition of matter, compounds, interaction, chemical equations, water and solvents
3.3	Alkalis, bases and salts	Acidity, bases and salts
3.4	Energy	Transformation and transmission, work and energy, thermal energy, transformation of energy, transmission of energy
3.5	Technological development and scientific advancement,	Examples of technological development and scientific advancement

Source: Ministry of Education, 2006b

The following section reviews the changes in pedagogical practices in teaching science. This section has particular relevance to the Saudi environment.

3.3.3 Science Pedagogy in Saudi Arabia

In concert with other Islamic nations, Saudi Arabia maintains its society and traditions within the gradual globalisation standards evolving for education. In past instructional practices, the teacher prescribed the methods and the objectives, this form of teaching often

leads to isolated and inert knowledge; a student may not have acquired the capacity to apply inert knowledge to solve problems in practice (Vermunt & Verloop, 1999). Contemporary pedagogy research in cognitive and constructivist theory alters concepts for maximising a student's knowledge and skills. Thus knowledge achievement needs to be considered as a qualitative change in a person's conceptions, not simply the amount of knowledge that a person possesses. It is no longer enough to count the number of correct answers on a test (Al-Sadaawi, 2008).

Teachers' roles evolve. In generations past, the traditional teaching and learning in Saudi Arabia was predominantly verbal, learning by rote, and acquiring sufficient literacy to read, write and add figures. A decree that all Saudis should be educated early last century before oil was discovered has proliferated into education as a prime directive for the government decades later. The first mass teaching colleges and universities produced teachers less than two generations past, and these teachers continue to instruct students according to pedagogical tenets of late last century. However, in the second decade of the 21st century, pedagogical theory has adopted social learning tenets of cognition and constructivism, and this is the adjustment that the Ministry deems its teachers must undergo (Al-Sadaawi, 2008). ICT is the tool of choice in this endeavour (Ministry of Education, 2003c).

A report from UNESCO (BouJaoude, 2003) on science teaching in Arab states acknowledges the continuation of these teacher-centred approaches and pedagogy that encourage memorising. BouJaoude notes that such approaches neglect development of critical thinking, problem-solving, and investigative skills; that teachers do not focus on the nature of science and that they have an inadequate understanding of it. The author acknowledges the paucity of Arab ICT education, either as an end to itself, or as a means in science teaching. However, as is the case with teachers' skills, attempts at reform have been limited in scope, duration and impact; primarily due to lack of facilities, equipment, and skills (BouJaoude).

Further, Islamic teachers are more likely to present new ideas and concepts in conjunction with traditional ideas and methods. In an Emirates study, Haidar (2002) found that secondary school science teachers did not view modern science as part of European culture and perceived no differences between modern science and Arab culture. It appeared that Arab teachers lacked an understanding of the social component of science and training was required in this aspect of science. The author argues that when they are discussing

culturally critical scientific issues in class, Arab science teachers should assume the role of cultural brokers to facilitate students' understanding of science. Teachers may therefore find difficulty in delivering the content of science within their community's ethnic traditions and cultural knowledge (Haidar).

The Ministry of Education's concept of "distribution of knowledge" is based on its curricula policy of meeting the principles of dogma. A centralised approach determines that the science curriculum is entirely encapsulated in Ministry-derived materials for each grade, both student textbooks and teacher guides. To this author's knowledge, textbooks are the sole scientific resource for students, and teachers are directed in the delivery of the curriculum. In this bounded Saudi pedagogical view, the use of ICT to deliver the science curriculum is an option only if the technology delivers data, measurements, or mathematical/statistical analysis which is not open to interpretation that strays from dogma. The internet, used for browsing, or theoretical and exploratory research, may be acceptable to the Ministry if there are appropriate security measures in place to protect Islamic values.

The lack of coordinated and clear strategies to implement technology education in the classroom, and the absence of qualified ICT educators to train the huge number of teachers and students, are paramount to educational reform through ICT implementation (BouJaoude, 2003). Resources for ICT implementation are also affected by population growth, as new schools' needs preclude expenditure on ICT upgrading and maintenance for existing equipment at older schools.

In a recent commentary by an international management consultant, Booz & Co (Maroun, Samman, Moujaes, & Abouchakra, 2008), the commercial researchers noted the advancement of ICT as an increasingly important factor in the structure of educational systems. For developing countries, ICT presents an opportunity to rapidly assimilate knowledge and development strategies to reach parity with global standards in the professions, including education. They note that Singapore developed a comprehensive plan to integrate ICT into its education sector to generate knowledge, focus on students, and create a self-directed education approach in which teachers and other education stakeholders were granted greater autonomy. In doing so, Singapore developed a number of best practices:

- the ICT plan can be implemented only after ensuring the education system can facilitate and support it through linkages to education policies and monitoring by stakeholders;

- the ICT plan must be a tool of education and not an end in itself; and
- flexibility of the education system is a prerequisite to successful implementation of ICT, due to adjustments necessary to traditional education practices (Maroun et al.).

There is also a standard of physical facilities and equipment necessary for adequate education outcomes for teachers and students, especially in specialist subjects such as science where students perform research. School buildings need to be managed to provide conditions that enable teachers and students to deliver educational goals, as an Australian school building audit report professes (Victorian Auditor-General, 2008):

practically, this means providing secure, comfortable and user-friendly environments that effectively support the delivery of a modern curriculum, that is, the type of courses schools should offer and the teaching methods that should be used to deliver these courses. For example, modern courses often require the use of individualised and small group teaching with an increased dependence on computer-based learning . . . In an area where the population is growing schools may have to enrol more students than they can comfortably accommodate. This is likely to have indirect and direct impacts on the type and quality of education provided. Overcrowded classrooms and corridors lead to cramped conditions and delays when students move between classes. The scarcity of specialist teaching facilities, such as science laboratories, means that some students may not get the opportunity to complete all parts of the curriculum (Victorian Auditor-General, 8-9).

Saudi Arabia has few equals in population growth. Although an early study as regards resource applications and growth statistics, Al-Mohaissin (2002) found the average number of boys in Saudi intermediate schools was then 483, with an average of 28 teachers, 5 of whom were science teachers; and an average of 31 students per class. There were less than 2 science laboratories in each school, with little equipment or science activities available. Science teachers are required to plan the delivery of the science curriculum in a traditional approach to teaching science, that is, by lecturing and examination by recall of factual data. This researcher, in the capacity of both science teacher and education supervisor in many Saudi education regions, can confirm these observations and data. The majority of intermediate teachers were observed to teach science using general classrooms, that is, lacking in scientific equipment and teaching aids. Many of the schools were housed in rented residential buildings, with long and very narrow rooms, which do not suit the layout required of specialist needs such as science laboratories. Therefore, the intermediate schools' science laboratories can be classified as either appropriate facilities in purpose-built government schools, or as usually inadequate facilities in rented school buildings where laboratory

equipment is not available and there are safety issues involved. Of note, the Agency for Buildings and School Equipment (2008) state that in 2006 nearly half (47%) of Saudi government school buildings were rented.

As observed in the Australian audit report, students in rented buildings, or ill-equipped public schools, are restricted in experimenting and observing scientific phenomena, and may be confined to classrooms which are small, overcrowded, and, unsuitable to the expanded horizons of audio-visual or internet viewing (cf. Victorian Auditor-General, 2008). They do not receive the maximum benefit from the curriculum, and may in fact be later repelled from science through an initial inability to absorb basic factual knowledge. This Saudi issue of a high proportion of rented school buildings may be an issue for integration of ICT into the science curriculum. It is equally noteworthy that the Saudi government is placing over 25 per cent of its budget annually into education and knowledge and skills outcomes (see section 2.3).

3.4 Factors in the ICT Change Process

While the integration of ICT into education may have the potential to bring about positive changes in teaching and learning environments, this process is complex. Barriers to ICT integration differ from case to case, depending on the prevailing environments of the country, society, education, school, teachers and perhaps the students. This review therefore seeks informed comment about issues which may relate to developing countries, and to Arab societies.

As suggested above, there are numerous and diverse issues in incorporating ICT into any given curriculum, including both external and internal barriers to reform (Jones, 2004). According to Ertmer et al. (1999) and Ertmer (1999), barriers comprise a lack of access to computers and software, insufficient time to plan instruction, lack of technical and administrative support, and limited resources. Finger, Russell, and Russell (1999), and Semenov (2005) add to these factors establishment and on-going costs of providing adequate ICT for teachers. The external environment includes systems outside individual schools, such as educational districts, communities, and the larger society. Education has been often criticised for isolating itself from the local and larger society. Community engagement during technology planning with new pedagogy is believed to be an essential part of building a

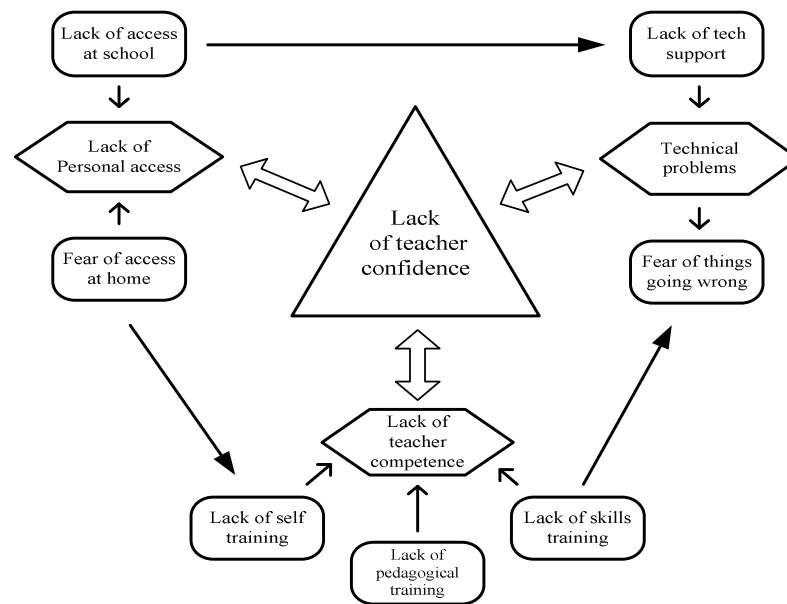
sustainable system (Makrakis, 2005). These points are discussed below as intrinsic and extrinsic barriers to change, and environmental issues.

3.4.1 Intrinsic Barriers

As science pedagogy changes, pre-service teachers moving into the classroom may be the first in a school to introduce new techniques or take unconventional paths, inviting students to explore the science domain. ICT is an excellent example of this exercise in contemporary pedagogy. However, there may be a cohort of teachers who resist change and the disruption to time-honoured curriculum outcomes.

Resistance to change may be “misunderstood or simply written off as anti-progressive or technophobia” (Deetz, Tracy, & Simpson, 2000). However, there may be many factors that prevent teachers from using ICT in their teaching. Cox et al. (1999b) opine that the level of teachers’ training and skills are significant factors that influence the uptake of ICT. Also, Selwyn (1997) and Tozer (1997) note that resistance to change relates to ICT anxiety through three factors: psychological, sociological, and operational.

There is arguably a causal relationship between the external and internal barriers (Ertmer et al., 1999; Jones, 2004). In an early study, Ertmer et al., observing and interviewing teachers who achieved varying levels of ICT integration, found that although external barriers constrained all teachers' efforts in the school, teachers responded differently to these constraints, based in part on an individual’s assessment of effective classroom practice. In a later study, Jones stated that the relationship between a lack of teacher confidence and teachers’ computer anxiety, and the lack of teacher competence were internal barriers or “intrinsic factors”; and the lack of access to ICT and resources were external barriers (extrinsic factors) (see figure 3.3)



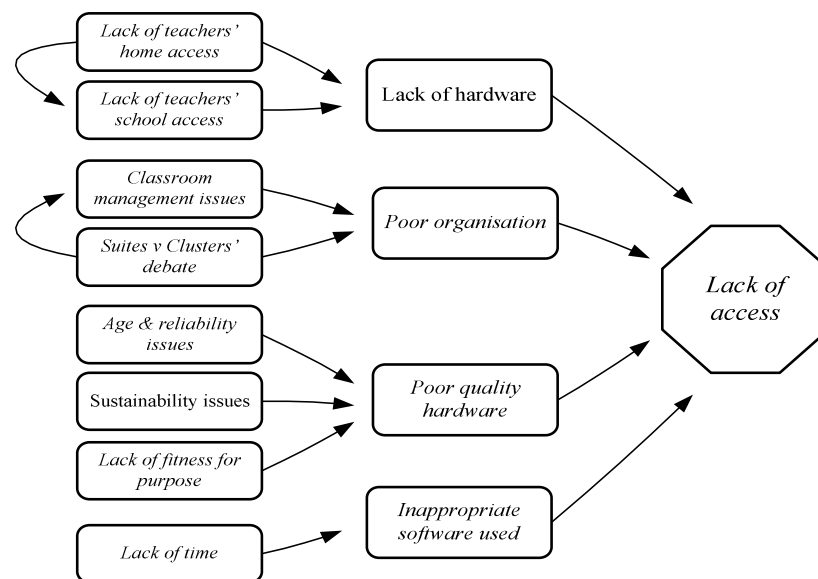
Source: Jones, 2004, p.21.

Figure 3.3 Adoption of ICT: Intrinsic and Extrinsic Factors

To integrate ICT successfully into the curriculum, teachers require competency in ICT skills as well as pedagogical knowledge of effective ICT teaching practices. Intrinsic variables in computer integration include positive teaching experiences with computers; teacher’s comfort with computers; beliefs supporting the use of computers as an instructional tool; training; motivation; support; and teaching efficacy (Mueller et al., 2008). Beggs (2000) and Jones (2004) found that quality of training and insufficient time as barriers that prevent teachers from integrating ICT into the classroom. Jones (p. 7) mentions that “many teachers who do not consider themselves to be well skilled in using ICT feel anxious about using it in front of a class of (students) who perhaps know more than they”. Sub-standard ICT skills comprise factors that may include insufficient skills or inadequate pedagogical training. Moreover, the lack of time available for teachers to complete their work includes little time for preparation of the subject, for the discovery and practice of using ICT equipment, and for receiving training; these are also considered important barriers to the integration of ICT. Osborne and Hennessy (2006) note that science teachers’ motivation is an important factor in introducing ICT, citing the lack of time to gain confidence with ICT, a science curriculum overloaded with content, and lack of subject-specific guidance for using ICT to support learning.

3.4.2 Extrinsic Barriers

Researchers note that the external barriers that prevent the teacher from using ICT in the classroom are primarily functional: lack of access to ICT and internet, insufficient time to develop courses, and ineffective training (Brush et al., 2003; Ertmer et al., 1999; Jones, 2004). Further issues cited by authors Ertmer et al., Finger et al. (1999), Semenov (2005), and Brush et al. relate to insufficient management and technical support, cost barriers in equipment, and that students lack skills. Jones cites functional issues of resources and access: “the lack of good ICT resources in a school will not only prevent teachers from making good use of ICT in their teaching, but it is also likely to have a detrimental effect on pupils’ achievement” (p. 11). These issues are summarised in the following figure 3.4



Source: Jones, 2004, p.22.

Figure 3.4 *Issues Regarding Access to ICT Resources*

Discipline-specific Issues Whilst there are generic functional barriers to integration of ICT into science education relating to resources, training, and attitudes, there are also specific science class-based issues. For example, Hendren (2000) adds a lack of vision regarding the benefits of ICT in science classes. In another study, Corbin (2003) concurs with the generic barriers, adding lack of access to computers, either in a laboratory setting or in the classroom. Also, Tebbutt (1999) notes the access and teacher competency issues, and

emphasises teachers' inadequate competencies in linking curriculum to ICT applications in science.

In Saudi Arabian science classes, Al-Mohaissin (1993) found in an early classroom study that equipment performance was unstable and frustrating for users, there was a shortage of computer software in schools, and science teachers did not distinguish between the general use of computers in schools and the use of computers in science classrooms. Al-Mohaissin (1993) also identified other barriers that prevented the effective use of ICT in science teaching, as follows: the equipment used for teacher ICT training was not compatible with that found in schools as Saudi schools had limited and dated software;

- the hardware installed supported only proprietary software applications which frequently did not serve the needs of science teachers; and
- there was little Arabic software for science and that which was available was expensive.

Adding the generic to the specific, overall barriers to integrating ICT into science tended to be functional, interrelated, and differed according to the prevailing local school conditions. To summarise, issues may be classified into the following categories: financial barriers including hardware, software, infrastructure, and training which are relatively high in cost, especially for developing countries; knowledge barriers including few ICT trainers and technicians to assist teachers acquire skills; technical barriers, such as availability of networks or compatibility between hardware, software, and training programs; and intrinsic barriers, especially with teachers long experienced in traditional curricula.

Cross-cutting Effects. As an example of the cross-cutting nature, or circularity, of these ICT integration issues, the use of ICT in classrooms for high school teachers in Victoria, Australia, were found to be both extrinsic and intrinsic: cost and unreliability of hardware and infrastructure, lack of management and technical support, teacher reluctance to embrace change, lack of graded professional development, lack of assessment criteria, and poor internet connections (Christophersen, 2002). In the Arab countries, Al-Moussa (2004) reported that obstacles to the integration of ICT into schools in the Gulf Cooperation Council countries were a lack of computer skills training for teachers and insufficient technical support, plus costs. A recent Omani higher education survey concerned a questionnaire based on literature from developed economies; faculty members perceived moderate levels in obstacles in applying ICT to their teaching practices: lack of equipment, lack of institutional

support, disbelief of ICT benefits, lack of confidence, and lack of time (Al-Senaidi, Lin, & Poirot, 2009). In Portugal, these general aspects were confirmed by Gomes (2005), who added that whilst teachers devalued the advantages of ICT in the science curriculum, this also contributed also to a lack of peer support. This confirms the findings of Ertmer et al. (1999) and Jones (2004) in external barriers supporting the negative intrinsic attitudes of teachers. It also has relevance to the outcome of this study which has a focus on teachers' professional development.

In Saudi Arabia, Al-Oteawi (2002) found that there was insufficient training and courses available in colleges, particularly courses related to basic computer and internet skills; colleges of education did not at that time encourage the use of ICT in the classroom and there was little incentive in that regard for trainee teachers. Further, there was little or no professional training available for teachers to advance their ICT skills or curricula usage of ICT processes. In a recent study, the general findings of Al-Moussa (2004) and Al-Oteawi were confirmed by Oyaid (2009): time constraints, lack of training, and financial issues. Nevertheless, Oyaid's findings included that teachers' ICT use is guided by local policies: in fact, she found that teachers' ICT use was more influenced by their schools' management policy than that of the Ministry of Education. There is therefore a disconnection between the professed aims of the Ministry to integrate ICT into the science curriculum, and the attitude of a particular school management or administration that impacts ICT implementation into the curriculum (Leach & Moon, 2000).

Teacher resistance to change, whether real or perceived, is of fundamental consequence to the outcome of this thesis, which investigates integration of ICT in the Saudi intermediate schools' science curriculum, and teachers' professional development. If teachers cannot or will not observe the direction that the Ministry desires, then resources will be abandoned and students will not be able to improve their position in science knowledge. Barriers to reform are considered below.

These cross-cutting intrinsic, extrinsic and environmental barriers to the adoption of ICT in the science classroom have implications for schools that have the responsibility to engender knowledge and skills in their students for the job market and further education and training. This is the topic discussed below.

3.4.3 Effectiveness of ICT Integration

Student knowledge acquisition is the fundamental position for the science curriculum. Particularly in Saudi Arabia, where arts and management graduates find difficulty in achieving work in their fields, improved outcomes for science and mathematics are the ultimate goal for the Ministry of Education (2003c) and to this end, it invited international scrutiny.

In 2004, the International Association for the Evaluation of Educational Achievement (IEA) released the results from its 2003 Trends in International Mathematics and Science Study (TIMSS). As global education practices evolve on the Peninsula, the comparative international standards gain credibility, and TIMSS 2003 was the fifth iteration of the IEA series, which began in the 1960s. TIMSS assesses achievement in 45 countries and includes information from students, teachers, and administrators. Although it has its detractors, TIMSS is a strong global measurement for student achievement (Wiseman, 2006). This was the first time Saudi Arabia and Bahrain entered in the assessment, with Saudi Arabia assessed at 39th in science and 43rd in mathematics. The author explains this result as indicative of a first attempt, and expected gradual improvement as the country adopts international criteria of curriculum and teacher standards.

In research of interest to this thesis, Al-Rasbi, Al-Balushi, Al-Kharusi, Al-Harhty, and Al-Zadjali (2008) studied TIMSS 2003 data to investigate the impact of computers on Arab students' test scores in mathematics. They found that in Arab countries, including Saudi Arabia, student performance on the mathematics assessment was significantly higher in schools that had higher number of computers. In Tunisia, however, students taught in schools with only a few computers achieved significantly higher achievement scores. Interestingly, in Bahrain, Egypt, Jordan, Lebanon, and Saudi Arabia, students using computers inside the school outperformed students using computers outside the school. Students who had access to computers during mathematics lessons in TIMSS classes in five Arab countries including Saudi Arabia scored at a higher level than the students in these countries who did not have access to computers during their mathematics lessons. The result of this study appeared to be that science students in Saudi Arabia lacked the rigour of Tunisian schools; arguably, students using computers in class rather than home were more focussed on the use of ICT as a tool rather than for entertainment; however, in general, Saudi students using computers for

mathematics lessons performed better than those who used pen and paper. It is open for discussion; however, the results could also be relevant for science examinations.

The TIMSS results are indicators of the Saudi government's intent to gain international recognition for its graduates. The initial attempt is expected to improve as the education system matures and standards begin to deliver improved performances from the teaching and learning experiences.

3.4.4 Summary

This section outlines the issues relating to implementing ICT into the science classrooms in Saudi Arabia. Integration of ICT into the science curriculum is predicated on achieving improved outcomes for both teachers and students. In this section, the goals of the science curriculum were found to be practical, so that students understood the principles of science, and which could also lead to a career in science. The issues in integrating ICT into the science curriculum for teachers were found in the literature to be cross-cutting so that intrinsic, extrinsic and discipline-based issues became interwoven and cross-causal. Teachers' possible resistance to change was therefore based on a series of factors which arguably could be affected by adequate training, resources and motivation.

Finally, the Ministry's willingness to use the international TIMSS' results country comparison for intermediate students is an acknowledgement of the need to improve outcomes for the considerable resources the government contributes to education. This step leads teachers and students further into global competition so that there is a real standard to address. The next section considers the professional development of teachers so that they are equipped for this endeavour.

3.5 Training and Development for Teachers

Continuing training and development is necessary to maintain teachers' competencies: for pedagogical and professional portfolio reform, and to learn new skills and approaches. In Saudi Arabia, as elsewhere, there can be entrenched opposition to change. Posner, Strike, Hewson, and Gertzog (1982) proposed that if an individual's problems can be solved within the current concept framework, then that person is satisfied with the current concept paradigm. Further, even when some problems remain unsolved, the person may make only moderate changes to conceptions. Glennan and Melmed (2000) and Hasselbring et al. (2000) consider that improving the quality of education depends on improving the quality

of teachers, and teachers must have access to professional development programs that enable them to gain multiple skills. Finger et al. (1999) found that teachers were more competent using ICT in the science curriculum when they received comprehensive training in ICT. Blackmore et al. (2003) and Hefzallah (2004) explained that when teachers perceived ICT as a tool to meet curricular goals, teachers' training was the key to integrating ICT into education. Hasanain (2005) explains that when organisations change their objectives, work methods, or want to introduce new technology to systems, staff training programs are necessary to improve outcomes.

Teachers' ICT training can be of a higher priority than hardware and software availability. Pan (1999) states that planning for integration of ICT in the curriculum has to include teachers' professional development and ICT infrastructure. The quality of the school's ICT equipment is immaterial if teachers do not have the required competencies, and authorities should recognise the value of attaining and retaining appropriate skills (Hasselbring et al. 2000; Ortega, 2000). As a result of pedagogical and technical advances, teachers require access to continuous skill and knowledge opportunities to maintain their positions in the evolving standards in these fields, and this factor is recognised by all capable educational authorities (UNESCO, 2002). For example, authorities in Australia support the professional development of teachers and provide continuous training; the Victorian government offers ICT teacher-training programs in three key areas: ICT skills, curriculum development, and classroom management (Christophersen, 2002). The following sections describe the approaches to teachers' ongoing professional development, and the acquisition of ICT skills is explored. The Ministry's response to teacher development is also presented.

3.5.1 Approaches to Teachers' Development

There are various approaches to training and development for teachers; all seek to improve the quality of teachers' work outcomes. The US National Council for Accreditation of Teacher Education (2002) reported that professional development includes in-service education, conference attendance, intra- and inter-institutional visitations, fellowships, and work in general education. The literature provides many examples of training and development opportunities for teachers; however, each education authority must craft its own policies and strategies based on sound macroeconomic principles; its history, culture, and geography; its unique competitive advantage; and its development goals (Kozma, 2005). For the purposes of this study, professional development refers to all opportunities teachers can

access to improve their skills and knowledge in their portfolio subjects, pedagogy, and technical evolution, including ICT.

Professional development opportunities have significant, positive effects on teachers' self-reported increases in knowledge and skills, and changes in classroom practice (Garet, Porter, Desimone, Birman, & Yoon, 2001).

In this case, Valente (2003), and Higgins and Packard (2004) consider that training should include the potential of ICT to assist in the construction of new knowledge, and an understanding of the role of ICT in the science curriculum. Higgins and Packard nominate a qualified teacher's skills:

- to use ICT confidently and effectively,
- to be familiar with a range of ICT equipment and software,
- to teach ICT to their students as part of their curriculum entitlement, and
- to develop an understanding of ICT and its capability to effectively use technology to support students' learning (p. 22).

Science teachers not only need to possess computer-based skills, they need to develop sound pedagogical knowledge to successfully integrate ICT into the science curriculum (Jones, 2004). The use of ICT in the classroom allows teachers to promote higher-order thinking skills in students, and the evolving role of teachers as "curriculum developers" refers to the principles of new pedagogy supported by technology. Although ICT can play a key role in instruction, curricula, and practices, the use of ICT as a tool must be based on sound pedagogical principles (Makrakis, 2005).

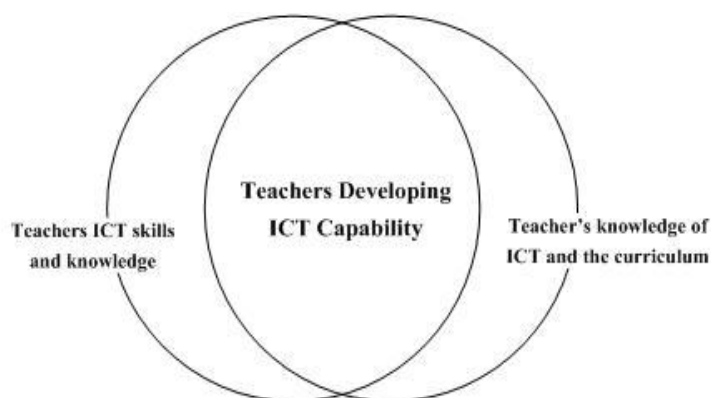
In 2004 the Saudi Ministry of Education announced a comprehensive education productivity strategy which included ICT implementation (Al-Omran, 2007). The question arises regarding the nature of teachers' ICT skills and this is explored in the following discussion.

3.5.2 Teacher ICT Skills

Teacher skills are becoming more widely identified as a major factor that affects the quality and efficiency of education and had a direct effect on learner achievement (Cheong & Kim, 2009). The integration of ICT into the science curriculum depends upon the teacher's skills, so the teacher is critical to this end (Means, 1997; Poole, 2000; UNESCO, 2002). The

US National Council for Accreditation of Teacher Education (2002, p.56) defines teacher skills as “the ability to use content, professional, and pedagogical knowledge effectively and readily in diverse teaching settings in a manner that ensures that all students are learning”. In another definition, Cheong and Kim define teaching skills as techniques to direct student’s learning toward desired behaviours. Finger et al. (1999) explain that teacher skills enable a teacher to assess a class and use this assessment to employ different techniques, style, or tools for the desired result: for example, using projectors to illustrate a process.

Pedagogical research identifies teachers’ skills that can significantly improve teaching: an understanding of the subject matter and the knowledge of the manner by which students learn (Darling-Hammond, 1997). More specifically, Cheong & Kim (2009) refer to the skill of teaching as a set of sub-skills, such as communication, technology (including ICT skills), motivation, reinforcement, questioning, and classroom management. ICT skills also refer to familiarity with technologies such as computers, and peripheral equipment including printers, scanners, cameras, and projectors, as well as knowledge of basic technologies’ functions, familiarity with installing and using software such as Microsoft Office, and using internet services including sending and receiving e-mail (McDonald, 2004; Semenov, 2005). However, Higgins and Packard (2004) connect teachers’ ICT skills with knowledge and motivation to develop teachers’ competencies; to improve productivity using ICT, teacher skills and knowledge must be augmented through a deeper regard for ICT potential (see figure 3.5).



Source: Higgins & Packard, 2004, p. 18

Figure 3.5 *Developing ICT Capability*

With the strong development of ICT, teachers are expected to have ICT skills and use ICT effectively to deliver the science curriculum (Pan, 1999). Jones (2003) concurs: ICT is useful for lesson planning and preparation of teaching materials, recording student assessments, and other administrative tasks.

Teacher ICT skills comprise basic and advanced. Hefzallah (2004, p.30) classifies teachers' ICT skills into two categories: the user or basic level, and an advanced competency. At the basic level the user should have an understanding and capability of basic computer software and a favourable attitude towards it. At the advanced level, the user should have a comprehensive knowledge of a broad range of applications, managing computer operations, designing certain educational programs, and publishing via the internet. Hefzallah suggests that to integrate ICT into education, teachers as users of technology must be familiar with at least basic keyboard skills.

Recently, UNESCO (2009) designed a comprehensive approach to teachers' ICT knowledge and applications. The goal of the "ICT Competency Framework for Teachers" (ICT-CFT) project is to improve teachers' practice by considering current practices in pedagogy, curriculum, and school organisation. The framework is designed for the professional development of teachers to use ICT skills and resources to improve their teaching, collaborate with colleagues, and contribute to a higher quality education system. The objectives of the project are:

- to develop a common core syllabus (defining various ICT competency skills for teachers) that training providers can use to develop learning materials sharable at a global level;
- to provide a basic set of qualifications that allows teachers to integrate ICT into their teaching; to extend teachers' professional development to advance their skills in pedagogy, collaboration, and school innovation using ICT; and
- to provide a harmonisation for different views and vocabulary regarding the uses of ICT in teacher education. The project also includes a mechanism for reviewing and approving the curricula and course offerings of these providers (UNESCO online).

Dimensions of economic theory are used by UNESCO to build its ICT competency framework to improve student outcomes: capital deepening (the use of equipment that is more productive than earlier versions), higher quality labour (a more knowledgeable

workforce that is more productive), and technological innovation: the creation, distribution, and use of new knowledge. These factors, according to UNESCO, are the basis for three complementary approaches that place education policy within an economic approach: to increase teachers' ICT usage by requiring technology skills as part of the curriculum (technology literacy); to add to students' knowledge through using ICT to solve complex, real-world problems (knowledge deepening); and to promote innovation for the benefit of the community (knowledge creation). The UNESCO ICT-CFT project encompasses the three approaches to address countries' varying policy goals; each approach impacts the education system differently: pedagogy, teacher practice and professional development, curriculum and assessment, and school organisation and administration (UNESCO 2009).

Teacher professional development is a particularly important component of educational improvement; this is manifest only when training is focused on specific changes to teacher style, and particularly if it is aligned with other changes in the educational system. However, UNESCO cautions in the overuse of ICT; it is intended only as part of a continuum of media used to serve educational goals. Lastly, ethical and legal issues arise with ICT in education, such as ownership of knowledge, and globalisation of education in juxtaposition to cultural diversity; in this case, Arab traditions.

This section explored the characteristics of skills acquisition and professional development for teachers, focussing on the requirement to "internalise" ICT so that it becomes inherent in the science classroom delivery for teachers, and highlighting the recent advice from UNESCO. The following section considers aspects of resources, training and motivation which influence the adoption of ICT and its integration into the science curriculum.

3.6 Summary

This chapter has reviewed relevant literature in relation to the integration of ICT in education, particularly in science education in intermediate schools. It began by defining ICT and explored factors affecting its integration into education, including access and teacher professional development. It then turned to consideration of the broad benefits of ICT to learning and then to teaching.

This was then followed by discussion of the integration of ICT into the Saudi Arabian education system, wherein I outlined some of the essential initiatives taken by the Ministry of

Education to achieve this aim. Then I turned to discussion of the conservative and traditional science curricula in Saudi Arabia, and the current limited role of ICT within it.

I discussed some of the issues with ICT integration including intrinsic and extrinsic barriers with a particular emphasis on the teachers. Finally I considered the importance of teacher professional development in relation to ICT, particularly relating to teacher ICT skills or competencies.

This chapter has presented the research history and contextual background of this study. The next chapter moves on to the primary research, describing the methodology for gathering data for analysis of the factors impinging on ICT implementation into the teaching and learning environments for intermediate school science classes in Saudi Arabia.

Chapter 4 Methodology

When successfully integrated into the Saudi education system, the evolving phenomenon of ICT may have the potential to widen and deepen the science curriculum so that students can gain access to the best information and the best teachers available. The preceding chapters discussed the advantages and challenges of ICT usage in pedagogy, especially that relating to science, and presented the education environment in Saudi Arabia. This study seeks to examine the manner by which the Ministry of Education wishes to integrate ICT into their educational system, specifically considering intermediate science teachers' competencies in this regard. Because of the differential treatment of boys and girls education until 2003, it is of particular interest whether the partial merger has resulted in differences between the ICT skills of male and female science teachers, and whether further training is required to bring the skills of all up to an acceptable standard.

Mixed research methods are employed in this study: a qualitative data collection and analysis was selected because it uses a naturalistic approach to understand an occurrence or phenomenon (Hoepfl, 1997). As well, a quantitative data collection and analysis is employed to explore more broadly the parameters of ICT integration into the science curricula in intermediate schools in the Jeddah province, and to identify the competencies of the science teachers charged with this responsibility.

This chapter describes the overall methodology and the data-collecting and analysis techniques that were employed in the study. It comprises the rationale for the research design, followed by a description of the two research study techniques used: interviews with policy makers from the Saudi Ministry of Education, and a questionnaire surveying male and female science teachers at intermediate schools in Jeddah province.

4.1 Research Design

A methodology for research entails the theoretical principles and frameworks that provide the guidelines for undertaking research (Sarantakos, 2005). The majority of social researchers identify two broad approaches, qualitative and quantitative research, although there are others who would categorise these differently. Qualitative research is a type of educational research that relies on the collection of qualitative data. It is a means for

exploring and understanding the meaning that individuals or groups ascribe to a social or human problem (Creswell, 2009; Johnson & Christensen, 2004). According to Creswell (2008, p.46), the researcher in qualitative research “relies on the views of participants, asks broad, general questions, collects data consisting largely of words or text from participants, describes and analyses these words for themes, and conducts the inquiry in a subjective biased manner”. Lichtman (2006), Sarantakos, and Patton (2002) point out that over the last twenty years, qualitative research increased in popularity in the field of education research; it is used to gain insight into people's attitudes, behaviours, value systems, motivations, culture, or lifestyles, and it is used to shape business decisions, policy formation, and communication.

On the other hand, quantitative research is a type of educational research that relies on the collection of data subject to quantitative analysis. It is generally a means for testing objective theories by examining the relationship among variables (Creswell, 2009; Johnson & Christensen, 2004). The researcher in quantitative research often “decides what to study, asks specific, narrow questions, collects quantifiable data from participants, analysing these numbers using statistics; and conducts the inquiry in an unbiased, objective manner” (Creswell, 2008, p.46). Hoepfl (1997) explains the two paradigms thus:

Where quantitative researchers seek causal determination, prediction, and generalisation of findings, qualitative researchers seek instead illumination, understanding, and extrapolation to similar situations. Qualitative analysis results in a different type of knowledge than does quantitative inquiry.

Both forms of analysis are used in this study to gather adequate data and to enrich its findings and conclusions.

Social research employs qualitative methods to gather data on individuals' experiences and perspectives on their professional lives. Qualitative methods provide insight into people's experiences which cannot be easily provided through other methods (Creswell, 2009; Lichtman, 2006; Sarantakos, 2005). Sarantakos points out that the researcher in qualitative research can choose the method of study before or during the study, and that the methods of research in qualitative research open pathways to data collection and employ flexible research designs. Wellington (2000) explains that the methods of data collection in educational research can focus on primary sources such as observation, interviews, questionnaires, and focus groups, and secondary sources such as documents.

4.1.1 Qualitative and Quantitative Research

When considering the views of Ministry of Education policy makers who influence the integration of ICT in Saudi education, qualitative data collection such as that from interviewing is appropriate for this study. Sarantakos (2005) and Patton (2002) both argue that qualitative analysis is an appropriate approach when flexibility is required for an in-depth study, and when attempting to understand a little-known phenomenon. Qualitative research seeks out the “why,” not the “how” of its topic, through the analysis of unstructured information, using interview transcripts and recordings, notes, and various forms of feedback (Creswell, 2009).

However, to complete this study, a questionnaire is useful to establish broader parameters for the research problem. Quantitative analysis was used for the science teacher questionnaire distributed to the large number of male and female science teachers at intermediate boys’ and girls’ schools. The questionnaire aimed to evaluate the ICT skills, and attitudes of the teachers towards integrating ICT in their curricula; it also aimed to identify the barriers that may hinder teachers from exploiting the resources available through ICT. The data from questionnaires may be analysed through descriptive analysis, described by Sarantakos (2005, p.300) as a “type of analysis that aims at identifying and describing the main content of data”.

Through this research design, the experiences and perceptions of the participants (the policy makers in the Saudi education system, and male and female science teachers) can be explored. It also provides rich data to better understand the phenomenon of the integration of ICT into science teaching and to determine the professional development needs of science teachers in the Saudi education system.

4.1.2 Mixed Methods

Many studies in the research field show that employing a mixed methods approach can give a broader understanding of the study, explain a research problem, increase the quality of the final results and provide a more comprehensive understanding of analysed phenomena (Creswell, 2009; Sydenstricker-Neto, 1997). Moreover, Gorard and Taylor (2004) and Johnson and Christensen (2004) state that research results are stronger when based on a variety of methods, as the researcher can confirm, explain, and verify the data. It is also thought that educational researchers can improve the accuracy of their observations by

collecting and analysing differing forms of data which relate to the same phenomenon (Johnson & Onwuegbuzie, 2004), in this case the integration of ICT into the intermediate science curriculum. Open-ended interviews provide comments that offer different perspectives on the study topic and provide a complex picture of the situation, while survey data offer useful information if the researcher needs to describe a large number of people. These data then inform the study (Creswell, 2008; Johnson & Christensen).

In this research, the combined effects of factors (e.g. teacher training, ICT integration) may also be difficult to assess. Qualitative results inform quantitative data and can assist overall analysis and outcomes. Among the purposes for mixed-method evaluation design Greene, Caracelli, and Graham, (1989, p.259) draw attention to five major advantages that might enhance the mixed-method evaluation which are following:

- Triangulation seeks convergence, corroboration, correspondence of results from the different methods;
- Complementarity seeks elaboration, enhancement, illustration, clarification of the results from one method with the results from the other method;
- Development seeks to use the results from one method to help develop or inform the other method, where development is broadly construed to include sampling and implementation, as well as measurement decisions;
- Initiation seeks the discovery of paradox and contradiction, new perspectives of frameworks, the recasting of questions or results from one method with questions or results from the other method; and
- Expansion provides richness and detail to the study exploring specific features of each method (p. 259).

In sum, the research strategy integrating different methods is likely to produce better results in terms of quality and scope. A mixed methods approach can extend the analysis, findings and conclusions of this study to better inform its results and create a stronger path towards a critical evaluation of ICT integration in to the intermediate science curriculum and become more useful and accountable to a wider audience.

The research design selected for this thesis is depicted at figure 4.1. It shows the relationships between the research questions that underlie the interview and questionnaire approach, the findings from the research and the discussion of the results in light of the research questions, the study implications and recommendations follow.

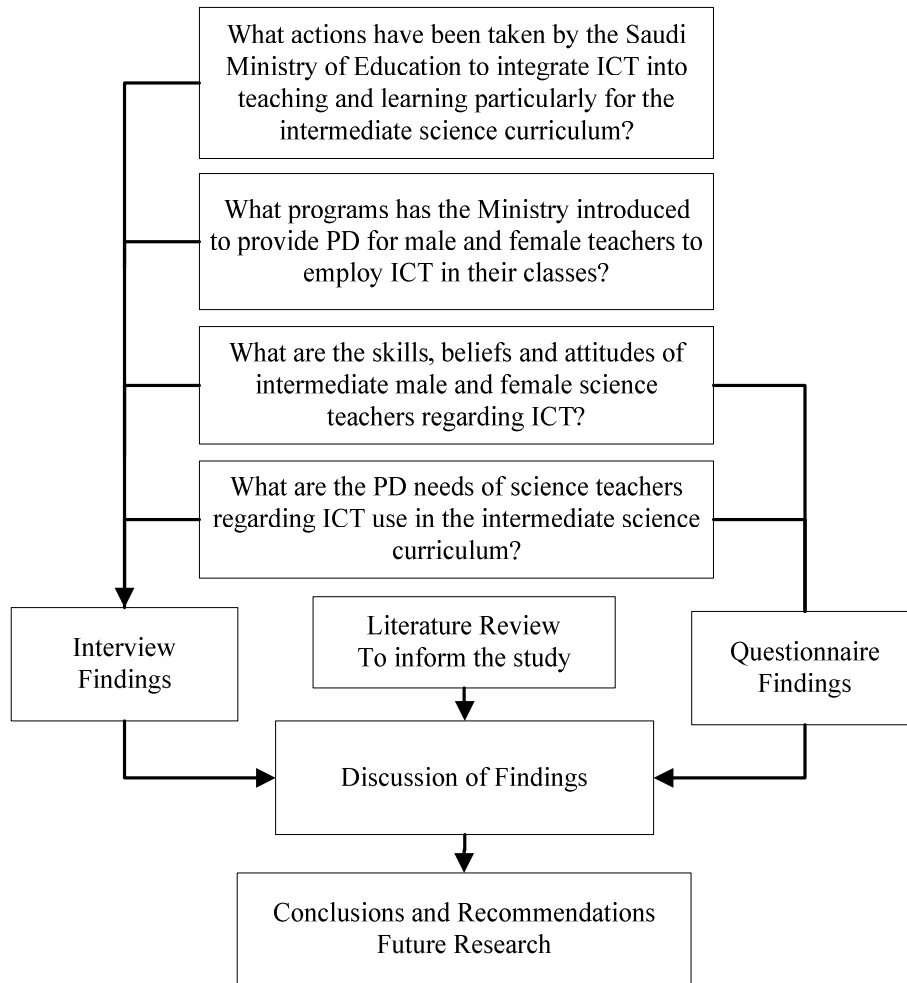


Figure 4.1 *Research Design*

The purpose of this study is to investigate the integration of ICT into the Saudi educational system, including the perspectives of both policy-makers and science teachers on the competencies and professional development needs of the science teachers. In Saudi Arabia, the school systems and curricula of boys and girls evolved separately until 2003, when the Ministry of Education assumed national responsibility. An assumed aim of this study is therefore to compare the competencies of each group of science teachers (male and female science teachers in the intermediate schools) to identify differential strengths and weaknesses in using ICT and professional development needs in the classroom. To realise these objectives, a mixed methods approach was selected. While data was systematically collected using interviews and questionnaires, a third source of data consisted of documentary evidence from official documents as indicated in the literature review.

The supporting research questions of this study (section 1.5 and part of figure 4.1 above) inquire into the decision by the Ministry to introduce ICT into schools, science teachers' ICT skills and attitudes to ICT; and the standard and frequency of ICT training and development programs available to science teachers, including attendance, assessment and teachers' perceptions of these programs. To address these questions, as a first step, official documents of the Ministry of Education were perused to identify the plans and strategies used for the integration of ICT into the Saudi education system. These documents are the framework for the integration process. Wellington (2000) asserts that such information can provide an important historical perspective and an excellent source of additional data to complement interviews or observation. Whilst detailed document analysis is beyond the scope of this thesis, policy documents were collected and reviewed as depicted in the literature review in chapter 3. These also form an excellent means of triangulation, helping to increase the trustworthiness, reliability and validity of the research. However, because they were reviewed in terms of broad policies, plans and programs rather than analysed as texts in themselves, it was decided that they formed part of the research background rather than part of the data collection and analysis. Hence while such documentary evidence has been reviewed in chapter 3 as part of the literature and is mentioned here in passing, it is not appropriate to document it further as a method of data collection or analysis. With previous chapters discussing the literature, and this explanation covering alternate sources of information, the remainder of the chapter considers the primary research.

4.2 Interviews with Policy Makers

An interview procedure was selected to gather information, perceptions, and (indirect) guidance for the survey questionnaire from decision makers who have responsibility for ICT integration into the science curriculum for intermediate students in Saudi Arabia, and for the professional development of teachers who deliver the curriculum. Data from the interviews were used primarily to inform the first two questions: actions the Ministry of Education has undertaken to integrate ICT into the education system, in particular, the science curriculum, and, programs the Ministry introduced to provide professional development for male and female science teachers to employ ICT in their classes.

The interview approach is commonly used for data collection because it allows a researcher entry into the opinions, attitudes, and belief systems of participants (Lichtman, 2006; May, 2001; Patton, 2002). Interviews have several advantages: they produce in-depth

data that are not possible with a questionnaire; they can obtain data that is difficult to capture on a questionnaire; and they allow follow-up to incomplete or unclear responses through probing questions (Gay & Airasian, 2009; Patton). Patton states that interviewing for the evaluation of programs is useful in data that reflects the interviewee's perspective on their experiences with the program, their assessment of its processes, and expectations for its outcomes. Sarantakos (2005) opines that interviews in qualitative research are an important technique as they are a systematic instrument, controlled by the researcher to minimise bias, and can be related to specific purposes.

The interview technique was used in this study for interaction with the policy makers in the Saudi education system to collect the data necessary from those who have experience and knowledge on the research topic. It allowed the subsequent exploration of themes that emerged during the interview; especially as this study utilises a variety of respondents to probe the nature of ICT implementation in the Saudi intermediate science curriculum. More specifically, the aim was to explore the policy makers' views and attitudes on the following points:

- ICT infrastructure, curricula and training programs for Saudi schools; and
- issues arising from integrating ICT programs into curricula, particularly science curricula for intermediate schools, and the means to address these.

The use of interviewing was important for this study as it provided rich data from interviewees who either have a deep knowledge of the integration of ICT into the Saudi education system from the perspective of policy-makers, or who are considered experts in the professional development needs of male and female science teachers. Interviews provided an opportunity to understand the policy makers' perspectives. They also served an important function in the research design in that they raised issues relating to science teacher skills and attitudes which were then explored further in the teacher questionnaires. The following section discusses data collection using interviews, participant selection for the interviews, the procedures involved, and the means of analysing the data.

4.2.1 Design of the Instrument

This study used semi-structured interviews as a means to collect data, because, as May (2001) pointed out, this form of interview is considered the most appropriate communication method because it provides both some control and flexibility during

discussion which helps to elicit valid responses from the interviewees. Williamson (2002, p. 243) states:

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

The use of semi-structured interviews in this study allowed a broad range of questions to be directed to policy makers to address the research aims (see below for more detail about the questions [section 4.2.3]).

4.2.2 Participant Selection and Recruitment

The selection of interviewees for this study constitutes a purposive sample because this method of sampling applies to situations where certain individuals have the required information and the goal of data collection is description and interpretation (cf. Lichtman, 2006) of the information needed to address the aims of the study (cf. Patton, 2002). Johnson and Christensen (2004) state that the purposive sample aims to select information, seeking data rich cases for in-depth study to investigate meaning, interpretations, processes, and theory.

The interview technique in this study was designed in particular to provide rich data from interviewees who have an in-depth knowledge about the integration of ICT into the Saudi education system, and who are cognisant of professional training needs for teachers integrating ICT into the science curricula. Identified through secondary research materials, the Ministry of Education agencies responsible for the integration of ICT into education and for teachers' professional development were contacted late in 2006. Each organisation received a copy of the research statement and an invitation to nominate a representative to participate in the study. These organisations are described below.

Agency of Educational Development in the Ministry of Education, Al-Riyadh: the Agency was established in 2002 to integrate the education of boys and girls under the supervision of the Ministry of Education (see section 2.2). Its responsibilities include the planning and supervision for integration of ICT in all Saudi schools.

General Department of ICT: Reporting to the Agency of Educational Development, Al-Riyadh: this department is responsible for implementing the Agency's agenda for ICT in schools, determining the technical specifications to meet the ICT objectives and contracting the projects.

General Directorate for Educational Training in the Ministry of Education, Al-Riyadh: the Directorate supervises educational training centres for teachers and designs specialist training programs, including ICT.

Educational Training Centre for In-service Male Teachers, Jeddah: responsible for improved teacher performance through general pedagogical, subject-based and specialist training and development programs designed by the central Ministry.

Educational Training Centre for In-service Female Teachers, Jeddah: similar to the Educational Training Centre for male teachers, it is responsible for improved teacher performance through general pedagogical, subject-based and specialist training and development programs designed by the Ministry.

Department of ICT, Jeddah: This department is responsible for providing ICT equipment to all-boys public schools in Jeddah, identifying the schools' requirements for ICT equipment (i.e. computer laboratories, science laboratories, and other ICT equipment). The organisation implements the Ministry's ICT agenda including Learning Resource Centres and Technical Halls (see section 3.2.2) and assists with training programs.

After two weeks, the organisations were approached to establish progress and it was determined that the invitations had been accepted and the representatives were available upon contact to work out mutually agreed times for the interviews. Of the six policy makers who agreed to participate in the interviews, three were in Riyadh in the Ministry of Education, and the other three were senior officials (two male and one female), each from the target organisations in the Jeddah region.

Particular ethical considerations were necessary for this part of the study because qualitative methods can be highly personal and interpersonal (Patton, 2002) and the following ethical practices were incorporated into this research to protect the institutions and the interviewees. Ethical approval for this research was obtained from the Design and Social Context Human Research Sub-Committee at RMIT University.

All interviewees received an explanatory letter which included information about the researcher and the supervisors of this study, the purpose of the study, the methods used, the requirements of data collection during the process, and the person who could be contacted in the event of a complaint. In the letter, the privacy and confidentiality of the interviewees were assured. A commitment was also made not to allow ready identification of any individual, or of the interviewees' employer in regard to analysis or comment. The names of the institutions

were recorded for information purposes only. Interviewees were assured of access to transcripts and research findings. The plain language statement letter is included at Appendix 1, Research Documentation.

A consent form was signed by each participant before the interview commenced. It explained that all information provided would be kept confidential and that participation was voluntary; they could choose not to participate and could withdraw before completion of an interview or analysis without being penalised or disadvantaged in any way. The consent form is included in Appendix 1, as above.

For the recording of each interview, audiotape cassettes were labelled only by number and not by name. Names and other identifying information were deleted from the transcript of the tapes and pseudonyms used with quotations. The audiotape cassettes are to be kept in secure and separate locations for five years following completion of the study, to be accessed only by researchers.

Hence, the interviewees for this study comprised six participants who were policy makers and senior officers from the Ministry of Education and the Educational Administration. The Ministry interviewees from Riyadh could provide rich information on the requisite points of ICT integration and teachers' competencies; as decision makers they formulate plans and design such programs. The interviewees from the Educational Administration in the Jeddah region could provide information on program implementation. Of assistance to this researcher, it is common practice for officials to question the efficacy of the programs and to seek efficiencies and solutions to issues that arise.

The term "policy makers" referred to in this study are participants who hold senior positions in the Ministry in Riyadh or in Departments of the Ministry in Jeddah and were eminently suitable for interviewing on ICT integration and teacher competencies. Participants served as members of the High Committee for the Development of Education in the Ministry of Education and participated in planning ICT integration, or were involved in professional development of male and female in-service teachers. All participants visited many schools around the country; some had undertaken international study tours. Interviewee 2, Interviewee 3, and Interviewee 4 were Ministry representatives, and Interviewee 1, Interviewee 5, and Interviewee 6 were Educational Administration managers.

It should be noted that no special relationship exists between the participants and this researcher. The initial contact was for the purpose of the interview and the interviews were

conducted without payment. The interviews were undertaken at the convenience of the participants, either in their offices or at a suitable venue. With the participant selection explained, the next part of the study moves to the interview implementation.

4.2.3 Interview Implementation

Interview questions were drawn from the research questions, with general guidance from the literature. The interview questions were first developed in the English language; they were then translated into Arabic, as that was the language of the interviewees. To ensure the accuracy and validity of the translation, a representative of the Office of Translation checked the translation and a Certificate of Conformity for both the Arabic and English versions was issued.

The approach to the interview began with preliminary questions relating to the interviewee; qualifications, training, and experience, particularly in relation to the research topic. The interview was structured first with general questions and then became more specific to elicit the required information. There were two topics for the interview questions: the first related to the Ministry's undertaking to integrate ICT into Saudi schools and the second inquired into teacher standards and professional development, particularly those for science teachers. The following is a list of the themes addressed during the interviews:

1. Participant's views on the pedagogical significance of ICT integration into curricula.
2. Participant's views on the significance of ICT in science.
3. Identify government agencies involved with ICT and the programs to integrate ICT into the science curricula.
4. Participant's views on the success of ICT integration into Saudi education to date.
5. Explain the delivery of professional development to science teachers.
6. Comment on the role of teachers in ICT integration.
7. Explain ICT competency standards for science teachers and the training and development programs involved.

Appendix 2 Interview Questions and Responses has a comprehensive list of the interview questions.

At the end of the interview, participants were invited to add comments or suggestions to improve the utilisation of ICT in the science curriculum, or to improve teachers' ICT

competency standards. The interview questions, not in any specific order, were used as guides, and other open-ended questions could be used depending on how the discussion unfolded.

The interviews were held at a place that was convenient to both researcher and interviewee. A suitable time for the interview was also determined with the participants. To minimise any bias that could affect data collection, there were no previous relationships between the researcher and the participants. The interviews for this study were conducted in Al-Riyadh City and Jeddah City, Saudi Arabia, in January and February 2007. Five of the six interviews with male policy makers were individual meetings in each person's office. For the interview with the female senior official, I took my wife along and conducted the meeting in a public place in Jeddah City because Saudi Arabia culture does not allow men to communicate with non-related females alone.

Before the start of each interview, the objectives of the study were fully explained, the expected time to complete the interview (60 to 90 minutes) noted, the fact that the identity of the interviewee was not to be disclosed in the study, that the meeting could be terminated by the interviewee at any time, and that the interviewee would have access to the final research report. After approval by the participant, audio equipment including audio cassettes, spare batteries, and a recorder, was used to record the interview. Further, each interviewee signed a consent form.

When conducting semi-structured interviews, Patton (2002) suggests guidelines for audio recording the data of interviews. During the interview, the respondent and the Interviewee spoke clearly, the recorder was turned off if the participant wished it, and breaks were taken as required. Hand written notes were also taken during the interview process: "when a tape recorder is being used during the interview, notes will consist primarily of key phrases, lists of major points made by the respondent" (Patton, p.381). Patton adds these advantages of note taking during the interview process: such field notes assist the researcher to formulate new questions, assist in focusing transcription, facilitate later analysis, and constitute a further record in case of recorder malfunction.

All the above ethical considerations (see section 4.3.2) were observed in the conduct of the interviews, including recording and transcription of the data in Arabic. Transcription is the process of transforming qualitative research data, such as audio recordings of interviews, into typed text (Johnson & Christensen, 2004). According to Lichtman (2006), the researcher

needs to transcribe most of interview data, not summarise it. In this study, the six interviews were fully transcribed and then translated from Arabic to English by the researcher. Kapborg and Bertero (2002, p. 54) state that “translating from one language to another can be very complex because of subtle differences in meaning, some languages are similar to the English language but others are not”. Therefore, to ensure that the meaning of the interview dialogue translation was consistent in both languages, the interview dialogue and the English translation were compared and certified by an accredited translator.

The next section discusses the method of analysis of the qualitative data.

4.2.4 Data Analysis

Data analysis in qualitative methods can occur during data collection. Sarantakos (2005), Wiersma and Jurs (2005), and Creswell (2009) indicate that in many qualitative methods, some analysis of data occurs as it is collected, so that collecting and analysing data comes together in the same process. Sarantakos concurs, that analysis can take place during and after data collection in interviewing:

analysis during data collection is the most common practice and the one that is most consistent with the principles of qualitative analyses. In this case, data are collected, coded, conceptually organized, interrelated, analyzed, evaluated and then used (p.44).

Moreover, analysis of the data during collection is important and plays a major role in the consistency of the findings of qualitative studies (Creswell; Lichtman, 2006; May, 2001).

On the day of each interview, a summary report for that interview was constructed as an interpretive analysis. The objective of the summary report was to assemble and interpret the information obtained that was collected from the tape recording and the notes taken during the interview. Further, during preliminary analysis of the data, the transcriptions were read while the interview tapes were played (following Creswell, 2009).

Six interviews with policy makers of the Saudi education system were transcribed and translated (Appendix 2). To assist the interview data analysis and to begin coding the raw data of interviews, the transcription texts of the interviews were imported into a qualitative software program, QSR NVivo8. Patton (2002, p.442) states that computers and software are tools that assist analysis, “qualitative software programs facilitate data storage, coding, retrieval, comparing, and linking (themes) ... speed up the processes of locating coded themes, grouping data together in categories, and comparing passages in transcripts or incidents from field notes”. Qualitative software programs help researchers to manage their

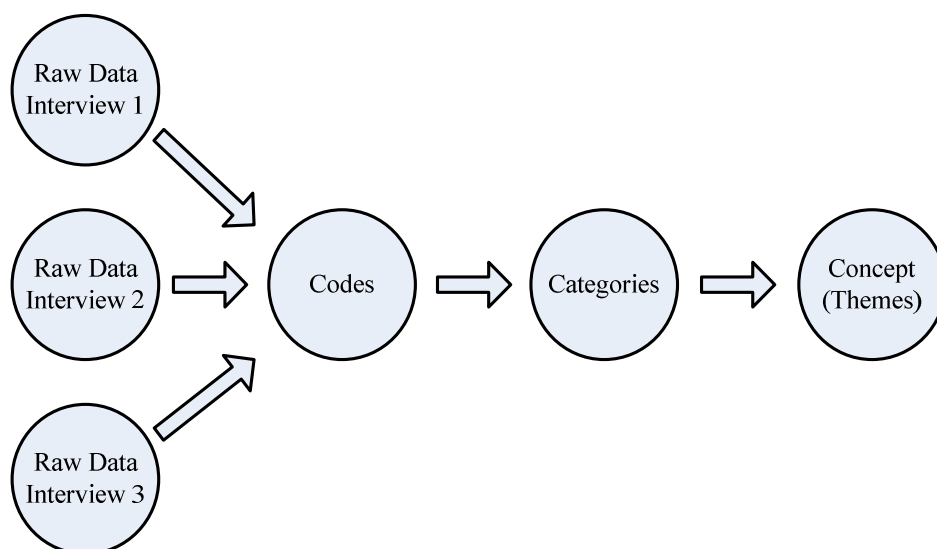
data, shape and make sense of unstructured data, save time on analysing the raw and discovered patterns, identify themes, glean insight and develop meaningful conclusions (Lichtman, 2006; Sarantakos, 2005). QSR NVivo is a program which is frequently used in qualitative analysis because of its efficacy in management of data (Lichtman, 2006). Thus, the data were coded using NVivo 8 software (QSR International, 2008)⁴, and the list of codes reduced by removal of redundant codes using Lichtman's model (2006) of analysis of interview data in QSR NVivo program as follows:

1. initial coding, forming some central idea of the responses;
2. revisiting initial coding;
3. developing an initial list of categories or central ideas;
4. modifying the initial list based on additional rereading;
5. revisiting categories and subcategories; and
6. moving from categories into concepts (themes).

The coding process is considered the heart of thematic analysis (Lichtman, 2006). Rossman and Rallis (2003) define coding as the process of organising the material into chunks or segments of text before bringing meaning to information. Sarantakos (2005, p.384) describes the levels of coding as: "phrase, number, line, sentence, paragraph, symbols, or whole document". Johnson and Christensen (2004, p.502) state that "coding is the process of marking segments of data (usually text data) with symbols, descriptive words, or category names".

At the end of the coding process, themes were identified for analysis. When the major themes emerged as the main points of the investigation, they were then written up as part of the research findings. Figure 4.2 summarises the analysis of qualitative research data designed by Lichtman and as used in this study.

⁴ Personal training associated with the NVivo 8 program was undertaken during the research.



Source: Lichtman, 2006, p. 168

Figure 4.2 *Qualitative Data Analysis: Codes, Categories and Concepts*

The final list of codes was then compared with the data to identify any new codes that emerged. Finally, the codes were categorised to create a hierarchy of concepts or themes, ‘(in NVivo, known as a tree with its parent and child nodes). Themes were refined in reference to the literature and validated through discussion and consultation with this researcher’s supervisor.

The main themes and categories that emerged from the coding of the interviews are explained and discussed in chapter 5. The following section relates to questionnaire data collection, which complemented the interviews by providing information and evidence on teachers’ views of ICT to interpret intrinsic and extrinsic barriers to the integration of ICT into the intermediate curriculum in Saudi Arabia.

4.3 Teacher Questionnaire

Data collected during the mixed methods research of this study comprises qualitative data generated through semi-structured interviews and quantitative data which was obtained through a questionnaire for science teachers of intermediate schools. The research intends to identify the factors related to integrating ICT in science curricula in Saudi Arabia, and the professional development needs of science teachers relating to pedagogy and ICT use at intermediate schools. The previous section addressed the methodology concerned with qualitative research through interviews. This section deals with collection of data through quantitative means.

Quantitative data offers useful information if the researcher needs to describe a large population (Creswell, 2005). According to Johnson and Christensen (2004), a questionnaire is a self-reporting data collection instrument that each research participant fills out as part of a research study. The authors add that through the use of the questionnaire instrument, “the researcher can gather information about the thoughts, feelings, attitudes, beliefs, values, perceptions, personality, and behavioural intentions of research participants” (p. 164). As a primary objective, this study evaluates science teachers’ skills, experience, knowledge and attitudes to determine their professional development needs. To achieve the objective of this study, data were collected directly from the teachers through a questionnaire designed to address the main objectives of the research.

This part of the study is presented in a similar manner to the qualitative research. It describes the type of data collected by a survey, the participant selection and the ethical and administrative steps undertaken, the distribution and collection of the survey, and means of analysis of the data.

4.3.1 Data Collection

To undertake the survey to assess factors related to intermediate science teachers’ experiences with ICT integration in the science curricula, permission was obtained from the Saudi authorities and RMIT University. The Saudi Ministry of Education and the education administration in Jeddah province furnished authorisation letters for the survey and permission to meet the participants and distribute the questionnaire. The authorisation letter contained the study's aims and the procedures that were taken to protect participant identities and to maintain organisational confidentiality. These letters were submitted to the RMIT Human Research Ethics Committee and approval for the questionnaire was received. Also, a plain language statement was approved by the Ethics Committee and a copy provided to each study participant, explaining the purpose of the study and the procedures that were undertaken to maintain the confidentiality of participant information. The construction of the questionnaire was based on findings from extant literature (further detail about the contents provided below). The questionnaire was self-administered. An explanatory letter was attached to the questionnaire and included instructions to assist respondents. In addition, a covering letter accompanied each questionnaire which contained information regarding the study, its objectives, and contact details for enquiry. The significance of the study was

explained to participants, and a request for participation as the focus of the research (see Appendix 2).

The questionnaire was divided into seven parts as described below.

Background information was collected through questions Q1 to Q10. The objective of the questions was to determine characteristics of science teachers and the nature of their work, such as gender, age group, experience, school location, and average number of students in the classroom. Statistics for this section such as frequencies and percentages were used to summarise the characteristics of the participants. Information on the ICT infrastructure in the school was sought through one question (Q11), with nine items to elicit information on available ICT equipment in the school and the science laboratories that could be used by science teachers during instruction, including computer laboratories, computer networks, internet access, data projectors, and electronic microscopes in the science laboratories.

Data regarding the nature of teacher training programs were derived from six questions, Q12 to Q17. This part explored the training programs attended by teachers in the ICT field, asking when and where the training was held; also the number of training programs the respondent attended in the previous three years. The final question in this section (Q17) contained ten items and asked about barriers to attending the training programs, and was measured using a Likert Scale. Wiersma and Jurs (2005) discussed different types of Likert scales that measure participants' responses, one of which was used in the study. The scale consisted of five options ranging from “strongly agree” to “strongly disagree.” At the end of this question space was provided for the participants to list any additional barriers.

The next question sought reports of the ICT skills of teachers and explored areas of strength and weakness. The single question had fourteen items, Q18a to Q18n covering computer skills including using computers, installing programs, saving educational files, using MS Office programs such as Word and PowerPoint, and using email (see section 3.4.2). Four responses were possible in this section: “not familiar,” “entry,” “adaptation,” and “transformation.” These categories were defined in the explanatory note to the question.

Question 19 explored the attitude of respondents towards ICT usage in their teaching. Science teachers' opinions were requested for 16 items, Q19a to Q19p, using a Likert scale with five options from “strongly agree” to “strongly disagree.” Five questions (Q20 to Q24) sought information on respondents' educational use of computers and the internet. The final question considered barriers to ICT usage, and included 15 items (Q25a to Q25o). This

question examined the types of obstacles that hinder science teachers' use of ICT in the educational process. A four-point Likert Scale ("does not limit" to "greatly limits") was also used for this series. At the end of the questionnaire, space was afforded for any explanation or comments the participant wished to add and a note of thanks for participating and for responding to the questionnaire.

The questionnaire was first written in English, and was then translated by the researcher into Arabic, as the questionnaire was intended for Arabic speakers. This demanded that the qualities and intent of the questionnaire did not differ during the translation. To ensure the accuracy and validity of the translation, a Certificate of Conformity for both the Arabic and English versions was obtained.

Pilot studies enabled the researcher to validate questionnaire items and to establish that all items represented their relevant dependent variable (Creswell, 2005; van Teijlingen & Hundley, 2001). A pilot study gives feedback useful for adjusting the questionnaire items if required. Van Teijlingen and Hundley add that the pilot is a crucial element of a good study design, and conducting a pilot study does not guarantee success in the main study, but it does increase its likelihood. As this questionnaire was written in English and translated into Arabic, the pilot study was an important validation step to obtain feedback for the questionnaire's items in its Arabic version.

Two pilot studies were conducted in Jeddah City. In the first pilot, July 2007, the Arabic version of the questionnaire was offered to five science supervisors in Jeddah City to evaluate and comment on the clarity of words and phrases, perceived ambiguity or duplication. The five respondents were also asked to record the time required to complete the survey. The feedback results included information on similarities, possible ambiguities and clarity of items. The average time for pilot participants to complete the questionnaire was 35 minutes. Based on these comments, items were adjusted or added and six items were deleted, reducing the questionnaire from 90 to 84 items. The adjusted questionnaire was then piloted on a small sample of the target population in August 2007; 16 science teachers at intermediate schools in Jeddah. In addition to answering the questionnaire, the second pilot respondents were asked to provide feedback regarding the content and clarity of items as well as the time taken to complete the questionnaire. A few changes were made to the questionnaire items based on their comments. In general, the data that were collected from the participants during the second pilot study improved the face validity of the questionnaire for the study. Thus the discussion moves now to the characteristics of the participants.

4.3.2 Participant Selection and Recruitment

The quantitative research took place in the province of Jeddah in January to March, 2008. Jeddah is the second-largest city in Saudi Arabia, and the educational administration in Jeddah province is also second only to Al-Riyadh, the capital. The Jeddah administration oversees almost 1,950 general education schools for Saudi boys and girls with more than half a million students and over 40,000 male and female teachers. The sample population for this quantitative research were all in-service male and female science teachers in intermediate schools in the 2008-2009 school year in the Jeddah educational province (646 science teachers).

The Educational Administration in Jeddah is divided into several Educational Supervision Centres, each of which is responsible for a number of schools based on population and area. There are seventeen Centres in Jeddah province; eight for boys and nine for girls as shown in figure 4.4 and the accompanying legend.



*BSSC Boys Schools Supervision Centre, GSSC Girls Schools Supervision Centre

Figure 4.3 Location of Educational Supervision Centres in Jeddah province

Table 4.1
Jeddah Educational Centres, Location and Number of Schools

Educational Supervision Centres		Intermediate schools
Map Identification		No.
BSSC1	North Centre (boys)	12
BSSC2	South Centre (boys)	23
BSSC3	East Centre (boys)	28
BSSC4	Central Centre (boys)	18
BSSC5	Al-Safa Centre (boys)	27
BSSC6	Al-Naseem Centre (boys)	12
BSSC7	Khelees Centre (boys)	18
BSSC8	Rabegh Centre (boys)	10
GSSC9	North Centre (girls)	26
GSSC10	Central Centre (girls)	21
GSSC11	Southeast Centre (girls)	32
GSSC12	Southwest Centre (girls)	30
GSSC13	Rabegh Centre (girls)	13
GSSC14	Khelees Centre (girls)	16
GSSC15	Al-Barza Centre (girls)	7
GSSC16	Hajar Centre (girls)	5
GSSC17	Al-Dhabia Centre (girls)	8

Source Ministry of Education Jeddah Educational Region (Boys-Girls)

4.3.3 Distribution and Data Collection

For administration in the intermediate schools, 646 copies of the survey were delivered to the Educational Supervision Centres for boys and girls. These were to be made available to science supervisors to deliver to intermediate male (304) and female (342) in-service science teachers and to request them to complete the survey. There were two sets of follow-up letters sent to the heads of the intermediate schools and all male and female science supervisors to encourage the science teachers to answer the questionnaire. A total of 340 questionnaires were returned (52.6% total return rate), that is, 155 male science teachers (50.9% response rate) and 185 female science teachers (54.1% response rate) who responded to the questionnaire. Thus 306 (47.4%) science teachers did not respond to the questionnaire.

On a limited literature survey of paper-based education course and teaching evaluation responses, (Nulty, 2008) found that response rates averaged 56 per cent in a range from 32 per cent to 75 per cent. An extensive organisational literature survey of 1607 studies by Baruch and Holton (2008) found that the average response rate for studies that utilised data collected from individuals was 52.7 per cent, with a standard deviation of 20.4. Thus whilst slightly low for the Nulty findings, this study's questionnaire return rate was acceptable compared to the Barush and Holton organisational survey. Further, when received, 29 were found to be incomplete, leaving 311 questionnaires. The findings from these responses are presented in chapter 6.

Distribution was necessarily limited. Participation in this study was voluntary for male and female science teachers at all intermediate schools in Jeddah province. Although distribution was organised to obtain a representative sample, because of logistical limitations in terms of insufficient time and resources, and the fact that not all questionnaires were returned, and participants self-selected to make the study sample:

- the survey was confined to the education administration in Jeddah province, hence it may not be representative of regional educational areas of the Kingdom
- the study focussed on science teachers at intermediate public schools; it did not include other schools, or other teachers
- the study dates from 2007 which may not be representative or capture in full the Ministry's ICT integration program outcomes.

Limitations are also inherent in the survey method; differences in results may exist between a teacher who responds to the questionnaire, and those who do not respond, thus self-selection may be an important factor, and therefore the assumption of lack of bias and representation of the full population may be invalid (Romer, 1993).

Finally, the analysis of the quantitative data from the questionnaire is presented below.

4.3.4 Data Analysis

This section of the analysis is descriptive in nature; the data were analysed and reported in percentages, means and frequencies. According to Johnson and Christensen (2004), descriptive statistics give a clear view of the situation, allowing the researcher to draw conclusions and give decision makers the means to base their decisions on rational

study: "the researcher can attempt to convey the essential characteristics of the data by arranging the data into a more interpretable form and by calculating numerical indexes such as averages, percentile ranks, and measures of spread" (p.434).

The data from the returned questionnaires were coded and entered into the Statistical Package for Social Science (SPSS). Williamson (2002) advises that the code ascribed to each question in the survey should be simple and easy to use. To analyse Q1 to Q10, Q12 to Q16 and Q20 to Q24) summary statistics were applied, such as the average of the frequencies and percentages, to describe the responses of the participants.

In regard to the items of Q17 (barriers to attending training programs) and Q19 (attitude to use of ICT), items were entered on a Likert scale that consisted of five responses: "strongly agree," "agree," "uncertain," "disagree," and "strongly disagree". To analyse these items, the answers of participants who responded "strongly agree" and "agree" were merged and collected in one column; similarly, the "disagree" and "strongly disagree" responses were merged and collected. The decision was made to reduce the Likert scale due to a lack of 'strong' responses from the teachers; arguably this may be due to an Arabic reserve to commit to a strong opinion on ICT. Next, the average of the means, standard deviation, frequencies, and percentages were applied to analyse the participants' responses.

For analysis of items of Q18 (ICT skills of science teachers), the means of the responses were divided into six levels, depending on the 4-point scale and the maximum possible score, starting from "excellent ICT skills level" to "very poor ICT skills level." In the last part of the questionnaire, which addresses the barriers to integration of the ICT into science teaching, the responses, "strongly agree" and "agree" were merged and collected into one column; as were the options, "disagree" and "strongly disagree". The lack of 'strong' statements was again the reason for the mergers. The barriers were then ranked based on the means.

This section described the methods used for this part of the study. The data collection methodology by questionnaire was discussed, and the nature of the questions set out, together with pilot studies and validation for the material and translations. The manner by which the participants were selected was presented, together with limitations inherent in selection, and distribution to the Supervision Centres and thus to the teachers at the intermediate schools. Lastly, the analysis procedures were described through summary statistics and statistical analysis using a Likert scale.

4.4 Summary

This study employed triangulation mixed research methods (quantitative and qualitative) to investigate and analyse the integration of ICT into science teaching, and to determine the professional development needs of science teachers in Saudi Arabia. This chapter presented the overall methodology and data collection techniques that were employed in this study, and consisted of three sections. The first discussed the research methodology, triangulation mixed methods research and explained the reasons for employing a mixed research methodology that included semi-structured interviews and a survey to investigate and analyse the use of ICT in the school science curricula, and investigate the science teachers' computer-based competency standards and the professional development and training of science teachers in ICT techniques and skills.

The following section concerned the qualitative data collection techniques. Semi-structured interviews were conducted with six policy makers in the Ministry of Education's central office in the capital, Al-Riyadh, and the Jeddah provincial administration. This section discussed the procedures used to select those participants, the participants' characteristics, ethical issues in human research, a description of the interviews, and the process of transcribing and translating the interview data from Arabic to English to prepare the data for the analytical phase. The instruments used to analyse the interview data were explained, including the use of a software program to create the themes and coding for the qualitative data.

The third section presented information about the science teachers' questionnaire, which was designed and constructed to collect data from both male and female science teachers in Jeddah province. The questionnaire and its objectives were described, and were the use of translation, pilot studies, and procedure for delivering the questionnaire, the study's distribution limitations, and data analyses.

The following chapters (five through eight) present and discuss the findings obtained from the analyses of interviews with policymakers in the Ministry, and the findings from the results of the science teachers' questionnaire. These outcomes are compared to the study's aims, together with conclusions and recommendations related to integration of ICT into the science curricula and the professional developmental needs of science teachers at intermediate schools in Jeddah.

Chapter 5 Interview Findings

The previous chapter explained the process for the data gathering and analysis procedures to study the integration of ICT into the science curriculum at Saudi intermediate schools and the professional development needs of the teachers to employ that ICT in science classes. Through data collection from qualitative research, interviews with policy makers in the Ministry of Education at Riyadh and Jeddah were conducted to contribute to the primary research for this study and the quantitative data collection. The semi-structured interviews were designed to elicit information on the Ministry's agenda in computerisation in the various schools' curricula, and to determine the Ministry's intentions regarding the professional development of its teachers. The policy makers' views were also sought on perceived obstacles to integrating ICT in the Saudi education system and the Ministry's plans to address these issues, and similarly, to achieve higher performance standards from teachers through further ICT training.

This chapter reports the outcomes and the results that inform this part of the study, beginning with the overview of the themes that emerged from the analysis. The details of the themes that emerged from the analysis related to ICT integration in schools are then presented, followed by those related to the professional development of teachers.

5.1. Qualitative Analysis Themes

For the interview transcript analysis, the interviewees' responses were classified into two groups: those relating to the integration of ICT into education and those relating also to the professional development of science teachers. These were grouped as follows:

Table 5.1
Themes Arising from the Interviews

Theme	Categories	Sub-categories
5.2 ICT integration into the Saudi education system	5.2.1 Significance of integrating ICT in schools' curricula	Advantages and issues of ICT in schools Value of ICT in science classes
	5.2.2 ICT integration programs	Programs for integrating ICT in curricula, especially for science Evaluation of programs
	5.2.3 External issues in implementing ICT in schools	Insufficient computer equipment Inadequate funding Inadequate communications and coordination Inadequate technical support Inappropriate school structures
	5.2.4 Teachers' issues	Teaching styles Resistance to change
	5.2.5 ICT integration strategy	Knowledge of plans Issues in implementation Seeking teachers' views
5.3 Professional development	5.3.1 Professional standards	Evolution of teachers' roles Attitudes to ICT Pedagogical and ICT skills competencies Training and development programs
	5.3.2 Training issues	Constraints to access: resources, gender and attitude Course content Inadequate ICT Participants' observations

5.2 ICT Integration into Education

This section concerns findings relating to the qualitative analysis for integrating ICT into the Saudi school system. First, the interviewees were asked their perceptions of the significance of ICT in the science curriculum, then their knowledge of previous and extant ICT programs to integrate ICT into the education system. This was followed by issues which they had experienced in the process and programs, particularly in relation to the teachers'

responses. Finally, they were invited to express an opinion on the Ministry's ICT planning process.

5.2.1 Significance of ICT in Curricula

All interviewees found benefits in integrating ICT into the classroom environment: both for extending the curriculum and for assisting teachers and students. The majority of the participants regarded ICT as no longer a luxury, that it was a basic classroom teaching aid. Nevertheless, ICT implementation of ICT integration in schools must serve educational objectives. The views and observations were almost universally positive and can be summarised as follows:

- ICT brings an exciting dimension into the curricula and facilitates the learning process, by raising students' motivation to learn.
- ICT opens new and wider perspectives into modern educational methods, for example cooperative and constructive learning, thus students are the core of the educational process.
- Students obtain a deep understanding of the curriculum through the use of ICT, which is becoming ubiquitous throughout international pedagogy.
- ICT improves the quality of education, raises students' educational level, and allows students to improve their research skills.
- The majority of a given curriculum can be better explained and presented by using ICT than by using other means.
- ICT minimises time required for planning and executing lessons; it allows teachers to make amendments during the lesson and use this material in different classes, where relevant.
- ICT elevates the teachers' role; teachers can exchange educational experiences, enhancing the flow of ideas.

Although the participant policy makers were generally positive about integrating ICT into the curriculum, there were several matters raised: the emphasis teachers placed on conceptualising ICT integration, the objectives of the integration, and whether there had been sufficient communications to the stakeholders on the objectives. However, the interviewees found that these matters may be considered of less consequence than the benefits they perceived emanating from a successfully implemented ICT program. These aspects are discussed below.

Conceptualisation of ICT for Saudi Education. Interviewee 3, from the Ministry's head office in Riyadh, said that there was an issue in the formalisation of educational ICT; the present concept of integrating ICT into the curricula was unclear, and teachers hesitated to adopt such a process until they could be more certain of inputs and outcomes. The participant said many Saudi teachers had misgivings about ICT in the curricula, and that other teachers were concerned that the ICT was beyond their capabilities. Also from the Ministry's head office, Interviewee 4 supported Interviewee 3's argument that a clearer idea about ICT integration is required to successfully meet the objectives of the various standalone programs (see section 3.2.2). Interviewee 4 stated:

I noticed that the majority of teachers in the educational field do not have a clear idea about the objectives of integrating ICT into the educational process; there is an urgent need to . . . clarify the concept.

Similarly located in Riyadh, Interviewee 2 considered it crucial to communicate the aims of ICT integration: "the Ministry of Education has to understand and spread ICT culture to (the education stakeholders); this includes teachers, managers, students, and parents". Interviewee 3, Interviewee 4, and Interviewee 2 stated that there was no agreement on the manner of integrating ICT into education, so that the majority of school administrations in Saudi Arabia pursued their own ICT agenda as resources became available.

Issues Concerning ICT Integration. In contrast to the benefits of ICT in the teaching and learning environment, interviewees reported that they had encountered negative perceptions of ICT in their interactions with staff from provincial Saudi education facilities. These issues concerned the objectives of the ICT integration program, a view that interaction between teacher and students could decrease when using ICT in classrooms and the concern that ICT becomes a goal in itself in the teaching process rather than a means or a tool to achieve the real goal.

According to Interviewee 3, there are negative aspects of integrating ICT in the teaching and learning environment. The interviewee was concerned that the novelty of using ICT in class may become the prime focus of the lesson, rather than the interaction of the learning process:

. . . excessive use of ICT equipment, such as TV or using PowerPoint to present lessons can attract the attention of the students, but at the same time can reduce the interaction between students and between students and their teacher.

In agreeing with this view, Interviewee 1 discussed the issue that ICT can overwhelm the teaching and learning process and become the main focus in the curriculum. The

interviewee expressed concerns about this potential focus on ICT rather than its use as a means or tool to achieve the real goal. In some cases, ICT can become a distraction rather than being used appropriately for the benefit of the students: “In some schools such as private schools, ICT has become so widely available that we are afraid that it might become more a matter of pride and something to show off”.

Science Curriculum. Four interviewees reported that science education, like any subject, benefits from the integration of ICT. However, as science education is characterised by different subjects, such as biology, chemistry, and physics, the use of ICT can be of assistance to science teachers in several aspects. Specific instances raised during the interviews are discussed below.

Interviewee 1, from Jeddah, stated that ICT allows students to learn interactively at any time and that education programmed through computers spares teachers time and resources. It is suitable for presenting many things that cannot be experienced otherwise. The participant also noted that some science topics are suited to ICT, for example observing the processes of volcanoes and hurricanes, as these cannot be experienced from static teaching aids. Through the use of computers the learner can observe such natural phenomena at will. Interviewee 1 continued in a similar vein:

I have seen many websites on the internet that present examples of lenses, light rays, electrical circuits, etc. This means that ICT enables students to see and study such things as if they were in a real lab. This applies to electrical circuits and the relationship between current and voltage levels. Thus, students who learn with ICT can obtain (virtual) hands-on experiences instead of merely hearing explanations of abstract and theoretical phenomena.

Interviewee 5, also from Jeddah, viewed ICT as crucial to science education, helping students learn interactively by using various computer programs and websites to aid their learning. The participant referred to digital cameras and discussed how this ICT can help students observe accurate details:

Using computer programs and related digital cameras or sensors enables students to see the most accurate details and carry out many scientific experiments. Computers are one of the tools that best support the educational learning process for different subjects and science education in particular.

Interviewee 6, in Jeddah, discussed the significance of ICT to both teachers and students in terms of conceptualisation and resources:

Integrating ICT into science teaching directly helps to overcome the obstacles that both teachers and students face. For example, ICT greatly helps teachers to explain

and present abstract concepts, present dangerous scientific experiments, perform experiments whose materials and tools are unavailable at school, enlarge micro-scale objects, and present motion.

These excerpts from the interviews approached the question from slightly different perspectives; however the interviewees emphasised the benefits of ICT in its many forms in the science curricula. Each interviewee discussed a branch of science where ICT was a significant contributor. The message conveyed during the interviews was that ICT in science education has a particular role in each branch of science and it is difficult to access that information from any other source, particularly through traditional means.

5.2.2 ICT Integration Programs

Part of the study's aim of establishing a framework for ICT integration in Saudi schools was the use of secondary documentation to establish the Ministry's intentions for ICT in its education system, particularly in the science curricula. This information was supplemented by the responses to probing questions during the semi-structured interviews.

To address this aim, the interviewees were questioned on the agenda for ICT integration in schools by the Ministry, the programs and projects it had planned and executed to achieve successful integration. It should be noted that this ICT agenda was being implemented in an environment where, in 2003, the Ministry assumed responsibility for the education of girls and was therefore the sole agency for the education of all children.

Science-based ICT Programs. The majority of the participants noted that the ICT initiatives of the Ministry were applicable to science courses as part of general school education. However, Interviewee 2 and Interviewee 3 offered information on two further projects being developed specific to science: science and mathematics curricula for each grade through from one to twelve for boys and girls; the second project for ICT integration in science laboratories in secondary schools. These are discussed further.

The science and mathematics curricula project aimed to raise Saudi Arabia's international standing in the TIMSS⁵ tests (see section 3.4.3), especially in chemistry and the cognitive domains of knowing and reasoning. Commenting on the initiative, Interviewee 3 said:

⁵ TIMSS: Trends in International Mathematics and Science Studies

The Al-Obaikan Company will translate one of the American-approved curricula and realign it to be suitable to Saudi society; the contract also includes training a specific number of teachers and preparing the electronic content of the science and mathematics studies for students.

To increase the ICT component in science courses, in 2002 the Ministry introduced the “Computerised Science Laboratories” concept to use computers in science experiments, including physics, chemistry, and biology, Interviewee 2 said. The participant continued that, after an initial trial to evaluate the equipment and software, the project apparently made substantial progress, with training workshops for supervisors. Interviewee 2 explained that “computerised laboratories with computers and sensors serving subject experiments in physics, chemistry, and biology have been provided; sensors are connected to software, providing measures and reports related to all scientific experiments on the subject”. The interviewee commented that some regional administrations were enthusiastic, while others were more reserved, but that the latter situation will surely change with time. Interviewee 3 added that “the computerised science laboratories are for secondary schools, but the Ministry of Education plans to provide these laboratories in intermediate schools after completing the secondary schools’ requirements”. The availability of further computers at intermediate schools should alleviate the resources issues regarding accessibility of ICT hardware.

Whilst interviewees reported mixed acceptance of ICT in the science laboratories, they believed that the continued implementation of the ICT program would ultimately succeed in addressing teachers’ concerns. The information from the study’s respondents shows that the Ministry of Education has undertaken significant projects and made some progress in providing ICT infrastructure, administration, and curricula for schools, especially in the science subjects: the Comprehensive Project to Develop Curricula and the computerisation of science laboratories in secondary schools. However, the success of these initiatives is measured also by addressing issues of integration to achieve planned outcomes.

Evaluation of the ICT Programs. Participants were queried regarding the means by which these programs are monitored and evaluated. They said that, after initial piloting and integration, monitoring and reporting on the efficiency and productivity of the programs was determined by ICT supervisors during their visits to schools.

Interviewee 2 noted that the majority of the Ministry’s projects were in use and assessed before they were imported into Saudi Arabia: “We know that most programs and projects for integrating ICT into education were successful because they were evaluated in

other countries before their introduction to the Saudi educational system”. Interviewee 2 also referred to the mechanism adopted by the Ministry for monitoring its programs:

The Ministry of Education monitors and evaluates its ICT projects through visits to relevant schools, and written reports by education administrators on the progress of their work. Also, the Ministry encourages researchers to undertake evaluative studies on the programs and projects related to integrating ICT into education.

Interviewee 5 reported that, due to the high cost of specific program evaluations, the Ministry depended on its administrators and ICT supervisors to act as monitors: “in Jeddah, monitoring ICT projects is based on the visits of ICT supervisors to schools”. However, the participant was not convinced that this was a satisfactory solution to the issue, especially as there were insufficient ICT supervisors in different technical specialisations: “There are only three school laboratories supervisors to oversee and respond to issues in the laboratories at all governmental and private schools at the intermediate and secondary levels, which covers more than 400 schools”.

Interviewee 6 agreed with Interviewee 5 regarding the shortage of ICT supervisors in girls’ education in Jeddah:

In Jeddah there are no special programs to evaluate the ICT integration programs for the educational field, this may be because the process of evaluating such programs requires continuous follow up and field visits to schools for long periods of time during the school year. This is difficult for us now because of the limited numbers of female supervisors in this field.

Interviewee 3 agreed with the other participants: “I have not heard of any such studies carried out previously to measure the role or the impact of the teacher of the process of integrating ICT into education”. It is for this reason that Interviewee 3 believed there were no accurate programs for follow up and accountability; there was no specific projects to evaluate the ICT plan or the component projects.

The interviewees reported that programs that foster ICT integration into Saudi education initially were those for hardware and networking in computer and science laboratories in secondary schools, then intermediate schools. Inadequate internet services were an issue; another was the practice of taking global software and programs and setting them in the different context of the Saudi Ministry of Education and its centralised administration. This was being addressed by tailored software for which there was extensive training for users. However, at this stage, there was no monitoring of ICT integration in the science curriculum or teachers’ use of ICT, nor were they compelled to undertake training.

5.2.3 External Issues for Integration ICT Programs

After discussing ICT programs and the issue of evaluation of the Ministry's ICT agenda, the interviewees were asked their views on issues that may impede the integration of the schools' ICT projects. These are presented as separate subsections to fully explore the implications of any identified issues or barriers that may arise.

The structural and operational issues impacting the integration of ICT into education were many and varied. The interviewees nominated insufficient systems, equipment and support, configurations of school buildings, inadequate finance, lack of communication and coordination between educational administrations and boys' and girls' agencies, and management issues.

ICT Systems. Participants nominated inadequate school computer hardware and software as a primary obstacle in implementing ICT programs. Further, participants regarded this situation as ongoing, due to the large increases in class sizes. Commenting on difficulties in providing adequate ICT equipment in both girls' and boys' schools, Interviewee 3 said "the Ministry of Education is equipping primary and intermediate schools with computer laboratories, and has now provided about 10 per cent of schools nationwide". Interviewee 5 gave the example of the lack of computer laboratories in boys' schools in Jeddah, noting that "at present in the Jeddah region only 20 per cent of primary schools (grade one to grade six) have a computer laboratory, whilst 50 per cent of intermediate schools now have computer facilities". Interviewee 6 also discussed the shortage of computer and allied equipment in girls' schools. She was emphatic that the current level of ICT projects for girls' schools was inadequate to address education goals and made it clear that modern technological equipment for girls' education is highly recommended and should be readily available.

Interviewee 3 and Interviewee 5 both highlighted the shortage of software programs necessary to enrich the school curricula. The internet was not available at many schools and the study participants discussed this issue, for example: "the internet connection at Learning Resources Centres is very limited despite some attempts between the Ministry of Education and the communication company to provide internet services to Learning Resources Centres" (Interviewee 3). Interviewee 4 and Interviewee 1 agreed that sufficient equipment and resources were not available at many of the schools visited. Teachers' training, discussed in the next section, frequently involved equipment that differed substantially from that available

at their schools; further, Interviewee 4 said, there was insufficient support for them to master the software and hardware configurations. For example, Interviewee 4 commented:

During field visits and observations . . . I noticed that some presentation equipment, such as overhead projectors and internet connections, were not available at many schools.

Interviewee 5 referred to inadequate ICT resources at both boys' and girls' schools, stating that student population increases made it very difficult to maintain adequate coverage, particularly in Saudi cities:

There are some schools in the large cities such Al Riyadh and Jeddah with over a thousand students, with just one or two computer laboratories each. In ICT-based classes, students may have to share a computer. The ratio of students to computers overall is very low.

Shortages of ICT equipment, software, and technical support, and lack of adequate internet access were the serious concerns for the interviewees. These resource concerns were largely due to finance, which is examined in the next section.

Financial Constraints. The majority of the study's participants reported that integration of ICT in boys' and especially girls' schools is slow due to lack of finance, given the high student populations, the large number of schools, and the cost of ICT equipment. Interviewee 3, an interviewee from Riyadh, noted that the Ministry planning may have been a factor:

Perhaps those responsible for the budget in the Ministry of Education felt that the annual financial allocation was adequate to support the integration of technical programs, but in reality ICT equipment such as computers and their laboratories are very expensive, especially when your objective is to make them available to all schools.

Interviewee 2 also commented on this issue regarding the "large number of boys' and girls' schools in the Saudi education system (requiring) a substantial sum of money, or disruption to the ICT programs". The interviewee added that

... as a result, the Ministry of Education unfortunately often divides the ICT projects into several years or several stages according to available finance, for example in the first phase funding covers 15 per cent of primary schools and 25 per cent of intermediate schools, in addition to 50 per cent of secondary schools.

This aspect of project implementation is symptomatic of the difficulties in resource acquisition, as ICT, population, and thus regional needs may differ sharply from original estimates after several years.

Interviewee 5 also believed that insufficient financial support was an issue, especially with the increasing number of schools and the increasing financial costs of providing infrastructure related to ICT. The interviewee continued:

By the end of 2007 Jeddah Education had 148 Learning Resource Centres in their schools, however, still more than 60 per cent of government schools were without an LRC; to place centres in all the government schools in Jeddah City, we may need another ten years.

Interviewee 1 and Interviewee 4 noted that whilst funding was an obvious concern for hardware and software programs, that internet provision was also costly, and in many cases, had poor coverage. Consequently the majority of Learning Resources Centres did not yet have the internet.

The financial constraints experienced by the Jeddah administration were acknowledged by interviewees from the central office, and from Jeddah's office. This may have been due to underestimation of the rate of growth and the high cost of ICT to upgrade older schools' equipment and to furnish the new schools, rented and purpose-built.

Administration. The study participants reported that a further factor that delayed the ICT integration was frequent changes in administration and the complexity of routine procedures. This caused wasted time and resources throughout the education system, and impacted on rising costs of ICT. Interviewee 5 said that during the last two years, the Ministry of Education had three administrative restructures, the most recent resulting in two agencies, one each for boys' and girls' education. Each agency was independent, with its own plans, funding, and employees Interviewee 5 said, continuing that: "administrative restructuring in the Saudi education system of course causes a great deal of confusion and disturbance for different administrations and departments in the educational regions".

Interviewee 4 and Interviewee 1 confirmed the frequent restructuring during their interviews:

In the new administrative structure of the Ministry of Education, there are two offices for General Administration of Educational Training, the first of which is responsible for designing training programs and training male supervisors and teachers. The second General Administration of Educational Training is responsible for designing training programs and similarly training female supervisors and female teachers (Interviewee 4).

As an example of this full division of resources, Interviewee 1 confirmed that the organisation that Interviewee 1 was employed by, the Administration of Boys' Education in Jeddah, was responsible only for boys' education and all programs and projects related to integrating ICT into education, such as infrastructure and training programs are directed to

boys' education and male teachers. Further, there was a lack of coordination between the supervisor and the training groups on addressing aspects of teacher evaluation, regarding training courses such as ICT aspects:

these administrative divisions are challenging; for example the follow up on the trainees and the effects of training programs on their teaching has been very limited because of insufficient coordination between the Administration of Educational Training and the Administration of Educational Supervision, which is supposed to be responsible for the process of teacher evaluation in the educational system.

Whilst there was duplication of all resources through the gender divisions, there were also issues within the hierarchy of boys' and girls' administrations. Education supervisors were subject-specific, such as science, and were responsible for addressing quality issues and offering assistance to teachers. ICT integration into the science curricula could be addressed through this line of responsibility; however, all schools did not have the same ICT resources, and, as noted, teachers were not required to take training. This perceived inability of the Ministry to manage the change process, in particular for the two gender-based bureaucracies, is the subject of the next section.

Approval Processes. Participants highlighted the complex and centralised approval process for new training courses. They noted that the procedure involved distribution of printed forms to regional educational supervisors to identify training needs, and on this basis the Ministry determines and produces all teacher training curricula for all subjects, including the ICT training programs. These courses are then available, without any modification, to be delivered throughout the country at teacher training centres. This procedural aspect controls the nature and objectives of the courses, the curriculum and course materials and the courses are delivered without further regard to location, population, or any further dimension or variable. There is little opportunity for teachers to contribute to Ministerial policy or procedures

Communication Issues. In addition to the restructures, participants reported that the coordination between the departments of the Ministry and between regional administrations was inadequate. Interviewee 2 gave the example of the lack of coordination for the LRC project between the different departments of the Ministry of Education: "as a result of this lack of coordination between departments relating to the provision of services, there are many Learning Resources Centres without internet access and which lack staff numbers". Interviewee 1 suggested that "if the Ministry of Education set out the functions of each

administration and department, and the relationships between all of them, perhaps we could get better results regarding the integrating process and avoid inappropriate ICT wastage at schools”.

Study participants commented that the girls’ schools ICT projects increased after the integration of girls’ and boys’ education under the Ministry of Education. Interviewee 5 and Interviewee 6 reported that there was some coordination between boys’ and girls’ education representatives for some technical matters, such as the exchange of educational experiences and technical specifications:

There is some cooperation and coordination between the two agencies dealing with boys’ and girls’ education, but it is limited to the exchange of consultants and curricula. However, coordination between boys’ and girls’ agencies does not reach the planning level (Interviewee 6).

Interviewee 6 continued that better coordination among different administrations and departments was urgently required, for example, there were often instances of inefficiencies and wasted resources with the many different ICT projects: “if there had been some coordination, the benefits would have been greater”.

Inadequate communications, the majority of participants stated, was symptomatic of issues that arose from the last administrative restructuring of the Ministry and that created a barrier to extracting efficiencies and performance from ICT integration. A single responsible agency for boys’ and girls’ education would save much time, effort, and money in terms of ICT integration.

Technical Support. During the interview Interviewee 3 mentioned that substantial technical support and software were required to achieve a successful outcome in ICT integration. The interviewee commented there were insufficient technicians and specialists available in computer laboratories to cover even basic requirements: “we are forced to postpone some of our projects until the required human resources become available”.

The view that technical and operational training were insufficient to fully exploit ICT was supported by Interviewee 2, who stated that insufficient resources were allocated for LRCs. Interviewee 5 also addressed this issue:

Jeddah education also suffers from the lack of technical personnel; for example only three school lab supervisors are available to monitor laboratories at all governmental and private schools at the intermediate and secondary levels, which numbers more than 400 schools.

In summing up, it seems that technical support from ICT projects was specific to the contractual period, so that ongoing support for ICT maintenance and user assistance was minimal. This aspect was an adverse outcome for the Ministry's successful integration of ICT in to the intermediate science curriculum, as well as the professional training for teachers.

Rented School Buildings. There are two types of public school buildings in the Saudi educational system: purpose-built and rented. All participants stated that rented buildings, usually intended for residential use, were inappropriate as classrooms and certainly did not adequately support ICT. Interviewee 1 was particularly pessimistic about the situation in Jeddah, where there were a greater proportion of rented buildings: "in most cases, the classrooms of such schools are too small to accommodate the infrastructure needed for such ICT". Interviewee 5 concurred: "Rented school buildings mean that only small areas are available for the classrooms and the infrastructure required for computer laboratories and internal networks". The data provided by Interviewee 6 was similar:

A large number of rented school buildings for girls are not suitable for the introduction of ICT infrastructure because their (classrooms) are too small, and it is too difficult to introduce computer laboratories or Learning Resources Centres into rented schools building.

Interviewee 3 explained that providing ICT cabling, power, and equipment for computer laboratories in rented buildings was proving to be difficult and expensive. Many older buildings required continuous maintenance, which impacted computer laboratories because of dust and the laboratories' equipment had to be frequently moved. Commenting on the nature of the buildings, Interviewee 3 summed up the situation:

This is because they were originally designed for residential purposes rather than educational purposes; the classrooms are too small to provide enough space for the computer laboratories infrastructure, making it difficult and even impossible to integrate ICT into education in such conditions.

The views of the study participants on organisational and physical issues to the integration of ICT in the Ministry's curricula were clear. The participants focused on six barriers: lack of infrastructure for ICT, shortage of finance, lack of cooperation between boys' and girls' education agencies, lengthy approval processes, lack of technical support, and types of school buildings. Of note, the Ministry was renting inadequate residential buildings for schools, a factor that is pursued in the discussion chapter.

5.2.4 Teachers' Issues

Teachers' attitudes to ICT were a systemic factor in integrating ICT in Saudi education. Whilst there were several substantive constraints to technological integrating reported by the interviewees such as organisational change, inappropriate school buildings and inadequate resources, the effect of unsuccessful project implementation and lack of a clear directive from the Ministry of Education resulted in scepticism by teachers for the outcome of any particular project. Teachers apparently tended to return to traditional teaching styles to fulfil the curriculum requirements and not place reliance on ICT.

These issues were directed to the study participants for comment. Whilst the interviewees strongly supported ICT integration in education to achieve world parity outcomes for students, they claimed that teachers' attitudes adversely affected ICT integration, despite the other constraints which were often marginal. This factor pertaining to teachers' attitudes is addressed in the following Chapter, 6.

Teaching Styles. The interviewees said that there was resistance of teachers to changing their reliance on book learning to ICT teaching styles. During school visits throughout the country, Interviewee 1 noted that there were some teachers who could not countenance any change in delivering the curriculum: "this probably arises from a lack of knowledge of the importance of teachers' professional development or from a fear of adopting modern teaching methods, such as cooperative learning". Interviewee 2 agreed: "a high proportion of teachers in Saudi schools might need more awareness than he or she has now to change his or her previous view and to overcome resistance to change". The participant discussed means to resolve this situation and concluded that further work was required of the Ministry to establish a priority for attitude change.

Interviewee 3 stated that there was a definite need for formal programs to change the mindset of officials and teachers:

If a teacher is sufficiently convinced of the importance of integrating ICT into education and has a suitable environment—good educational content and curriculum—he or she will be encouraged to integrate ICT into education".

Interviewee 6 agreed with Interviewee 3: "the most serious problem is that many ... teachers do not have the desire or motivation to integrate ICT into the educational process, especially those with more than 15 years of occupational experience".

In this case, the majority of interviewees considered that teachers' attitudes were crucial in integration of ICT into education. Teachers' attitudes are considered in the discussion chapter (7).

Resistance to Change. The attitude of some teachers against the use of ICT was reported to be a contributing factor to the Ministry's mixed results in integrating ICT into the curricula. Interviewee 2, Interviewee 5, and Interviewee 6 stated that further work was necessary to address barriers that sceptical teachers raised against computerisation, that some officials and teachers remain unconvinced of the benefits of ICT in the classroom, and educational officials and teachers in some case were not aware of the Ministry's intentions to use ICT. An interviewee commented that:

Many female teachers greatly need to change their attitude toward utilising ICT in the educational process. If they were convinced of the importance of integrating ICT into education, they would seek . . . (the required) skills (Interviewee 3).

Interviewee 1 agreed with Interviewee 3, observing:

If we managed to convince teachers of this ICT's importance for achieving their objectives and showed them that it saves time and effort and improves the quality of education, they would accept it and try their best to integrate ICT into the educational process . . . if the teachers did not realise the importance and benefits of integrating ICT into the teaching process, they might consider it an obstacle that wasted their time or as an educational luxury.

Interviewee 3 noted also that, as the educational officials involved were administrators, more resources were required for non-teacher awareness programs if the attitudes of officials for girls' schools were to be changed.

In agreeing with Interviewee 1 and Interviewee 6, Interviewee 3 offered the observation that publications on ICT in curricula were generally issuing instructions, guidelines, and even precautions for misuse of equipment. There was no promotional material that set out the advantages of computers in opening up opportunities for students to pursue their own learning experiences

Again, the observations of the study participants on teachers' attitudes to ICT integration were clear. Teachers' attitude as a factor in adopting computers comprised resistance to change in teaching style, and a distrust of ICT to deliver the curriculum. These views were those of Ministry policy makers. Chapter 6 presents teachers' views in this regard, and the discussion of this study is presented in Chapter 7.

5.2.5 ICT Integration Planning

Extant research emphasises the advantages of a coordinated strategy to integrate ICT in an organisation, particularly necessary for complex structures such as education (see sections 3.2, and 3.3). When discussing issues impacting ICT integration, study participants noted that a strategy was necessary to implement ICT; a focussed program to achieve attitude change in staff was urgently required, Interviewee 4 stated, teachers needed to be aware of new tasks and of the need to utilise ICT in the educational process. Interviewee 1 agreed with this view, adding that all Ministry staff should be involved:

A comprehensive national plan is needed to raise teachers' awareness of their new roles and tasks, to encourage them to develop their occupational skills and performance, and to change their attitudes towards integrating ICT into schools and that suitable training for both male and female teachers can be achieved through professional development programs that develop their occupational skills to use modern ICT, and to remove psychological barriers.

To be successful, an ICT integration strategy should include objectives, expected outcomes, and due dates for the various ICT programs. Views were sought from the interviewees about the current ICT integration plan and to what extent its objectives had been achieved. Participants had different responses; some confirmed the existence of a comprehensive national plan and some had not heard of any plan to integrate ICT in the educational system. Interviewee 2, in the Ministry of education, stated:

there is an upper-level committee at the Ministry of Education for the integration of ICT in education; most departments in the Ministry of Education are involved in it, such as the Centre for Information and Computers, and the Administrations for Developing Education and Learning Technology, Educational Development, Educational Supervision, and Curricula.

This committee was responsible for planning the integration of ICT into boys' and girls' curricula. This was part of "the National Plan for ICT" in the Kingdom.

The National Committee for ICT formulated a National Plan to integrate ICT into almost all aspects of life in Saudi Arabia, Interviewee 3 confirmed. Members of the National Committee represented all ministries, and the task of the committee was to prepare a comprehensive ICT plan for all governmental agencies and institutions. Interviewee 3, Riyadh, added that:

there is an educational plan at the national level that contains the general strategic guidelines of education for the next ten years, one of its objectives is to utilise and integrate ICT into education . . . The ten-year plan for the educational process is

considered to be the first published plan; it is available on the Ministry's web site. The process of raising teacher capacity, such as the levels and skills of teachers is crucial to integrating ICT into education.

Interviewee 5 noted the effect of the ICT strategy on boys' schools in Jeddah:

Our role at the Administration of Education Technology in Jeddah regarding the integration of ICT into education is confined to specifications for the infrastructure (and equipment) for all public schools; to provide for the . . . needs of schools from the ICT budget in the Jeddah Region; and to follow up and supervise the preparation of ICT infrastructure, such as LRCs, computerised laboratories, and the Technical Halls projects; also to participate, as much as possible, in ICT training programs at the Educational Training Centre.

On the other hand, Interviewee 1 reported that there was no general plan to integrate ICT into education in the Jeddah Educational Region; however, each administration or department worked individually towards its own goals:

The Jeddah Education Region still needs to prepare awareness plans and programs for society in general, and for teachers in particular, to explain the importance and the role of ICT in teaching and learning process.

Issues in Implementation. Interviewees' comments on the ICT integration strategy varied, some related to the objectives of the plan, and others to its programs. Interviewee 3, for example, was critical of the Ministry's ten-year plan: General Plan for the Development of Education in Saudi Arabia; the objectives are general, vague, and inaccurate. This view is shared, as the 2004 to 2014 plan was established years ago, and has not been updated to reflect ICT or curricula development over time. Further, other pedagogy and economic developments intervened, rendering part of the ten-year plan irrelevant. Interviewee 3 explained this stance:

- There (is nothing) in the general plan regarding the projects or programs for integration of ICT. In other words, I do not know if (any particular) project is included.
- The objectives of the ten-year plan for integrating ICT into education are aspirational and vague. For example, one of its objectives is to raise skills of the teachers in terms of (pedagogy and ICT) through training programs and courses. In reality, the Educational Training Centres at the administrations that carry out such programs and courses cannot manage the large numbers of teachers who wish to attend.
- The Ministry does not know if educational administrations in different regions

have detailed plans to integrate ICT into their schools because they do not submit their plans.

Interviewee 3 then referred to confusion in objectives and outcomes among the Ministry's various consultants and contractors:

Each new work team that comes to the Ministry of Education or to the regional administrations has its own specific plans, visions, and attitudes; every team believes that its suggestions and solutions are the only suitable ones, does not accept other ideas, and ignores all plans, projects and efforts of previous teams.

Interviewee 1 agreed with Interviewee 3's views, and referred to the unrealistic nature of the Ministry's plans:

(They) tend to form idealistic and impractical objectives, for example most statements refer to broad goals, such as providing a computer for each student, or schools without books, or the digital curricula. In most cases, however, such projects do not succeed simply because they are impractical.

Interviewee 5 commented on the ten-year plan and said that many of the programs and projects to integrate ICT started with significant support from the intended recipients but the initiatives did not gain enough support from agencies at the ministry level, especially after changes in leadership:

Most the integration ICT plans or the projects for integrating ICT into education at the Ministry of Education levels are not considered to be national plans or projects; rather they are viewed from a personal perspective. So, the integration ICT plans or the projects may dissipate once the director or manager leaves his or her office. This may cause a great deal of wasted resources and delays in the process of integrating ICT into Saudi Education System.

Interviewee 6's view that "the process of integrating ICT into education in KSA is going slowly compared to the worldwide information explosion, in spite of the remarkable effort made by the officials responsible for the educational process". Moreover, an interviewee agreed with Interviewee 5' perspective, commenting that it was not known whether or not a given programs are parts of the general plan to integrate ICT into education:

I do not know if there is a plan to integrate ICT into education at the Administration of Educational Development for Girls' Education in Jeddah. However, the Saudi Education System is in great need of a comprehensive national plan to raise awareness of teachers regarding the new roles and tasks, to encourage them to develop their occupational skills and performance, and to change their attitudes toward integrating ICT into the education and learning processes.

Interviewee 4 stated that accurate and clear objectives that can be measured and evaluated were necessary in the Ministry's ICT plan; and that responsibilities for achieving those objectives should be allocated to evaluate performance: "as far as I know, there is no scientific research to determine the skills that must be acquired by teachers to integrate ICT into education".

Further, Interviewee 1 mentioned that there was no monitoring to evaluate the effects of ICT programs and integration projects; this was due to many reasons, such as the availability of specialist evaluators; no databases to either monitor ICT equipment in school or teachers' ICT training. A responsible entity within the Ministry should act as policy administrator to coordinate the various Ministry departments in delivering ICT outcomes: procurement, training, integration, and maintenance.

The interviewees' perceptions on issues in integrating ICT in education were that the Ministry's intention was not well communicated and objectives under the ten-year plan unclear. The lack of project monitoring and bureaucratic changes contributed as issues that impacted full integration of ICT.

Seeking Teachers' Views. Interviewee 6 and Interviewee 1 emphasised that the teacher must be an effective partner in all plans, programs, and projects to integrate ICT into the educational process; simply, teachers implement the plans. At the very least, teachers require input to establish ICT requirements for their classes and to request appropriate training. However, Interviewee 6 and Interviewee 1 reported that teachers implement instructions according to the Ministry's plans. There is no input or feedback from the teachers on the relevance, efficiency or outcomes of the plan.

Similarly, Interviewee 3 and Interviewee 2 believe that the Ministry of Education does not appreciate the role of the teachers in ICT implementation, and that the Ministry of Education focuses on infrastructure and equipment supply. Interviewee 3 added,

I think that teachers . . . do not participate in the formulation of integration of ICT plans; also the Ministry of Education did not carry out any studies to measure the role or impact of the teacher on the process of integrating ICT into education.

Although teachers' cooperation was central to implementation of ICT, they were not consulted on ICT integration, nor were they accorded the opportunity to contribute to the education debate. This is discussed further in Chapter 7.

5.2.6 Summary

The study participants returned often to the need for a coordinated national strategy to implement ICT objectives. Given an appropriate strategy, a detailed plan that is subject to monitoring, feedback and adjustment when circumstances change should, in their opinion, also include the objectives for successful implementation of ICT in Saudi education. Once objectives are established, then performance elements include establishing ICT requirements through the teachers, supplying equipment, training and supporting teachers and students, monitoring and continuing training.

Participants' views on the progress of ICT implementation in Saudi public schools were clear, and can be summarised thus:

- the goals in the ten-year ICT plan are broad and aspirational; the plan lacks definition through targets and performance elements;
- the ICT project material purchased by the Ministry is international and is not adequately interpreted and prepared for Saudi use;
- as there are no detailed preparation or implementation plans, such plans are difficult to bring to fruition in schools;
- funds for the larger plans are spread over more than one year, thus the initiative is not available in its entirety for some years; therefore its impact is muted and its objectives rarely fully realised; and
- frequently, ICT projects relate to equipment and infrastructure supply, without sufficient attention to explaining the advantages of the ICT to prospective users, or focusing on training and support.

Factors that affect integration of ICT in Saudi education, relate to the ICT requirements, such as its availability and technical support, and other factors that depend on teachers' support. The next section will present the responses of the participants regarding the issue of teachers' professional development and its importance in the process of integrating of ICT into the Saudi education system.

5.3 Professional Development

The study's interviewees emphasised in the importance of professional development for teachers to underline successful integration of ICT. This section discusses the views the

participants in relation to teachers' training and development, and the Ministry's programs for male and female science teachers to increase their pedagogical and ICT skills. The participants' observations in regard to training and development issues are noted. Finally, the participants' information on relevant factors that may assist in the process of integrating ICT in the Saudi education system is presented.

5.3.1 ICT Standards and Training

Professional standards for teachers were the subject of discussion at section 3.4.1, where teachers' development was mandated to ensure that teachers remained committed to best practice pedagogy to ensure the best outcome for students. Several aspects of this aspirational role are discussed in the following section: teachers' roles, their attitudes to ICT, pedagogical and ICT competencies, and their professional development.

Evolution of Teachers' Roles Among the participants, Interviewee 4, Interviewee 2 and Interviewee 5 focused on the changing role of the teacher, as they believed that the integration of ICT into education contributed significantly to this change. Interviewee 4 said that with technological development, educational concepts were changing and new approaches and methodologies were emerging. As a result, the role and thus the classroom practices of teachers also altered. The interviewee found fault with many Saudi teachers who did not accept this change and avoided using ICT in their classes.

This generation of students can be called the ICT generation, Interviewee 2 stated, as the greater majority use ICT, although many of their teachers do not, or will not. There was thus a substantial difference in ICT skills between teachers and students. Interviewee 2 opined that the teacher who was not able to effectively employ ICT in the classroom would not be able to deliver the curriculum in the near future.

In agreeing with Interviewee 4 and Interviewee 2, Interviewee 5 said that it was notable during school visits that certain teachers were unable to comprehend their changing educational role. The teacher now becomes a guide to the student, supervising and directing students toward information and learning. Interviewee 5 explained that teachers must be able to access educational sources, such as programs, scientific encyclopaedias, and the internet. To achieve ICT competency for this new role, they must be provided with appropriate pedagogical development opportunities. Interviewee 3 noted that many computer teachers do not utilise computer laboratories as required; teachers complained of their classroom hours,

and others, especially in rural areas, did not accept that computer laboratories were necessary for the new teaching role.

Attitudes to ICT. Interviewee 5, Interviewee 1, and Interviewee 6 focused on teacher attitudes to ICT as a reflection on the need for professional development. Interviewee 5 and Interviewee 1 reported that there were some schools that had good ICT equipment; however, even in well-equipped schools, there were many teachers who shunned computer laboratories, unable to comprehend the ICT. Interviewee 5 and Interviewee 1 believed that teachers' professional development was an important pathway to address this attitude and to enable such teachers to gain familiarity with ICT.

Female teachers in particular were adverse to ICT. The woman Interviewee explained that many female teachers were in great need of changing their attitude towards teaching with the aid of ICT. In particular, those who had been teachers for some decades would not countenance ICT to deliver the curriculum. The Interviewee offered the opinion that they were not convinced of the benefits of integration of ICT in the teaching process, or they had psychological barriers to the use of ICT in education. They therefore required extensive professional development in both the changing role of teachers, and to enable them to use ICT in the learning process.

Pedagogical and ICT Competencies. The majority of the participants agreed on the importance of teachers' ICT skills and that continual training and development were crucial for the teaching profession to improve not only pedagogical skills, but also technical skills. Interviewee 1 said that teachers must not neglect their pedagogical skills and provided an example, stating that there are many other professionals who are also dependent on ICT, such as doctors, engineers, and pilots; as such, successful teachers are noted for their ability to integrate technical skills with pedagogy. Interviewee 6 also highlighted the importance of the pedagogical skills of teachers:

teachers have to be able to plan their lessons according to the methodology of integrating ICT into education, be able to control the class, encourage students and increase their motivation, identify individual differences, and also acquire the skills of educational evaluation.

Interviewee 1 expressed surprise that until recently there were a large number of teachers who lacked ICT literacy:

I really am astonished to find in the ICT age many teachers and administrators still suffering from technological illiteracy. I think many teachers do not desire to use ICT

in their teaching because they do not realise its benefits or because they may lack the necessary ICT skills to do so.

Interviewee 2 and Interviewee 5 concurred that, although many schools have comprehensive ICT resources, the majority of teachers did not have the skills required to integrate ICT into the educational process. They suggested that teachers' professional development as a means to raise the pedagogical and ICT skills of the teachers and to increase their confidence in using ICT in the curriculum.

As noted, study interviewees considered teachers' professional development crucial to the successful integration of ICT to achieve educational reform. The continual reliance on training and development arises from the changing role of teachers, teachers' attitudes, and sometimes sub-standard pedagogical and ICT skills. These matters are discussed in chapter seven.

Training and Development Programs. A critical skill for teachers in the digital age is that of accessing information and programs to deliver a curriculum, Interviewee 1 opined. To deliver their classes professionally, teachers must be fully conversant with educational ICT and their peripheral equipment, software, and the internet. Interviewee 2 said that whilst a national set of professional standards for teachers was being pursued, there were as yet no standards which Saudi teachers were obliged to attain.

Short training sessions were available for Microsoft programs: Word, Excel, PowerPoint and e-mail, Interviewee 5 noted. There was a course for the design of websites. Interviewee 5 said there were other basic skills training concerning computer operation and maintenance. Beside Microsoft programs, teachers were required to make presentations which required copying and photo processing to prepare educational materials. Interviewee 6 agreed with Interviewee 5 that teachers have to acquire basic ICT skills to utilise modern educational ICT. Further, teachers must be familiar with different educational sources, such as programs, CD-based materials such as encyclopaedias, and the internet. Interviewee 3 confirmed these skills and said that international pedagogy standards demanded that teachers

be computer-literate; this could be confirmed through certification, such as IC3⁶ or the first level of ICDL⁷, which should be minimum standards for all Saudi teachers.

There were no specific science-based ICT training programs as they were usually focussed on generic keyboard and software standards for teachers of all subjects. The participants knew of few ICT training programs directed to science teachers (see a secondary school example below).

There are, however, full training programs available for supervisors and teachers. Interviewee 4 said that the Administration of Educational Training at the Ministry of Education designed and implemented two types of training programs. The first type was the comprehensive educational supervisors' course available at the Ministry's central training facility in Al-Riyadh. The second type referred to teacher training programs which were delivered in the 42 educational training centres throughout the country. ICT training programs were available in all locations. Interviewee 4 reported that the Ministry of Education had many training programs for integrating ICT into the teaching process. Examples include:

- “Partners in Education”. A substantial Ministry program commenced in 2007 in partnership with Intel to train 30,000 teachers to integrate ICT into public education (see section 2.6.1).
- Computer Illiteracy Eradication. This five-year computer literacy program commenced in 2006 and aimed to raise Saudi teachers' basic ICT competencies.
- Computerised Science Laboratories. Computer laboratory supervisors and science subject supervisors (chemistry, physics, and biology) were trained to pass on their knowledge to science teachers.
- Computer Laboratory Technicians. This was a training program for technicians in primary and intermediate school computer laboratories. On graduation, they worked at the schools and prepared students' and teachers' training kits and assisted teachers for all subjects to use the laboratories. The program was on-going; during its first year, 1,700 computer- laboratory technicians were trained throughout the Kingdom.

⁶ IC³ is a US certification program for digital literacy skills for basic computer and internet use.

⁷ ICDL is an international standard in basic computer competence achieved through testing. It provides a performance benchmark for all employers.

From 2003, the Ministry of Education and Educational Training Centres substantially increased teachers' training, Interviewee 3 said, noting many ICT programs, such as training courses in computerised laboratories for science teachers at secondary schools. In agreeing with a Ministry emphasis on training, Interviewee 1 provided statistical information on Jeddah. In 2007 the Educational Training Centre for boys' education in Jeddah Region had 900 training programs, including 85 on ICT, and more than 17,000 training opportunities were provided to male teachers and administrators during the morning and evening periods. This extensive program was prepared in collaboration with universities and other training institutes in the private sector. The centre created a database for all training programs available during the school year to enable male teachers to choose suitable times to attend such programs. Interviewee 1 mentioned a two-year contract with Microsoft in Jeddah in 2007 to train 2500 male teachers to implement ICT at 80 boys' schools at both the primary and intermediate levels. Interviewee 1 explained that the objective of the Microsoft training program was to train teachers in advanced ICT skills to integrate ICT into the curriculum. This was also the purpose of the Intel program:

According to the program evaluators, the Microsoft training program was successful because its scientific content integrates both pedagogical and ICT skills to challenge teachers' attitude and interest them in using ICT in the curriculum.

Further, Interviewee 1 mentioned skills training in Microsoft Office as well as computer skills training such as maintenance and addressing software and hardware problems. There was also an agreement with Jeddah universities to provide advanced training courses for educational managers and supervisors.

In any new ICT program or project for ICT equipment, Interviewee 2 said, the Ministry began by training education supervisors so that they could train teachers. Interviewee 5 said the Administration of Educational Technology at Jeddah was interested in training staff in other ICT-related equipment also:

For example, when we wanted to provide digital cameras for all government boys' schools in Jeddah Region in 2001, we planned to provide them over a four-year period. The Administration for boys' education in Jeddah decided that each school would receive a digital camera and the school could send teachers to be trained in the use of such cameras, learning ways that the cameras could be used by teachers as aids for different classroom subjects (Interviewee 5).

Whilst there was little available in specialised ICT training for intermediate science teachers, availability of such training for secondary school teachers may lead to appropriate

professional development for intermediate teachers when funds become available, as implied by Interviewee 5.

5.3.2 Training and Development Issues

It was generally agreed among the interviewees that training and development for teachers as professionals was on-going and difficult. They discussed several issues regarding training.

Constraints to Access: Resources, Gender and Attitude. Participants mentioned shortages in the number of trainers, especially for ICT. Interviewee 3 said that, when considering the large numbers of teachers to be trained, the Educational Training Centres were under-resourced. The interviewee opined that it would take many years to achieve the Ministry's teacher training objectives without increased allocations of funding and trainer skills. Interviewee 1 and Interviewee 5 stated that there were separate issues for each Jeddah training facility; however, the common obstacles were limited educational training opportunities for the large number of teachers and too few trainers, particularly in ICT. Also, Interviewee 3 noted that there was even less opportunity for teachers in distant rural schools, who had to travel longer to attend training:

most education administrations have limited training programs, so they do not cover teachers working in village schools, so most of the teachers working in remote villages do not have the opportunity to attend such training and development programs, although they have computer labs in their schools.

The study participants agreed that male teachers have a greater opportunity to seek professional development than female teachers in Saudi Arabia. Therefore, women teachers required significantly more resources dedicated to in-house training than the men. Interviewee 2 and Interviewee 4 reported that male teachers are more skilled in ICT as boys receive ICT education at higher levels in their studies than girls. Interviewee 4 explained that there are wider ICT-based curricula opportunities available in boys' education. This occurred through the separation of the two administrations earlier, when ICT had a higher profile in the boys' curricula. The Ministry was working to achieve gender equity on an ICT curriculum which began only a few years ago at girls' schools. In general, ICT equipment and infrastructure were better at boys' schools than at girls' schools.

Despite private sector women's training centres in the larger cities such as Al-Riyadh and Jeddah, "girls' schools education administration in Jeddah City cannot make agreements with these private training centres to train female teachers like they do male teachers".

Interviewee 6 said that Saudi culture made it extremely difficult for women teachers to attend training programs outside their school, while the male teachers attend advanced training programs or conferences at any place and any time. However, she added “this does not mean girls education in Jeddah City do not implement training programs for female teachers”. Jeddah girls’ school administrators invite private sector female trainers to sessions, and encourage teachers to attend available training to develop their skills and knowledge and improve performance. The interviewee said that the majority of female supervisors are offered advanced training programs, have expertise in designing training programs, and they have quality trainers.

Interviewee 5 argued that male teachers have greater career opportunities as they can attend training and development wherever and whenever available, which is not the case with female teachers. Because of Saudi culture, female teachers are prevented from attending mixed gatherings without a relative, so that such developmental opportunities are denied them. Interviewee 5 said there should be a concerted effort to assist women to access training and development, so that they may pass skills and knowledge to the next generation of girls. Interviewee 1 also stated that boys’ ICT education was more advanced than girls’, simply because it began earlier and went longer:

an important difference is that educational training for male teachers takes place in the morning and in the evening, which is not the case for female teachers who cannot have training programs in the evening, add to that, the number of female teachers is larger than the number of their male counterparts.

Interviewee 6 reported that, unfortunately, training opportunities for female teachers were far fewer than those for male teachers, for many reasons. For example, female teachers could attend training programs during the morning period only, while male teachers have two periods in which to attend the training programs, morning and afternoon.

Nevertheless, Interviewee 1 said that the boys’ schools education centre in Jeddah was instituting a teacher training program after classes, as teachers were occupied in the morning at school:

It is too difficult to free them for training courses in the morning, but most teachers are unwilling to join such courses, especially in the afternoon, and maybe all Administration of Educational Training centres in other educational regions have this problem; this is due to the low incentive that teachers have to train in the afternoon.

Further, Interviewee 1 mentioned that Jeddah boys’ school administration used reports from the Administration of Educational Supervision to assess teacher performance in

the classroom, This assessment included the extent to which teachers were using ICT in curriculum delivery: “the Jeddah boys’ education centre intends to develop a database on teachers’ attendances at training programs, and link their occupational skills and knowledge files to that database”. This would be useful in future teacher performance assessment relying on further training.

This view was confirmed by Interviewee 2 and Interviewee 3, who were critical that each teacher decided whether training was required. They said that the General Administration of Educational Training did not determine whether a teacher was required to attend courses; this was strictly a decision by the teacher. Performance measures were put aside, if the teacher did not intend to pursue training and development, there was little to contradict that decision.

To determine the causes for the lack of enthusiasm to attend training courses, this point was raised in the quantitative data collection. The teachers’ responses are presented in chapter six and discussed in chapter seven.

Course Content. Training courses are either purchased through private sector providers or developed in-house. The tailored programs are diverse and inclusive of all topics, such as general training programs for Islamic teachers, mathematics teachers, and science teachers. Interviewee 4 added that “the Ministry designs the training plans and programs according to the objectives of its educational policies, bearing in mind that the teacher is the target”. Interviewee 4 continued that the Ministry requests supervisors to nominate their requirements through a standardised format, and then assesses needs from the replies received. Interviewee 4 noted that regional administrations are given the opportunity to design training to meet local requirements for teachers. Training and development courses for the specialised ICT requirements of Saudi teachers were not subject to rigorous assessment (Interviewee 4 and Interviewee 5).

A low technical content for training courses was a significant issue in training and development, Interviewee 1 said. The interviewee noted that there were insufficient incentives for trainers to provide quality programs or to prepare interesting and informative training aids for students. Trainers were generally educational supervisors who have some teaching experience and attempt to transfer their knowledge to teachers through those training courses. Interviewee 4 and Interviewee 5 also noted a low standard of training materials and delivery, saying that the Training Department of the Ministry of Education did not have a

quality perspective on ICT training. Interviewee 4 said that training aids prepared by the Administration of Educational Training to integrate ICT into education was an initiative of a project team drawn from Arab countries.

Inadequate ICT. After they receive training, according to Interviewee 4 and Interviewee 1, teachers frequently find out of date, inadequate, or insufficient ICT at their schools. The interviewees said that during field visits they noticed that ancillary equipment such as metering equipment, overhead projectors, and internet connections were not available at many schools. Interviewee 4 said that after training, teachers obviously required the appropriate equipment for use in their classrooms.

Summary of Participants' Further Observations

At the end of every interview the participants were asked for recommendations that may assist to integrate the ICT into Saudi education system or contribute to the development of male and female science teachers and encourage them to use ICT. These responses are summarised below.

The evaluation of teachers' performance, Interviewee 1 said, must include ICT competencies. Further, ICT should be integrated far earlier into a child's education: "I wish we could teach ICT as a basic element of the curriculum from the elementary stage; this might help students to raise the profile of ICT in Saudi society".

Interviewee 5 agreed with Interviewee 1 on teachers' performance upgrading, that it was a priority in the goal of teachers' use of ICT: "all programs for integrating ICT into education must be easy and simple to encourage teachers to adopt them; these programs also must be suitable for training teachers on all new programs and projects".

Focused on the issue of administrative gender differentiation, Interviewee 2 proposed unification of these departments and agencies within the central Ministry structure and throughout the regions. Other observations were:

- in part accord with Interviewee 1, Interviewee 2 said teachers' evaluations should be changed to concentrate on modern educational methods, such as cooperative initiatives that enhance the integration of ICT
- a system of awards should be initiated for teachers who integrate ICT into education as an example for other teachers; this can include both recognition and material components

- provision of awareness programs could change teachers' and supervisors' attitudes toward adopting ICT
- solutions must be found to obstacles hindering women teachers from attending training programs, and to provide suitable training environments for them
- provision of sufficient ICT knowledge and skills, such as experts, supervisors, and technicians.

There was an immediate need, Interviewee 6 agreed, to change teachers' attitudes toward adoption of modern educational methodologies, such as cooperative and constructive learning. For this, both male and female teachers need suitable training in ICT; this could be achieved by strong training programs to develop their occupational skills in the use of ICT, to remove psychological barriers, and to facilitate their use of ICT in the classroom. The interviewee continued that professional and material incentives were necessary to encourage teachers to attend training programs to raise their occupational skills. Of course, incentives must be available to male and female teachers who excel in the process of integrating ICT into the educational process.

The necessity for teachers' training was also emphasised by Interviewee 3. The participant stated that ICT will be an advantage only when teachers enjoy using their ICT skills, otherwise ICT will be a burden to both teachers and students.

After training, teachers must be able to utilise their skills using appropriate ICT at their schools, Interviewee 4 asserted, so as not to lose the skills they acquire through training programs.

5.4 Summary of the Interview Results

The overview of the findings was that the interview participants broadly endorsed integration of ICT into education, particularly the intermediate science curriculum, and they acknowledged the breadth and depth of the government resources that were committed to this end (Category 5.2.1: Significance of integrating ICT in schools' curricula). They agreed that ICT skill acquisition was critical for the education profession to impart appropriate skills and knowledge to students so that the next generation may meet the challenges of the future (Category 5.3.1 Professional standards). The interviewees noted the physical resources the Saudi government provided for ICT integration, such as the Watani Project, Learning Resources Centres, and Technical Halls. For science education, there were the

Comprehensive Project to Develop Science and Mathematical Curricula and Computerised Science Laboratories (Category 5.2.2 ICT integration programs).

The interviewees found that the ICT integration process in education was complex and many issues were raised: these included structural issues, such as misconceptions about the meaning or the objectives of the integration process; and operational: a concern regarding impact on interaction between teacher and student when computers are used frequently during class. The interviewees focused on structural issues: inadequate ICT infrastructure, equipment, and technical support; financial constraints; disparities in Ministry agencies based on gender differences. Further, rented school buildings created space problems (Category 5.2.3 External issues in implementing ICT in schools).

The interviewees remarked on the reluctance of teachers to embrace technology, to attend training, and teachers' substandard ICT skills (Category 5.2.4 Teachers' issues). The interviewees differed only occasionally in their views toward integration of ICT into the school curricula. For example, in discussions on the government's ICT strategy for Saudi Arabia, and to what extent its objectives were being realised in education, some participants confirmed that there was a national ICT strategy, including education; whilst others knew of no national initiative (Category 5.2.5 ICT integration strategy). However, all participants were critical of the uncoordinated and disparate means that the Ministry used to integrate ICT into education, especially as ICT integration was the driver to pedagogical reform. As another example, it was established that the outcomes of the various projects were not specifically monitored, except through the Ministry's general procedures using ICT supervisors (Category 5.2.2 ICT integration programs, Evaluation of programs).

Turning to professional teachers, male and female, the participants were in full agreement for ongoing and high quality training and development. This was emphasised by the changing roles for teachers from being the focus of the classroom to a role of assisting each child to learn (Category 5.3.1, Professional standards, Evolution of teachers' roles). The interviewees remarked on the reluctance of teachers to embrace ICT, to attend training, and most notably, teachers' substandard ICT and pedagogical competency standards (Category 5.2.4 Teachers' issues: Attitudes to ICT).

There were cultural, structural and operational factors impinging on teachers' attitudes and their career development. The participants noted that male teachers have greater developmental opportunities through their cultural ability to attend training courses or

conferences at any time and place, inside or outside school, in the morning or the evening, but female teachers are not provided with such opportunities (Category 5.3.2 Teachers' training issues: Constraints to access: resources, gender and attitude). Structural factors include the observation that training centres were gender separated organisations, and training courses were difficult to access for rural village teachers. There were generalised Ministry training programs at the centres, but none directed to ICT competencies for intermediate school science teachers (Category 5.2.2 ICT integration programs: Programs for integrating ICT in curricula, especially for science).

Operationally, interviewees spoke of inadequate ICT course content, trainers' skills levels, and perhaps their inability to cope with diverse workloads of supervision and training. Moreover, the majority of participants spoke of barriers that may impede teachers' course attendances: the limited number of training programs, lack of ICT infrastructure, and the technical level of the training programs (Category 5.2.5 ICT integration strategy: Issues in implementation).

Whilst this qualitative research informs the study on the perceived situation for ICT integration into intermediate science classes in Saudi Arabia, the results of the research form a valuable insight of the ability of the Ministry of Education to allocate sufficient resources in a coherent framework to address the challenges of modern pedagogy. Population pressures, insufficient numbers of knowledgeable and dedicated teachers and even substandard school buildings render this undertaking of modernising Saudi education extremely difficult. Whilst these factors remain for resolution in discussion in Chapter 7, Chapter 6 seeks to understand the results from the quantitative research, the Science Teachers' Questionnaire.

Chapter 6 Questionnaire Findings

The study's aim of investigating the integration of ICT into Saudi education, specifically in intermediate school science curricula, is continued with this chapter of data analysis. Earlier chapters sought theoretical grounding and environmental information about the Saudi education system and its status and the previous chapter was a qualitative analysis, exploring the perceptions and responses of Saudi education policy makers during interviews. This chapter reports on the quantitative data, namely the responses of a large number of male and female science teachers in Jeddah province by means of a questionnaire. The analysis in this chapter is based on intermediate science teachers' views on the Saudi education system. Jeddah is the country's primary port and, after Al-Riyadh, its largest city, so the data from this section may reflect the general conditions in Saudi Arabian education with regard to ICT integration, as argued in Chapter 3.

The first part of this chapter presents background information provided by the participants, followed by their reports on the ICT available for their use at school. Significantly, their account of data on ICT teacher training programs and attendances are next presented, whilst their reported teacher competencies in ICT, their knowledge and skills are interpreted in the next section to gain insight into their abilities in using this ICT effectively. This leads on to an investigation of the participants' attitudes toward ICT's value in the classroom environment and their usage of such learning resources. In the final part, there is a presentation of the issues that emerge from the quantitative analysis, which will be discussed in the following chapter.

6.1 Questionnaire Description

The questionnaire, described at section 4.3, is briefly summarised to assist the reader. In the first of the seven parts of the questionnaire, background information was collected through questions Q1 to Q10 to determine characteristics of science teachers and the nature of their work, such as gender, age group, experience, school location, and average number of students in the classroom. Information on the ICT infrastructure in the questionnaire participant's school was collected at Q11, including computer laboratories, computer networks, internet access, data projectors, and electronic microscopes in the science

laboratories. Questions 12 to 17 were devoted to teacher training programs: when and where training was held; the number of training programs the respondent attended in the previous three years, and barriers to attendance. The next question, 18, involved the teacher participants' self-assessed ICT skills levels, including using computers, installing programs, saving educational files, using text and spreadsheet programs, and using email. For Q19 science teachers' opinions were requested for 16 items on respondents' educational use of computers and the internet. The final question considered barriers to ICT usage, and examined the types of obstacles that hinder science teachers' use of ICT in the educational process.

The next section explores the characteristics of the teacher respondents.

6.2 Respondents' Characteristics and Environment

The demographic characteristics of the science teacher participants from the Jeddah region, their professional details, training and occupational information are explored in this section. These data give structure to the nature of Saudi intermediate schools in the Jeddah province, and the basis for secondary school and vocational training or higher education. Analysis is presented as frequencies and percentages.

6.2.1 Demographic Data

There were 646 questionnaires delivered to the Educational Supervision Centres for boys and girls in the Jeddah region, with 340 questionnaires returned and 311 (from 148 men and 163 women teachers) found to be complete (see section 4.4.3). This is illustrated at table 6.1 which presents the gender details of the participants. Hence there were roughly equal numbers of males and female participants in this part of the study, with the number of female respondents being slightly greater, which reflects overall teacher proportions in this sector.

Table 6.1

Teacher Participants: Gender

Gender	Frequency	Percentage
Male	148	47.6%
Female	163	52.4%
Total	311	100

These totals and percentages will be assumed in the following tables, except where the totals do not represent the entire group.

Age. The second question focused on the age of the science teachers. The largest age group for all respondents was between 31 to 40 years (195, 62.6%), with the smallest category of 4 (1.3%) respondents being aged 51 to 60 years. Table 6.2 shows that the second and third most-common age groups were between 41 to 50 years, and 20 to 30 years, respectively. Thus three quarters of science teachers were under the age of 41 years.

Table 6.2

Teacher Participants: Age Cohorts

Gender	20-30 years	31-40 years	41-50 years	51-60 years
Male	5.8%	28.6%	11.9%	1.3%
Female	6.7%	34.0%	11.7%	0.0%
Total	12.5%	62.6%	23.6%	1.3%

It can be seen that female teachers were more represented in the younger age categories, whilst the four respondents in the 51-60 years age group were men.

Education. Table 6.3 shows that the great majority of science teachers had a bachelor's degree, a total of 275 participants (88.3%). The smallest group had master's degrees, 15 participants (4.9%), whilst the remainder (6.8%) had diploma qualifications.

Table 6.3

Teacher Participants: Highest Educational Attainment

Gender	Diploma	Bachelor	Master
Male	3.9%	41.1%	2.6%
Female	2.9%	47.2%	2.3%
Total	6.8%	88.3%	4.9%

Experience. The participants were asked how many years they had been employed as a science teacher. Table 6.4 shows that the greatest number of participants, 187 (60.1%), had between 11 to 20 years of experience, while the lowest number of participants, 45 (14.5%), had more than 21 years experience. Thus nearly nine out of ten science teachers had less than 21 years' teaching experience. There is also a mild indication that male teachers are being

recruited more so than females, given the differing gender balances of 1-10 years' experience and 11-20 years' experience.

Table 6.4

Teacher Participants: Teaching Experience

Gender	1-10 years	11-20 years	21-30 years
Male	14.1%	27.0%	6.5%
Female	11.3%	33.1%	8.0%
Total	25.4%	60.1%	14.5%

As more women were under the age of 31 years (table 6.2), it appears that teacher transfers within the system, or the less likely explanation of expatriate recruitment account for the slight anomaly. Further, there is a slight preponderance of male teachers in the 11-20 years cohort.

Summary. Thus, the demographic data from the study participants showed that the science teachers were predominantly in their thirties, held bachelor's degrees, with less than 21 years' experience. There were a greater number of women teachers in the sample, with the largest group (34 per cent of the sample) being women in their thirties, but with none over the age of 51 years. Further, one third of the sample had from 11 to 20 years' experience, whilst women with bachelor's degrees comprised nearly half (47.2%) of the sample

6.2.2 Teaching in Schools

Participants' professional experience in their schools was the topic for the next set of questions. They were asked about the nature of their schools, and their working conditions.

Rosters. Q5 concerned the number of weekly classes for which each teacher was rostered. The school year in Saudi Arabia consists of two semesters, each of which is fifteen weeks long, thus seven and one half months per year is class work. The number of classes for teachers varies from 4 to 24 per week, each of which is 45 minutes in length (see section 2.2.4). Teachers work 40 hours per week. The participants' responses are depicted in table 6.5.

Table 6.5

Teacher Participants: Weekly Class Schedule

Gender	Scheduled classes per week					
	4	8	12	16	20	24
Male	0.0%	2.9%	1.6%	10.0%	21.9%	11.2%
Female	0.6%	1.3%	6.1%	21.9%	16.7%	5.8%
Total	0.6%	4.2%	7.7%	31.9%	38.6%	17.0%

As can be seen in table 6.5, male and female teachers differed on the number of hours they were rostered to teach each week, although the highest sample percentages were both at 21.9 per cent (68 teachers). However, the largest group of male teachers took 20 classes per week whilst the largest group of female teachers were rostered for 16 classes per week. One third of the sample was male teachers who were scheduled for 20 or more classes per week, whilst 38.6 per cent of the sample was female teachers who had 16 or 20 classes per week. Thus 70.5 per cent of all teachers were rostered for 16 or 20 classes per week.

Non-teaching Tasks. Training and development opportunities during work times were affected by teachers' workload. Class work includes preparation of the curriculum, and student assessment, and there are organisational matters such as meetings and religious breaks. However, the next query was regarding duties apart from those related to teaching, administrative tasks, for example (see table 6.6).

Table 6.6

Teacher Participants: Non-teaching Duties

Gender	Other tasks	No other tasks
Male	21.5%	26.1%
Female	30.2%	22.2%
Total	51.7%	48.3%

Table 6.6 shows that nearly one third of the sample were female teachers who had other duties besides their teaching tasks (94, 30.2%). Of the 148 male teachers, 81 (26.1% of the sample) answered that they had no other tasks.

Urban or Rural Location. Respondents were asked about their school locations to identify the proportion of participants within the city of Jeddah or in the outlying counties (see table 6.7).

Table 6.7

Teacher Participants: Urban or Rural Location

Gender	City	Rural
Male	40.2%	7.4%
Female	49.2%	3.2%
Total	89.4%	10.6%

Table 6.7 shows that the majority of respondents were from Jeddah City; nearly half the sample were women teachers from the city. Just 10.6 per cent of the sample was from schools in the counties of Jeddah.

Schools: Purpose-built or Rented. There are two types of public school buildings, government-owned or rented. The percentage of rented schools was higher than that of government buildings, as shown at table 6.8.

Table 6.8

Teacher Participants: Schools: Purpose-built or Rented

Gender	Purpose-built	Rented
Male	20.9%	26.7%
Female	25.4%	27.0%
Total	46.3%	53.7%

Table 6.8 shows that the majority of both male and female teachers, 83 and 84 respectively (53.7% of sample), taught in a rented school building. The implications of this for ICT usage will be addressed in the next chapter.

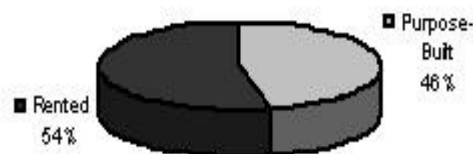


Figure 6.1 *Types of public school buildings*

Average Student Numbers. Answers to this question, the last in the section on background information, are shown in table 6.9. The average number of students in boys' and girls' schools was similar throughout; nearly 90 per cent of respondents averaged between 21-30, or 31-40 students in each class.

Table 6.9

Teacher Participants: Average Student Numbers in Class

Gender	Average number of students in class			
	<20	21-30	31-40	>41
Male	5.5%	23.5%	18.0%	0.6%
Female	5.1%	25.4%	21.6%	0.3%
Total	10.6%	48.9%	39.6%	0.9%

Table 6.9 shows that 23.5 per cent of the sample, 73 male teachers, said they averaged between 21 to 30 students in class, and 56 (18% of the sample) had 31 to 40 students as an average. Similar ranges for female teachers, 79 (25.4% of the sample) answered 21 to 30 students, and 67 (21.6% of the sample) said they had 31 to 40 students as an average number of students. Thus nearly half of the study's teachers (39.6%) reported high average numbers of students, which can influence ICT usage through resourcing students and space considerations.

Summary. The reports from the science teachers indicate that the greater proportion of women took fewer classes per week, 16; however, more women teachers than men had tasks unrelated to their profession. The greater majority of teachers worked in city schools, and over half were in rented buildings. Teachers also reported high numbers of students; particularly for men, where nearly one in five had over 31 students in their classes. These factors impinge on ICT usage for busy teachers in perhaps inappropriate buildings, and the questions regarding ICT availability are addressed in the next section.

6.2.3 ICT Infrastructure and Equipment

The objective of this set of questions was to seek information regarding the ICT resources available to teachers in classrooms and in the science laboratories. These resources include computer laboratories, computer networks, internet access, data projectors, and electronic microscopes in science laboratories. The purpose was to identify the equipment regarded as essential to the new forms of pedagogy, where the student accesses information

during the learning process (see section 3.3.1). Table 6.10 summarises the ICT resources in the schools as reported by the teachers. Further explanation follows in the sections below.

Table 6.10
Summary of ICT Infrastructure

Q10	Item	Gender	Yes		No	
			Freq	%	Freq	%
Q10a	Computer laboratories in your school	Male	83	26.7	65	20.9
		Female	77	24.8	86	27.7
		Total	160	51.4	151	48.6
Q10b	Computer network in your school	Male	40	12.9	108	34.7
		Female	50	16.1	113	36.3
		Total	90	28.9	221	71.1
Q10c	Internet access in your school	Male	51	16.4	97	31.2
		Female	88	28.3	75	24.1
		Total	139	44.7	172	55.3
Q10d	Computers in classroom	Male	15	4.8	133	42.8
		Female	14	4.5	149	47.9
		Total	29	9.3	282	90.7
Q10e	Data projector in classroom	Male	25	8.0	123	39.5
		Female	25	8.0	138	44.4
		Total	50	16.1	261	83.9
Q10f	Computers in the science laboratory	Male	26	8.4	122	39.2
		Female	31	10.0	132	42.4
		Total	57	18.3	254	81.7
Q10g	Data projector in the science laboratory	Male	33	10.6	115	37.0
		Female	59	19.0	104	33.4
		Total	92	29.6	219	70.4
Q10h	Internet access in the science laboratory	Male	4	1.3	144	46.3
		Female	3	1.0	160	51.4
		Total	7	2.3	304	97.7
Q10i	Electronic microscope in the science laboratory	Male	26	8.4	122	39.2
		Female	26	8.4	137	44.1
		Total	52	16.7	259	83.3

Note Total in each case of 148 (47.6%) males and 163 (52.4%) females, 311 (100%) science teachers

Computer Laboratories. When asked about computer laboratories at school, just over half the respondents (51.4%) said they had laboratories. The highest proportion without laboratories was women teachers (27.7% of the sample).

Computer Networks (Intranet). The great majority of participants had no local computer network in their schools. Table 6.10 shows that 71 per cent of the sample responded in the negative. The highest proportion of teachers with intranet access was women teachers, at 16 per cent of the sample.

Internet Access at Schools. Although the proportion of computer laboratories was slightly higher at boys' schools (27% of the sample) than girls' schools (25%), the percentage of internet access in girls' schools (28%) was more than boys' schools (16%). Table 6.10 shows that 172 (55.3%) participants did not have access to the internet in their schools.

Computers in Classrooms. A large majority of participants, 91 per cent, reported that they did not have personal computers in the classroom. This was slightly more evident with the women respondents, with 48 per cent of the sample (149 female teachers) without this resource (table 6.10). There were comments on the questionnaire that teachers used a laptop computer instead, which may explain why there were more data projectors than computers reported for classrooms.

Data Projectors in Classrooms Table 6.10 shows that data projectors were not evident in the classroom (84%). Whilst 8 per cent of the sample for both men and women (16% of the sample) answered in the positive, more women than men (44% and 40% of the sample, respectively) did not have this resource.

Computers in Science Laboratories. Again, a large majority of the respondents (82%) answered in the negative (see table 6.10). However, of the 18 per cent who answered that they do have computers in the science laboratories, 10 per cent were women teachers.

Data Projectors in Science Laboratories. More teachers reported that they had data projectors in the science laboratories at their schools, although there were still 70 per cent (219 teachers) who answered in the negative. In this instance, men teachers were again under-resourced, with 37 per cent of the sample (115 teachers) reporting that they had no data projectors (table 6.10).

Internet Access in Science Laboratories. There were very few responses in the affirmative to this question; 98 per cent of the sample replied in the negative. The positive replies were relatively even between male and female teachers (table 6.10).

Electronic Microscopes in Science Laboratories. Given the importance of using electronic microscopes in the science learning environment, the participants were questioned regarding the availability of an electronic microscope as part of the ICT infrastructure in science laboratories. Table 6.10 shows that there were few answers in the affirmative; 83 per cent of teachers had no electronic microscope in the science laboratories, and the remainder were relatively evenly split between the schools for girls and boys.

Summary. Whilst half the teachers had computer laboratories, the majority were not networked and half did not have internet access. In the classrooms, the teachers reported that the greater proportion did not have computers or data projectors. In isolated instances, there was evidence that these items were portable rather than permanent classroom fixtures. This pattern was repeated in the science laboratories, where respondents reported few ICT resources. Overall women teachers reported slightly better ICT resources in girls' schools than the men advised for boys' schools.

The next section reports on survey questions relating to teachers' ICT training and capabilities in the use of ICT resources in the teaching and learning environment.

6.3 Teacher Training and Development

Research findings underline the necessity for teacher training and development, particularly in the emerging ICT field. As well as skills acquisition, the integration of ICT into the curricula requires a realignment of pedagogy principles and practice (see section 3.4). The objective of the next section of the questionnaire is to discover the characteristics of training courses and development programs available to science teachers, compare their availability and attendances to training and development, and to seek their attitudes to such training. The first set of five questions requests details of training and development experiences from the respondents for the previous three years, as Ministry policy states that teachers must attend at least one ICT training program every three years. The second section contains ten items on issues regarding attendances, measured by a Likert Scale (see section 4.3.1). For analysis, frequencies and percentages are used.

6.3.1 Attendance

The first question concerned attendances at ICT training programs at any time during the respondent's professional career (table 6.11).

Table 6.11

Teacher Attendance at any ICT Training Program

Gender	Did not attend	Attended
Male	28.0%	19.6%
Female	27.3%	25.1%
Total	55.3%	44.7%

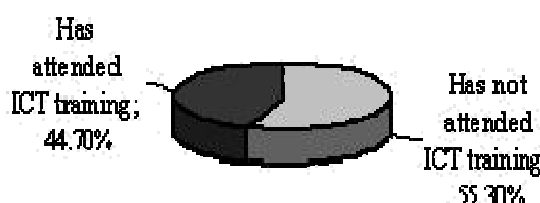


Figure 6.2 Teacher Attendances at ICT Training Programs

Table 6.11 shows that a majority of teachers had not attended any ICT training courses or development programs during their years of teaching (illustrated at figure 6.1). Of those who had attended, there were more women, 78 and a quarter of the sample, than there were men teachers, 61, or less than one fifth of the sample (19.6%). This statistic shows a low proportion of teacher accreditation or in-service training related to ICT, which is discussed in Chapter 7.

Training Courses Attended. For the 139 respondents who had attended any ICT training course, question four in this part addressed the number of attendances over the past three years (table 6.12).

Table 6.12

Selection of Teacher Sample: ICT Courses Attended in Past Three Years

Gender	Number of training courses attended			
	>6	4-6	1-3	None
Male	0.7%	4.3%	25.2%	13.7%
Female	3.6%	5.0%	38.1%	9.4%
Total	4.3%	9.3%	63.3%	23.1%

Table 6.12 shows that two-thirds of the teachers who signified that they had attended training courses (88, 63%), had in fact attended 1 to 3 training programs in the previous three

years. However, nearly one quarter (32, 23%) had not attended any training program during the previous three years.

Accreditation or In-service ICT Training. Of the 139 participants who had attended ICT training programs, 10 (7%) stated they attended pre-service training, 112 teachers (81%) were trained in-service, and 17 (12%) accessed both forms of training (table 6.13).

Table 6.13

Selection of Sample: Pre-Service and In-service ICT Training

Gender	Pre-service training	In-service training	pre-service and in-service training
Male	2.9%	33.1%	7.9%
Female	4.3%	47.5%	4.3%
Total	7.2%	80.6%	12.2%

There is some debate regarding the low numbers of teachers who received ICT training prior to accreditation. Whilst there are a quarter of all respondents who reported one to ten years' experience, and half of those less than 31 years of age (12.5% of full sample) pre-service ICT training since 2000 could be expected as part of their accreditation. However, 27 teachers report accreditation ICT training, less than ten per cent of the full sample.

Public or Private ICT Training. Teacher training centres in Jeddah city comprise gender-based Ministry centres (educational training centre) which provide free training programs, and private training centres (commercial training centre) which have superior ICT courses (see table 6.14).

Table 6.14

Selection of Sample: Public or Private ICT Training

Gender	Private training	Public training	public and private training
Male	14.4%	23.7%	5.8%
Female	33.8%	13.7%	8.6%
Total	48.2%	37.4%	14.3%

Table 6.14 shows that, of the 139 teachers who had accessed ICT training during their teaching careers, some 48 per cent of respondents had undertaken private training (one-third of the selection of sample were women teachers) whilst 37 per cent had accessed government

training courses. The remainder reported they had attended both forms of ICT training. The high proportion of private training for women is an interesting aspect of the study and it is discussed in depth in the next chapter.

6.3.2 Issues with Access to ICT Training

The objective of this part of the questionnaire was to identify factors that might impede science teachers from intermediate schools in Jeddah province from attending ICT training programs. The first part of this section discusses the questions and statements on the questionnaire, the remainder notes issues raised by invitation from the respondents in open-ended questions.

The survey questions include ten factors derived from the literature (s3.4) scored using a Likert scale. Analysis includes frequencies, percentages, means, and standard deviations. Table 6.15 shows a summary of responses of male and female science teachers regarding perceived barriers to attending ICT training programs, which are then explained.

Table 6.15

Issues with Access to ICT Training Programs

Q 17	Factors	N	Mean	Std Dev ⁸ .	Disagree**		Neutral**		Agree**	
					Freq	%	Freq	%	Freq	%
Q17a	ICT training low priority	302	2.16	1.223	220	72.8	19	6.3	63	20.9
Q17b	Ministry does not encourage attendance	302	3.51	1.425	95	31.5	24	7.9	183	60.6
Q17c	ICT session times not suitable	301	3.96	1.163	46	15.3	20	6.6	235	78.1
Q17d	No school administrative support	302	3.38	1.351	92	29.6	35	11.3	175	56.2
Q17e	Training Centre too distant	301	2.42	1.308	178	59.1	41	13.6	82	27.3
Q17f	Insufficient ICT resources at school	301	3.80	1.332	76	18.3	15	10.9	210	67.5
Q17g	Not required to attend ICT courses	302	2.48	1.205	189	60.6	38	12.2	75	24.2
Q17h	ICT courses not available	302	3.91	1.082	35	14.4	56	18.0	211	67.8
Q17i	Insufficient time to attend courses	302	3.16	1.361	123	39.6	24	7.7	155	49.9
Q17j	Superior knowledge to ICT instructors	302	2.90	1.123	120	38.6	93	29.9	89	28.6

* N= 301 or 302, incomplete surveys = 3.5%

**SD (strongly disagree = 1) and D (disagree = 2) were combined as disagree; U (uncertain = 3); A (agree = 4) and SA (strongly agree = 5) were combined as agree

Q17a *ICT Training is a Low Priority.* Table 6.15 shows that the mean for 302 responses to this question was 2.16, which is lower than the midpoint of a 5-point scale. The majority of these respondents, 220 (73%), rejected the premise that training was not a priority for them at this time, which means that the majority of science teachers disagreed or strongly disagreed on this factor.

Q17b *Ministry does not Encourage ICT Training Attendances.* For this question, 17b, the mean for 302 participants was 3.51, which is greater than the midpoint of a 5-point scale. This indicates that the majority of participants agreed or strongly agreed that the Ministry of Education's lack of encouragement impacted their attendance at ICT training. The

⁸ While not statistically accurate (for reasons explained in chapter 3), the standard deviation gives an idea of the relative spread on these items. SD in this table varies from 1.082 to 1.425, which means that responses were relatively close to the mean.

percentages also illustrate strong support for this statement, with 183 (61%) either agreeing or strongly agreeing with the statement.

Q17c *ICT Training Times are Unsuitable for Attendance.* Over three-quarters of the 301 participants (78%) who answered this question agreed that ICT training course times were unsuitable. Table 6.15 shows that the mean of this factor is the highest (3.96) for all parts of this question.

Q17d *Inadequate Administrative Support from School.* Table 6.15 shows that the mean for 302 responses for this issue was 3.38, higher than the scale midpoint. Thus 58 per cent of the participants agree or strongly agree that the lack of school administrative support is a barrier which hinders science teachers from attending ICT training course.

Q17e *Distance to Educational Training Centre Hinders Access.* The mean of the statement response *Educational training centre is too far away* was 2.42, which is lower than the midpoint of a 5-point scale (table 6.15), thus the majority of the participants 178 or 59 per cent disagreed (strongly disagree and disagree). However, 27 per cent (82 participants) agreed, which represents a notable difficulty for many teachers in accessing ICT training because of travel issues.

Q17f *Insufficient ICT Resources at School.* Table 6.15 shows that 210 participants (70%) agreed that a lack of computer hardware and software in the school impeded attendance at ICT training courses. As a result, the mean of the responses was 3.8, which indicates the strength of the concurrence to this item. On the whole, it appears that, while the majority of teachers were required to attend ICT courses, a sizable proportion believed they were not.

Q17g *My Attendance at ICT courses is not Required.* The mean for all of the participants' responses to the statement *I do not have to attend ICT training programs* was 2.48, which is slightly less than the scale midpoint. Table 6.15 shows that 189 (63%) of science teachers disagreed (disagree and strongly disagreed) with this statement, with one quarter agreeing that the statement was true. This result may indicate a minority group of respondents who either consider their skills adequate for the training available, or who believe their school administrators do not encourage attendance at ICT training.

Q17h *ICT Training Courses not Available.* Table 6.15 shows that the mean of this statement was 3.91, second-highest mean after Q17c regarding unsuitable course times. The

results indicates that 211 of 302 (70%) science teachers agreed that ICT courses were not available to them and only 35 (12%) disagreed with this statement.

Q17i *No Time to Attend ICT Courses.* The mean of this response was 3.16, which is higher than the scale midpoint (table 6.15). Over one half of the respondents (155, 51%) agreed with the statement, whilst many disagreed (123, 41%).

Q17j *Inadequate Knowledge of ICT Trainers.* There was a high neutral response (93, 31%) to this statement, which is unsurprising, as participants would not be expected to be aware of the extent of trainers' ICT knowledge. Nevertheless, the mean was higher than midpoint, at 2.9. Therefore 120 participants (40%) disagreed, whilst the remaining 89 (29.5%) of the participants agreed they did know more than the trainers, which suggests that available courses were not appropriated for some of the teachers.

Summary. This section sought information regarding issues teachers encountered in attending ICT training. Whilst the majority of teachers did not agree that ICT training had a low priority, a lower proportion concurred with the statement that the Ministry of Education does not encourage such training. A high majority gave the reasons that ICT training was not available, that times for training were not convenient for them, and that there was insufficient ICT resources at their school. Over half the respondents reported they had no support for ICT training from their school administrators, and one half said they did not have sufficient time to attend. Three quarters of the teachers disagreed with the statements that they did not have to attend ICT training, and that they knew more than the instructors.

Other Matters Raised by Participants. At the end of each section of the questionnaire, space was provided for the study participant to make observations or suggestions. There were 17 comments received from the participants for this topic (eight comments from male teachers, and nine from female teachers). After removal of duplicates, the following observations remain which largely support the statements on the survey:

- *I have not been asked by my science supervisor or equivalent to attend ICT training during the last four years.*
- *Female teachers usually cannot attend training programs in the afternoon.*
- *Very often, the announcement of the training programs is very late; I was not informed about the training program.*
- *Other matters unrelated to science classes impede many teachers from attending training.*

- *There is a lack of ICT training programs for science teachers to integrate ICT into science education.*
- *The capacity of trainers is limited, particularly in the ICT field.*

These comments, as noted, support matters concerning ICT training that were raised in the formal statements. Science supervisors tend to specialist science training and may not see their role in ICT; arguably, this matter could be raised by the teachers if they so desired. Women are impeded in their ability to travel, and with home duties and thus may not attend training sessions later in the day. Further, the dearth of ICT training opportunities and, when they are available, the lack of quality of delivery is noted.

Whilst the above analysis considers total respondent numbers, table 6.16 shows the issues considered most important by male and female science teachers in their respective abilities to attend ICT training programs. It should be noted that while these six items rated highly for both genders, the rankings differ for males and females. Discussion on the implications of these rankings can be found in Chapter 7.

Table 6.16

Issues with Access to ICT Training Programs: Ranking

Barriers to attending ICT training programs	Teachers' assigned ranking	
	Males	Females
Unsuitable ICT training times	1	2
Training was not available	4	1
Inadequate ICT resources at school	2	3
Inadequate encouragement from Ministry.	3	6
Lack of school administrative support	5	4
Insufficient time to attend ICT courses	6	5

6.4 Participants' ICT skills

Given the apparent importance of appropriate professional development of teachers in the integration of ICT in the curriculum, a primary objective of this study was to identify and evaluate the ICT skills of science teachers in intermediate schools and determine their training and development needs in relation to those skill levels. Given that professional development courses need to be specific to the needs of the teachers they are designed for, the objective of the questions in this part was to identify teachers' ICT skills and their strengths and weaknesses. The skill levels addressed relate to the "basic computer

applications (and) multimedia, desktop publishing and presentation software” of Jones (2003). An interviewee noted that “teachers must be able to access educational sources, such as programs, scientific encyclopaedias, and the internet” (see section 5.3.1). Thus the survey asks for skills levels such as knowledge of basic computer functions, familiarity with installing programs, saving educational files, preparing and editing text documents for Microsoft Office programs such as Word and PowerPoint, and using the internet including email and collecting data. Further skills include setting up and editing Ministry websites, and using science software and voice-based chat programs.

To measure the ICT skills of participants, they were asked them to rate their perceived skill levels using one of four options: not familiar, entry, adaptation, and transformation as explained in the questionnaire prefacing Q18. Descriptive statistics (means, frequencies, and percentages) were used to analyse the participants’ responses regarding their ICT skills. To determine whether training was required to improve ICT skills levels, the means of the responses on teachers’ self-described ICT skills levels were presented on a four-point scale (not familiar, entry, adaptation, and transformation), ranging from “ICT skill at a very poor level” to “ICT skill at an excellent level”, defined as follows:

- ICT skill at an excellent level: the mean of the participants’ rating of the skill was between 3.6 to 4.00 (i.e., 90 to 100% of the maximum score),
- ICT skill at a very good level: the participants’ skill ranged from a mean of 3.20 to 3.59, or 80 to 89% of the maximum,
- ICT skill at a good level: the participants’ skill ranged from a mean of 2.80 to 3.19, or 70 to 79% of the maximum,
- ICT skill is at a satisfactory level: the participants’ skill ranged from a mean of 2.40 to 2.79, 60 to 69% of the maximum,
- ICT skill at a poor level: the participants’ skill ranged from a mean of 2.00 to 2.39, 50 to 59% of the maximum,
- ICT skill at a very poor level: thus the participants’ skill mean was less than 2.00, or under 50% and less than the midpoint of a 4-point scale.

Table 6.17 shows the results of participants’ perceptions of their ICT skills.

Table 6.17

Analysis of the Means of Teachers' ICT Skills

Q18	ICT Skill	Male	Female	All
		Mean		
Q18a	Using a computer	2.73	2.61	2.67
Q18b	Handling operating systems	2.86	2.80	2.83
Q18c	Organising and saving files	2.73	2.79	2.76
Q18d	Preparing text documents	2.59	2.77	2.68
Q18e	Using graphics and drawing programs	1.99	1.99	1.99
Q18f	Preparing multimedia presentations	2.27	2.49	2.39
Q18g	Using data tables (Excel)	1.86	1.85	1.85
Q18h	Setting up and deleting software	2.18	2.04	2.11
Q18i	Using science software	1.81	1.67	1.74
Q18j	Collecting information from the internet	2.55	2.54	2.55
Q18k	Designing web pages	1.59	1.47	1.53
Q18l	Sending and receiving email	2.14	1.80	1.96
Q18m	Managing emails and emails groups	2.01	1.85	1.92
Q18n	Using voice chat programs by internet	2.04	1.82	1.92
Average of the mean		2.23	2.17	2.20

The average of all the means for 310 participants' responses for all ICT skills was 2.20 (55%) which is slightly higher than the midpoint of a 4-point scale. The highest mean of the participants was 2.83 for skill number Q18b *Handling operating systems - changing desk top settings, date, time region, the degree of screen clarity*. Six of fourteen ICT skills⁹ had an average between 2.76 and 2.11; this is higher than the midpoint of a 4-point scale. However, there were seven skills with means lower than the midpoint of a 4-point scale¹⁰. Table 6.17 also shows that the average of the means for the ICT skills of male teachers was 2.23, while the average of the means for the ICT skills of female science teachers was 2.17; this indicates

⁹ Q18a Using a computer, Q18c Organising and save files, Q18d Preparing text documents, Q18f Preparing multimedia presentations, Q18h Setting up and deleting software, and Q18j Using science software.

¹⁰ Q18e Using graphics and drawing programs, Q18g Using data tables (Excel), Q18i Using science software, Q18k Designing web pages, Q18l Sending and receiving email, Q18m Managing emails and emails groups, and Q18n Using voice chat programs by internet.

that the existing level of ICT skills among the male teachers is a little higher than that of the female teachers, but neither are within the satisfactory range, as defined above.

As shown in Table 6.17, the means of the ICT skills for the male science teachers are all between 1.59 and 2.86, average mean at 2.23. At the same time, means of the ICT skills of the female science teachers are between 1.47 and 2.80, average mean at 2.17, slightly lower than for the males.

6.4.1 Evaluation of Participants' Skills

An analysis of the differences in the ICT skills of the male and female science teachers is presented in this section. The self-rated ICT skills are at levels which vary between “very poor” and “good”, beginning with the higher end of the range.

ICT Skills Level Self-evaluated by Respondents as Excellent. There were no occurrences of means in the range of 3.6 to 4 on the table, thus no skill levels were evaluated as excellent.

ICT Skills Level Self-evaluated as Very Good. There were no occurrences of means above 3.2, therefore this ranking did not apply.

ICT Skills Level Self-evaluated as Good. Table 6.18 shows item 18b (Handling operating systems - changing desk top settings, date, time region, the degree of screen clarity) is at an average “good” ICT skills level for both male and female teachers. The average of the means of the operating systems skill were 2.86 for male teachers and 2.80 for female teachers.

Table 6.18

Example of Teachers' ICT Skills: Operating Systems, by Gender

Q18	ICT skill	Gender	Unfamiliar	Entry	Adaptation	Transform
Q18b	Handling operating systems	Male	2.2%	13.5%	20.3%	9.4%
		Female	8.1%	13.5%	21.6%	9.4%
		Total	12.3%	27.0%	41.9%	18.8%

Table 6.18 showed that, of the 147 male teachers, 140 (43.2% of the sample) reported diverse ability (entry level to transformation level) to use operating systems such as Windows or Macintosh. Similarly, of the 146 (43.9% of the sample) female science teachers who

reported being familiar with operating systems, 42 were at entry level, 67 reported being at the adaptation level and 29 had advanced level ability for this skill.

ICT skills level evaluated as Satisfactory. A “satisfactory” self-reported ICT skills level by the teachers has a mean of reported skills at 2.40 to 2.79, or 60 to 69 per cent of the maximum score. Table 6.19 indicates that there were four ICT skills in this level for men teachers. The skills and their means were:

- Q18a Using a computer (2.73)
- Q18c Organising and saving files (2.73)
- Q18d Preparing text documents (2.59)
- Q18j Collecting information from the internet (2.55).

Table 6.19

ICT Skills Level “Satisfactory”: Sample Gender Comparison

Q18	ICT skill	Gender	Unfamiliar	Entry	Adaptation	Transform
Q18a	Using computers	Male	4.2%	13.5%	20.3%	9.4%
		Female	8.1%	13.5%	21.6%	9.4%
		Total	12.3%	27.0%	41.9%	18.8%
Q18c	Organising and saving educational files on computers	Male	4.8%	14.5%	16.5%	11.6%
		Female	7.4%	9.7%	22.3%	13.2%
		Total	12.2%	24.2%	38.8%	24.8%
Q18d	Preparing and editing text documents	Male	9.0%	13.2%	13.6%	11.6%
		Female	8.7%	9.7%	19.0%	15.2%
		Total	17.7%	22.9%	32.6%	26.8%
Q18j	Using internet search engines (collecting data)	Male	10.0%	11.9%	14.8%	10.7%
		Female	11.9%	10.7%	19.7%	10.3%
		Total	21.9%	22.6%	34.5%	21.0%

Table 6.19 shows that the perceived ICT skills of the women teachers at the “satisfactory” ICT skills level were the same items: Q18a, 2.61; Q18c, 2.79; Q18d, 2.77; and Q18j, 2.54. The men had superior perceived skills when using a computer and accessing the internet, whilst women had higher means for file management and word processing of text documents. Further, female teachers also have a mean “satisfactory” skills level for ICT skill Q18f (Preparing multimedia presentations for educational purposes).

For Q18a, ability to use computers, table 6.19 indicates that the majority of male teachers and female teachers (88%, comprising male teachers at 43% of the sample and female teachers at 45% of the sample) reported being able to use ICT at a satisfactory skill level, including the assembly of computers and accessories such as screens, printers, scanners, modems, and digital cameras. Again at Q18c, 88 per cent of teachers (male teachers at 43% of the sample and women teachers at 45%) reported being able to organise or manage computer files at this skill level, including opening new documents and saving, deleting, copying and naming data files. Also, table 6.19 shows that 82 per cent of the sample, 119 of 147 of male science teachers, and 136 of 163 female teachers report being able to prepare text documents, abstracts, and educational brochures using programs such as Microsoft Word; thus ICT at this level facilitated the classroom procedures. Table 6.19 shows, in addition, that more than 78 per cent of study participants report skills sufficient to access the internet for information (Q18j).

For ICT skill item Q18f, Table 6.20 shows that 76 per cent of female teachers reported skills in preparing audio-video presentations (via Microsoft’s PowerPoint) for use in the curriculum; this percentage included 36 teachers at the entry level, 54 at the adaptation level, and 33 teachers at the transformation level. Forty female teachers reported that were “not familiar” with this skill.

Table 6.20

Selection of Sample: Women Teachers’ “Preparing Presentation” ICT Skills

<i>Preparing multimedia presentations to be used in class</i>				
Q18f	Unfamiliar	Entry	Adaptation	Transformation
	24.5%	22.1%	33.1%	20.2%

6.4.2 ICT Skills Level Evaluated as Poor

As mentioned above, a “Poor” ICT skills level means that the participants’ perceived mean degree of skill between 2.00 to 2.39, or 51 to 59% of maximum possible score. The male teachers reported five ICT skills’ means at this level (means are indicated):

Q18f Preparing multimedia presentations for class work (2.27)

Q18h Setting up and deleting programs such as scientific programs and encyclopaedia (2.18)

- Q18l Sending and receiving emails to communicate with teachers, students, and parents after school hours (2.14)
- Q18m Managing emails and emails groups (2.01)
- Q18n Using voice chat programs (such as Messenger and Pal Talk) (2.04) (See table 6.21).

Table 6.21

Selection of Sample: Men Teachers' Skills Evaluated as "Poor"

	Evaluation			
	Unfamiliar	Entry	Adaptation	Transformation
Q18f	<i>Preparing multimedia presentations to be used in class</i>			
	33.3%	26.5%	19.8%	20.4%
Q18l	<i>Sending and receiving emails</i>			
	34%	30%	23.8%	12.2%
Q18m	<i>Preparing emails and emails groups</i>			
	39.4%	30.6%	19.7%	10.3%
Q18n	<i>Using voice through internet</i>			
	38.8%	30%	19.7%	11.5%

Table 6.21 shows in the reported means for ICT skills for men evaluated as “poor” that 33 per cent of the male teachers were unfamiliar with preparing or creating PowerPoint and multimedia presentations (audio-video) for classes, the remainder reported varying capabilities with such skills. With regard to sending and receiving email, 97 (66%) of 147 male teachers reported being able to send and receive emails at various skill levels to communicate with teachers, students, and parents. For the establishment of new e-mail accounts, and the preparation of email groups (Q18m), 58 of the cohort (39%) reported that they were not familiar with this skill, whilst 15 (10%) reported that they were at an advanced level. Table 6.21 also shows that 90 respondents (61%) reported they could use voice programs such as Messenger or Pal Talk to communicate with teachers, students, and parents, the other 39 per cent reported they did not have this skill.

In contrast to the male teachers’ results, female science teachers reported a “poor” skill level, with an average mean of 2.04, only for skill item Q18h (setting up and deleting programs). Male teachers also rated on average at the “poor” ICT skill level on item Q18h (see table 6.22).

Table 6.22

Participants' "Poor" Results: Installing and Deleting Software Programs

Q18h	Gender	Unfamiliar	Entry	Adaptation	Trans-formation
Setting / deleting programs	Male	17.1%	11.6%	11.6%	7.1%
	Female	23.6%	9.7%	13.2%	6.1%
	Total	40.7%	21.3%	24.8%	13.2%

Table 6.22 indicates that a total of 94 male teachers (30% of the sample) reported the ability to install, use and delete educational programs, for example, science software and encyclopaedia. Seventeen per cent of the sample, 53 men teachers, reported being unable to exercise this skill. Of women teachers, 73 (29% of sample) were not familiar with this skill, whilst 19 (6% of sample) professed advanced ability.

6.4.3 ICT Skills Level Evaluated as Very Poor

Based on the defined classifications, a “very poor” ICT skills level was considered to be where participants perceived themselves on average at less than the midpoint (the mean, 2.00) of a 4-point scale, or 50 per cent of the maximum rating. Table 6.17 shows that there were four ICT skills that both male and female teachers had in common at this level: these skills were Q18e, Q18g, Q18i, and Q18k. Female teachers reported three additional ICT skills at the “very poor” level, namely Q18l, Q18m, and Q18n. To clarify these results, first the results of the four common ICT skills that were ranked as “very poor” by both male and female teachers are presented, and then the results of the three additional “very poor” ICT skills for the female teachers.

Graphics Programs. Despite the importance of the use of photographs and graphics in science education, the mean of both the male and the female teachers for the “Using graphics and drawing programs” item (Q18e) was 1.99, which is slightly less than the midpoint of a 4-point scale (table 6.23).

Table 6.23

Participants' "Very Poor" Results: Graphics Programs

Q18e	Gender	Unfamiliar	Entry	Adaptation	Transformation
Graphics / drawing programs	Male	18.7%	15.5%	8.0%	5.2%
	Female	20.0%	17.4%	10.6%	4.6%
	Total	38.7%	32.9%	18.6%	9.8%

Table 6.23 shows that 120 (39%) of the participants reported that they were unfamiliar with graphics software (such as the Adobe Photoshop or Microsoft’s Paint) to edit or draw pictures. Of the teachers surveyed, 102 (33%) reported having simple skills, whilst 30 (10%) reported an advanced ability to use these professional programs for drawing or editing photos and drawings.

Data Programs. For item Q18g “Ability to use data tables”, the mean was 1.85 for both male and female teachers, which is less than the midpoint of a 4-point scale and thus about one half of the respondents could not manipulate data table software (table 6.24).

Table 6.24

Participants’ “Very Poor” Results: Data Analysis Programs

Q18g	Gender	Unfamiliar	Entry	Adaptation	Transformation
Data analysis programs	Male	22.6%	12.9%	8.0%	3.9%
	Female	27.1%	10.3%	11.0%	4.2%
	Total	49.7%	23.2%	19.1%	8.0%

Table 6.24 indicates that 154 of the male and female teachers (49.7%) reported that they were not familiar with using data analysis programs such as the Microsoft Excel Program, 72 (23%) had an entry skill level, while 84 (27%) had medium or advanced level skills to use data tables, so useful to analyse data, create diagrams or register examination results. This suggests these teachers are missing out on very useful generic skills.

Science Education Programs. For Q18i, teachers were questioned regarding their ability to use science educational programs such as laboratory simulation software programs. The mean of this skill was 1.74 for both male and female teachers, which is less than the midpoint of a 4-point scale. This suggests that more than half of the participants do not have the ability to use science educational programs (table 6.25), which require specific ICT skills.

Table 6.25

Participants’ “Very Poor” Results: Science Education Programs

Q18i	Gender	Unfamiliar	Entry	Adaptation	Transformation
Using science education programs	Male	24.2%	11.9%	7.4%	3.9%
	Female	31.6%	9.0%	9.4%	2.6%
	Total	55.8%	20.9%	16.8%	6.5%

Table 6.25 shows that 173 participants (56%) reported that they were not familiar with using science educational programs, 65 (21%) reported having entry level skills, while 72 (23%) reported having medium or advanced skills in using these programs.

Designing a Web Page .The mean for the *designing a web page* (for example, to disseminate information on a subject or its scientific content, or publish student work on the internet) skill was 1.47 which was the lowest mean of all the ICT skills (table 6.26).

Table 6.26

Participants’ “Very Poor” Results: Designing Web Pages

Q18k	Gender	Unfamiliar	Entry	Adaptation	Transformation
Designing education web page	Male	30.3%	9.4%	4.5%	3.2%
	Female	36.4%	8.7%	6.5%	1.0%
	Total	66.8%	18.1%	11.0%	4.2%

Table 6.26 shows that 207 of all participants (67%) (94 male and 113 female teachers) were not familiar with designing educational web pages. Fifty-six (18%) had entry level skills (29 male and 27 female teachers) while 47 participants (15.1%) had a medium or advanced ability for designing educational web pages.

As noted at the beginning of this ICT skill level section, in addition to four “very poor” ability level skills that the female teachers shared with the male teachers, there were three ICT skills with means at a “very poor” ability level for female teachers only. These were:

Q18l Sending and receiving emails (mean = 1.85)

Q18m Preparing emails and emails groups (mean = 1.80)

Q18n Using voice chat programs (Messenger, Pal Talk) (mean = 1.82) (table 6.27).

Table 6.27

Selection of Sample: Women Teachers' Skills Evaluated as "Very Poor"

	Not familiar	Entry	Adaptation	Transformation
Q18l	<i>Sending and receiving emails</i>			
	51.6%	20.2%	20.2%	8%
Q18m	<i>Managing emails and emails groups</i>			
	55.2%	18.4%	17.8%	8.6%
Q18n	<i>Using voice through internet</i>			
	57.1%	14.7%	17.8%	10.4%

Table 6.27 shows that 84 of the 163 female teachers who responded to this question reported an inability to use email (Q18l) to communicate with teachers, students, and parents; this means that 52% were not familiar with this aspect of ICT. A total of 79 of the 163 female teachers had varying perceptions of their levels of ability, with just 13 at a transformation level of this skill. For new e-mail accounts and establishing email groups (Q18m), Table 6.27 shows that 90 (55%) female teachers reported unfamiliarity with this skill, and 73 of the 163 were at varying levels of competency (30 at entry level, 29 at adaptation level, and 14 at the transformation level). Table 6.27 also shows that more than 57 per cent women of participants said they were unable to use voice programs over the internet (Q18n) such as Messenger or Pal Talk, while 24 (14.7%) reported having an entry level skill, and 17 (10%) as having advanced ability to use such programs for communicating with other teachers and with students and parents after school hours.

6.4.4 Summary of the Participants' ICT Skills

The ICT skills of science teacher participants in this study were classified by standards drawn from the means of the survey responses. The average of the mean for all of the participants' answers for all ICT skills, as noted in the introduction to this section was 2.20 (55%), which was slightly higher than the midpoint of a 4-point scale. This indicates that many male and female science teachers did not have a satisfactory level of basic ICT skills' competencies.

Table 6.28 represents the mean results of male and female science teachers.

Table 6.28

Evaluation Summary

Male science teachers	Level of ICT skills based on the mean value	Female science teachers
No skills reported	Excellent ICT skills (3.6 to 4.00)	No skills reported
No skills reported	Very good ICT skills (3.20 to 3.59)	No skills reported
1 Handling operating systems	Good ICT skills (2.80 to 3.19)	1 Handling operating system
1- Using computers 2- Organising and saving files 3- Preparing text documents 4- Accessing information from the internet	Satisfactory ICT skills (2.40 to 2.79)	1- Organising and save files 2- Preparing text document 3- Using computer 4- Accessing information from internet 5- Preparing multimedia presentations
1- Preparing multimedia presentations 2- Setting and deleting software 3- Sending and receiving emails 4- Managing emails, emails groups 5- Using voice through internet	Poor ICT skills (2.00 to 2.39)	1- Setting and deleting software
1- Using graphics, drawing programs 2- Using data tables (Excel) 3- Using science programs 4- Designing web pages	Very poor ICT skills (less than 2.00)	1- Using graphics, drawing programs 2- Using data tables (Excel) 3- Managing emails and emails groups 4- Using voice through internet 5- Sending and receiving emails 6- Using science programs 7- Designing web pages

It should be noted that for both groups there is no ICT skill based on the mean value at either the “excellent” or “very good” levels.

Table 6.28 shows that male and female teachers were both at a “good” ICT skill level for only one item, operating a computer. At the “satisfactory” level, there were four common ICT skills claimed by both men and women, *organising and saving files*, *preparing text documents*, *using computers*, and *accessing information from the internet*. A further “satisfactory” level item claimed by women was *preparing multimedia presentations*. Male respondents reported five ICT skills at the “poor” skill level: *preparing multimedia presentations*, *setting and deleting software*, *sending and receiving emails*, *managing emails* and *using voice through internet*. Female teachers claimed only one skill at the “poor” level *setting and deleting software*. At the “very poor” ICT skill level, there were four common skills: *using graphics applications*, *data tables* and *science programs*; and *designing web pages*. Women respondents reported three additional “very poor” skills, all relating to emails and voice over the internet protocols.

The summarised results at table 6.28 show that basic computer functions are common ICT skills for the full sample of participants, with the relatively surprising report, given the lack of ICT infrastructure in the schools; that women teachers consider they can prepare multimedia presentations. Arguably, men teachers were not integrating ICT functions into the science curriculum at boys’ schools with the same ability as the women teachers at girls’ schools. On the other hand, women teachers were uncomfortable with the communications ICT of emails and voice over the internet; more so than the men who may have more confidence in their ability to utilise this valuable ICT resource. However, for science teachers, basic computer management skills are insufficient to introduce ICT into the teaching and learning process. Further, the analysis of participants’ ICT skills show differences between the ICT skills of male science teachers and those of female teachers, thus their training and development needs differ. This will be discussed further in the next chapter.

6.5 Science Teachers’ Attitudes to ICT

The previous studies indicated that the science teachers’ attitudes towards using ICT can be a barrier to integration of ICT into the teaching process (see section 3.3.3). Therefore the survey contained questions on the perspectives of science teachers in implementing ICT in their classes.

In this section (Q19), sixteen items were included to study firstly the perceived use of ICT in classrooms and science laboratories, and secondly the perceived impact of ICT on

teaching methods. The items also include the teachers' views of their ICT competencies and interest in further training. These items were measured on a five-point Likert scale (strongly disagree =1, disagree = 2, uncertain = 3, agree = 4, and strongly agree = 5).

It should be noted that these results address both the teachers' attitudes towards using ICT in class, as well as their self-perceived competencies. The sixteen items reflect both positive and negative aspects of the use of ICT, so using the mean average of the participants' responses does not give a clear indication of the results. Therefore, the frequencies and the percentages of agreement and disagreement are used to analyse the participants' responses. The results are divided into two groups, the first include the items on attitude to ICT, and the second relates to competencies.

6.5.1 Participants' Attitudes Toward ICT in Science Curricula

Nine of the sixteen items of Q19 are included in the first group which reflects the science teachers' attitudes to using ICT in class work. These items are:

- Q19d Using ICT has a negative impact on student learning
- Q19e Using ICT has a positive impact on my teaching method
- Q19f Using ICT is not useful for science lab experiments
- Q19g Using ICT in class wastes lesson time
- Q19i I want to use ICT but do not have adequate ICT equipment at school
- Q19j I prefer to use traditional teaching methods without using ICT equipment
- Q19m I think it is difficult to manage classes while using ICT
- Q19o Good teachers do not need ICT
- Q19p Using ICT reduces interaction between me and the students.

Q19d, Q19e Impact in Classroom. Table 6.29 illustrates the descriptive statistics of science teachers' beliefs about the impact of ICT on the learning and teaching process which include items 19d and 19e.

Table 6.29

Participants' Attitude: Impact of ICT in Classroom

Q19	Item	Gender	Disagree	Neutral	Agree
Q19d	ICT has a negative impact on learning	Male	38.9%	3.6%	5.1%
		Female	42.8%	5.1%	4.5%
		Total	81.7%	8.7%	9.6%
Q19e	ICT has a positive impact on my teaching	Male	0%	1.9%	45.7%
		Female	1.9%	2.6%	47.9%
		Total	1.9%	4.5%	93.6%

Q19d *ICT has a negative impact on learning.* Table 6.29 shows the majority of participants (82%) disagreed (strongly disagree, or disagree) with this statement. This percentage includes 121 of 148 male and 133 of 163 female teachers. Thirty (30) teachers (10%) agreed (strongly agree, or agree) with the statement. Thus a large majority of science teachers consider that using ICT has a positive impact on student learning.

Q19e *ICT has a positive impact on my teaching methods.* 291 science teachers (94%) agreed (strongly agree and agree) with this statement, while no male teacher and six female teachers disagreed. These answers indicate that the majority of participants find advantage in using ICT in their teaching (see table 6.30).

Q19f, Q19g, Q19m *Using ICT in Science Laboratory and Classroom.* Table 6.30 illustrates the descriptive statistics of science teachers' beliefs for the using ICT in science laboratory and classroom which include three items, Q19f, Q19g, and Q19m.

Table 6.30

Participants' Attitude: Using ICT in the Science Laboratory and Classroom

Q19	Item	Gender	Disagree	Neutral	Agree
Q19f	ICT is not useful for science laboratory experiments	Male	32.4%	9.0%	6.0%
		Female	36.4%	11.2%	4.8%
		Total	68.8%	20.2%	11%
Q19g	ICT in classes wastes lesson time	Male	35.7%	6.4%	5.5%
		Female	34.4%	11.9%	6.1%
		Total	70.1%	18.3%	11.6%
Q19m	Managing classes is difficult while using ICT	Male	32.2%	7.4%	8.0%
		Female	38.6%	6.8%	7.0%

	Total	70.8%	14.1%	15.1%
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Q19f *Using ICT is not useful for science laboratory experiments.* Table 6.30 shows that 101 male teachers disagreed with this statement. A similar number, 113 of female teachers, also disagreed. On the other hand, 19 male teachers and 15 female teachers agreed. These results indicate that the majority of the participants do not agree with the statement that ICT is not useful for science laboratory experiments.

Q19g, *Using ICT in classes wastes lesson time.* Table 6.30 shows that 218, or 70 per cent, of teachers in the sample disagreed with this statement, whilst 57 remain unconvinced of the benefits of ICT in the classroom. This result suggests that 30 per cent of the participants perceive that using computers in class uses time unnecessarily. Arguably, this may reflect the various competencies of both students and teachers in large classes.

Q19m *I think it is difficult to manage classes while using ICT.* Table 6.30 shows that 220 (71%) teachers disagreed with this statement. Again (as with Q19g) a similar number of teachers are unconvinced of the usage of ICT and the changes this brings about in the classroom routines.

Availability of Adequate ICT Equipment. Table 6.31 presents the descriptive statistics of science teachers' perceptions for using ICT equipment at school with two items, Q19i and Q19j.

Table 6.31

Participants' Attitudes on the Pedagogical Benefits of ICT

Q19	Item	Gender	Disagree	Neutral	Agree
Q19i	Inadequate ICT equipment at school	Male	6.8%	4.1%	36.7%
		Female	9.3%	3.9%	39.2%
		Total	16.1%	8.0%	75.9%
Q19j	Prefer traditional classroom practices	Male	33.1%	3.9%	10.6%
		Female	37.9%	4.5%	10.0%
		Total	71.0%	8.4%	20.6%

Q19i *I want to use ICT but do not have sufficient ICT equipment at school.* Table 6.31 shows that 236 (76%) teachers agreed with this item, including 114 male teachers and 122 female teachers. Twenty-one male and 29 female teachers said that they disagreed. The majority considered that they had inadequate technological equipment at school.

Q19j *I prefer to use traditional teaching methods without ICT equipment.* There were 103 male teachers and 118 female teachers (71% of sample) that disagreed with this statement, whilst 33 male teachers and 31 female teachers (21%) agreed. The majority did not report choosing traditional pedagogical practices; however there remains a significant proportion of teachers who do not prefer ICT in their classroom practices, or who are undecided.

Excellent Teachers are Capable of Teaching Without Using ICT. Table 6.32 presents participants' attitudes regarding the use of ICT in the teaching and learning process.

Table 6.32

Participants' Attitude: Excellent Teachers do not need ICT

Q19	Item	Gender	Disagree	Neutral	Agree
Q19o	Excellent teachers capable without ICT	Male	7.7%	7.1%	32.8%
		Female	11.6%	6.1%	34.7%
		Total	19.3%	13.2%	67.5%

Q19o *Excellent teachers are capable of teaching without using ICT.* Table 6.32 shows that 210 (67.5%) of the participants agreed (agree and strongly agree) with this statement, 102 male teachers and 108 female teachers, whilst 60 (19%) disagreed and 41 (13%) were uncertain. Educators propound ICT's place in the curricula (McKenna et al. 2000, Norton & Sprague, 2001; Semenov, 2005), and the study interviewees unanimously found benefit from ICT implementation into the classroom environment: extending the curriculum and assisting teachers and students (see section 5.2.1). However, the respondents in this study demurred. This may relate to the notion that excellent teachers can teach well regardless of the resources at hand, as they have notified their interest in ICT applications in the classroom: more than two-thirds of the teachers disagreed with negative statements at table 6.30: *ICT is not useful for science laboratory experiments; ICT in class wastes lesson time; and managing classes is difficult while using ICT.*

ICT Decreases Classroom Interaction In this category, participants were asked whether ICT reduced teacher-student communications. The results are shown at table 6.33.

Table 6.33

Participants' Attitude: ICT Decreases Classroom Interaction

Q19	Item	Gender	Disagree	Neutral	Agree
Q19p	ICT use decreases classroom interaction	Male	35.0%	5.5%	7.1%
		Female	30.9%	9.6%	11.9%
		Total	65.9%	15.1%	19.0%

Q19p *Using ICT decreases the interaction between me and the students* is presented at table 6.33 and shows that 66 per cent of participants disagreed, including 109 male teachers and 96 female teachers. Fifty nine teachers (19%) agreed (22 male and 37 female teachers) that using ICT decreased the interaction between them and their students. This result indicates that one third of participants questioned the amount of classroom interaction that occurred when ICT was involved. This may indicate that competency was an issue, or that inexperienced teachers were not using ICT to enhance their students' experiences in class.

Summary. In general, the results of the analysis of all the items in the first group indicate that the majority of science teachers, about three-quarters, view ICT as a positive experience in the classroom. This result is surprising given findings about teacher resistance reported in the previous chapter. These apparently contradictory results will be discussed in the next chapter.

6.5.2 Participant's Views on their Professional Development

Seven of the sixteen items of Q19 were included in the second group. These items reflect science teachers' views on their competencies regarding ICT, and their perceived training requirements. These items are:

- Q19a I wish to learn more about using ICT in teaching
- Q19b ICT training programs are useful for my professional development
- Q19c I must develop ICT skills to keep pace with the teaching profession
- Q19h There is no need for me to learn more about ICT
- Q19k I do not have adequate skills to use ICT
- Q19l Using ICT requires extra time and effort
- Q19n Training programs for using ICT are for beginner teachers.

The results of descriptive analysis for these items are presented in table 6.34.

Table 6.34

Participants' Views on Professional Development

Q19	Item	Gender	Disagree	Neutral	Agree
Q19a	Learn more about ICT	Male	2.0%	1.0%	44.6%
		Female	0%	1.0%	51.4%
		Total	2.0%	2.0%	96.0%
Q19b	ICT training is useful for my career	Male	1.3%	1.0%	45.3%
		Female	0%	1.0%	51.4%
		Total	1.3%	2.0%	96.7%
Q19c	Learn ICT to keep pace with profession	Male	0.65%	1.0%	46.0%
		Female	.3%	0.65%	51.45%
		Total	1.05%	1.65%	97.45%
Q19h	Further ICT training not necessary	Male	39.3%	3.2%	5.1%
		Female	46.3%	2.2%	3.9%
		Total	85.6%	5.4%	9.0%
Q19k	Inadequate skills	Male	9.6%	6.5%	31.5%
		Female	10.3%	6.8%	35.3%
		Total	19.9%	13.3%	66.8%
Q19l	ICT is difficult and time-consuming	Male	5.1%	3.9%	38.6%
		Female	3.9%	3.2%	45.3%
		Total	9.0%	7.1%	83.9%
Q19n	ICT training is for novice teachers	Male	38.9%	1.9%	6.8%
		Female	40.5%	5.8%	6.1%
		Total	79.4%	7.7%	12.9%

Q19a *I wish to learn more about using ICT in teaching.* Table 6.34 shows that an overwhelming number of teachers (299, 96%) reported wanting to learn more about incorporating ICT as an element of their pedagogical practices. No female teacher and only six male teachers disagreed. This is an indication of the importance teachers place on their career development; arguably, those who did not agree may be near retirement or seeking a career change.

Q19b *ICT training programs are useful for my professional development.* Over 300 respondents, 97 per cent, concurred with this statement, and again, no woman teacher disagreed. This reinforces the results of Q19a above.

Q19c *I must develop ICT skills to keep pace with the teaching profession.* Table 6.34 shows that, in concert with the previous two points, participants overwhelmingly agreed with this option. The results for this item were the strongest for the question. Thus the participants recognise that pedagogical practices in the future will depend on integrating ICT further into the curricula of the sciences.

Q19h *There is no need to learn more about ICT.* The results were 266 (86%) teachers disagreed (strongly disagree, disagree) with the statement. Only 28 (9%) reported that they did not think there was any need to learn more about ICT. This result is in agreement with the previous statement's results (table 6.34).

Q19k *I do not have adequate skills to use ICT.* Table 6.34 shows that two-thirds of the respondents (67%) agreed with the statement, including 98 male teachers and 110 female teachers. Nearly 20% of participants, 30 male and 32 female teachers, reported that they have sufficient ICT skills.

Q19l *Using ICT requires extra time and effort.* Table 6.34 shows that previous responses seeking further training are reflected in the high proportion of participants (261, 84%) who agreed, that is, 120 male and 141 female teachers. Only 28 teachers (9%) disagreed. These results reinforce the findings of the previous section (Participants' ICT skills), and may indicate that the greater majority of the participants have low-level ICT skills and may need to develop their abilities to use ICT appropriately.

Q19n *ICT training programs are for beginner teachers only.* Again, nearly 80 per cent of teachers, 247, at table 6.34 disagreed, including 121 male and 126 female teachers. Twenty one male and 19 female teachers agreed that ICT training was necessary only for new teachers, which may indicate that they personally felt they required training only at their discretion.

Summary. In general, the result of all the items in the second group indicates that the greater majority of the respondent teachers were positive in their attitude towards ICT and further personal training. As with the findings in the previous section, this is surprising given the interviewees' responses regarding teacher resistance. This apparently discrepant finding is discussed in the following chapter.

6.5.3 Participants' Use of ICT

The majority of the study participants had the ability and skills to use ICT, such as computers and the internet. However, the future for ICT is in its appropriate use in the science curriculum, as pedagogical principles evolve toward greater emphasis on the student and the learning process (see section 3.2.1). The objective of the survey questions in this section was to establish whether science teachers use ICT in the science curriculum.

Use of Computer. At Q18, the participants were asked if they *could* use computers; at Q20 they were asked whether they actually employed this skill (table 6.35 and figure 6.3).

Table 6.35
Participants' use of Computers

Q20	Gender	Use a computer	Do not use a computer
Do you use a computer?	Male	41.2%	6.4%
	Female	46.0%	6.4%
	Total	87.2%	12.8%

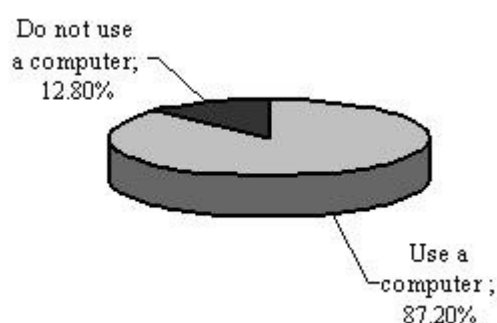


Figure 6.3 *Teacher Participants' use of Computers*

Table 6.35 shows that 128 male teachers (41% of the sample) and 143 female teachers (46%) answered that they used a computer, while 40 participants (including both male and female teachers) (13%) reported not using a computer. This result indicates that the greater majority of science teachers (271, or 87%) perceive themselves as users of computers.

Location of Computer Use. Next, survey participants who responded in the affirmative (271 = 100%) were asked the location where they usually use a computer (table 6.36).

Table 6.36

Selection of Sample, Computer Usage: Location

Q21	Gender	At home	At school	Home and school
Where do you use a computer?	Male	24.0%	1.1%	22.1%
	Female	16.6%	0.7%	35.5%
	Total	40.6%	1.8%	57.6%

Table 6.36 shows that 65 of 128 male teachers (24% of all users) reported using a computer only at home, whereas 60 reported they use the computer both at home and at school. However, 45 of 143 female teachers (17% of all users) reported they only use the computer at home, and 96 females (36% of all users) said they used the computer both at home and at school. Thus, of those who use a computer, the majority have both a computer at home which they use, and access to computers, which they use, at school (156, or 58%). Further, many who do not use a computer at school (110, or 41%) use a computer at home. Few use a computer at school, but not at home. This leads to the conclusion that many more teachers (110 of the total sample) would use ICT if appropriate resources were available at their school.

Use of Computer for Educational Purposes. Q22 followed through the line of questioning by asking whether the computer use was for educational purposes (table 6.37).

Table 6.37

Selection of Sample, Educational Usage

Q22	Gender	Used for educational purposes	Not used for educational purposes
Use a computer for educational purposes	Male	38.3%	8.9%
	Female	51.0%	1.8%
	Total	89.3%	10.7%

The greater majority of science teachers who used a computer reported that they use it for educational purposes. Over half the reduced sample were women teachers who used their computers for educational purposes, whilst fewer men 104 or 38 per cent, used their computers for that purpose. Surprisingly, many more male teachers used a computer for non-educational purposes (24 or 9% of the reduced sample) than female teachers (5, or 2 % of the reduced sample) (table 6.37).

This result is a key finding for this study. Of the full 311 sample, 242 survey participants (78%) use a computer for educational purposes, thus more than one in five respondents apparently do not use a computer at all in the science classroom or laboratory or in preparing classes.

Access to Internet. Table 6.38 shows both access to the internet at school, and its use for educational purposes.

Table 6.38

Selection of Sample, Educational Usage of Internet

Question	Gender	Internet access at school	No internet access at school
Q23a Internet access	Male	35.8%	11.4%
	Female	30.3%	22.5%
	Total	66.1%	33.9%
Q23b Use internet for educational purposes	Male	22.5%	24.7%
	Female	22.1%	30.7%
	Total	44.6%	55.4%

Table 6.38 shows that 179 science teachers, or two-thirds of those who use a computer, reported they have access to the internet at school, slightly more men teachers (36% of reduced sample) than women teachers (30% of reduced sample). On the other hand, only 45 per cent of those who use a computer use the internet for educational purposes.

The analysis therefore shows that 179, or 58 per cent of the full sample of 311 respondents, have internet access at school. However, use of the internet for educational purposes, a key study objective, relates to just 121 science teachers from the full 311 sample (39%). These points are discussed in Chapter 7.

6.6 Factors Impeding Integration of ICT into Science Curriculum

The last part of the questionnaire investigates 15 factors likely to impede Jeddah's intermediate science teachers' use of ICT, and through extrapolation, teachers in the Ministry of Education, Saudi Arabia. Participants responded on a four-part Likert scale (does not limit = 1, slightly limits = 2, somewhat limits = 3, and greatly limits = 4) for each factor. To analyse these factors, a selection of descriptive values: frequencies, means, rank, and standard

deviations are employed for participants' responses. Further, male and female teachers' responses are ranked and compared to highlight differences (see table 6.39).

Table 6.39

Ranking of Factors Impeding Integration of ICT into Science Curriculum

Q 25	Statement	Gender	N	Mean	Rank	Std D
Q25a	Shortage of ICT equipment at school	Male	148	3.38	1	.876
		Female	161	3.23	2	.963
		Total	309	3.30	2	.924
Q25b	Insufficient technical support for using ICT	Male	148	3.14	5	.825
		Female	161	3.16	3	.863
		Total	309	3.15	5	.844
Q25c	Insufficient space to use ICT in classes	Male	148	3.16	4	.990
		Female	161	3.14	4	1.012
		Total	309	3.15	4	1.000
Q25d	Large class numbers limits use of ICT	Male	148	3.36	3	.841
		Female	161	3.07	5	1.070
		Total	309	3.21	3	.976
Q25e	Internet connections are not available	Male	148	3.06	7	1.018
		Female	161	2.93	8	1.040
		Total	309	2.99	8	1.030
Q25f	Internet speed is not suitable for use in education	Male	148	3.03	9	.922
		Female	161	2.98	7	.928
		Total	309	3.00	7	.924
Q25g	Limited number of Arabic web sites	Male	148	2.82	12	1.035
		Female	161	2.88	11	.907
		Total	309	2.85	12	.969
Q25h	There are no Arabic software programs	Male	148	3.05	8	.906
		Female	161	2.78	12	.968
		Total	309	2.91	10	.947
Q25i	The science curriculum is not suitable for using ICT	Male	148	2.47	13	1.000
		Female	161	2.26	14	1.070
		Total	309	2.36	14	1.040
Q25j	Extensive science curriculum for completion in year	Male	148	2.85	11	1.096
		Female	161	2.89	10	1.121
		Total	309	2.87	11	1.100
Q25k	No plan to introduce ICT in the school	Male	148	3.12	6	.790
		Female	161	3.06	6	.920
		Total	309	3.09	6	.859
Q25l	Insufficient time in schedule to acquire ICT skills	Male	148	3.37	2	.851
		Female	161	3.25	1	.964
		Total	309	3.31	1	9.120
Q25m	Technical constraints in using ICT	Male	148	2.45	14	1.139
		Female	161	2.66	13	1.018
		Total	309	2.56	13	1.081
Q25n	Concerns of ICT competency in class situation	Male	148	1.89	15	1.064
		Female	161	2.02	15	1.060
		Total	309	1.96	15	1.620
Q25o	Insufficient pre-service teacher training in ICT	Male	148	2.95	10	1.061
		Female	161	2.89	9	1.058
		Total	309	2.92	9	1.050

The results of the questions on factors impeding integration of ICT (table 6.39) differed somewhat between male and female science teachers. The results indicate that the highest mean for male teachers was 3.38 on barrier (Q25a), *shortage of ICT equipment at school*. This value is the mean equal to 84.5 per cent of the maximum (4) score. The lowest average means was 1.89 on Q25n *concerns of ICT competency in class situation*, which is less than the midpoint of this scale. The results for the female teachers were the highest average means of 3.25 on Q25l, *insufficient time to acquire ICT skills*, which is 81.25 per cent of the maximum score. The lowest mean for the female teachers was 2.02 on Q25n, as it was for the male teachers. Otherwise, there are similarities among the top five barriers to the integration of ICT into science between male and female teachers (Q25a, Q25b, Q25c, Q25d, and Q25l), although different ranking.

6.6.1 Assessment of Factors

There are 15 factors perceived by the teachers in the survey as barriers to using ICT in science classes and table 6.40 is a statistical summary of these factors. Based on the mean value of each barrier, the participants converged on ten as the strongest obstacles.

Table 6.40
Limitations for Integration of ICT into Science Curriculum

Limiting factor	Gender	Does not limit		Slightly limits		Somewhat limits		Greatly limits	
		Freq	%	Freq	%	Freq	%	Freq	%
Q25a Shortage of ICT equipment at school	Male	11	3.56	6	1.94	47	15.21	84	27.18
	Female	18	5.83	6	1.94	58	18.77	79	25.57
	Total	29	9.39	12	3.88	105	33.98	163	52.75
Q25b Insufficient technical support for using ICT	Male	9	2.91	14	4.53	72	23.30	53	17.15
	Female	12	3.88	13	4.21	74	23.95	62	20.06
	Total	21	6.80	27	8.74	146	47.25	115	37.22
Q25c Insufficient space to use ICT in classes	Male	17	5.50	11	3.56	51	16.50	69	22.33
	Female	21	6.80	9	2.91	57	18.45	74	23.95
	Total	38	12.30	20	6.47	108	34.95	143	46.28
Q25d Large class numbers limit use of ICT	Male	7	2.27	14	4.53	46	14.89	81	26.21
	Female	25	8.09	11	3.56	52	16.83	73	23.62
	Total	32	10.36	25	8.09	98	31.72	154	49.84
Q25e Internet connection is not available	Male	19	6.15	15	4.85	52	16.83	62	20.06
	Female	23	7.44	24	7.77	56	18.12	58	18.77
	Total	42	13.59	39	12.62	108	34.95	120	38.83
Q25f Internet speed is not suitable for educational usage	Male	10	3.24	30	9.71	53	17.15	55	17.80
	Female	11	3.56	38	12.30	56	18.12	56	18.12
	Total	21	6.80	68	22.01	109	35.28	111	35.92
Q25g Limited number of Arabic web sites	Male	21	6.80	31	10.03	49	15.86	47	15.21
	Female	17	5.50	26	8.41	78	25.24	40	12.94
	Total	38	12.30	57	18.45	127	41.10	87	28.16
Q25h No Arabic software programs	Male	10	3.24	27	8.74	57	18.45	54	17.48
	Female	22	7.12	31	10.03	69	22.33	39	12.62
	Total	32	10.36	58	18.77	126	40.78	93	30.10
Q25i Science curriculum not suitable for ICT	Male	28	9.06	49	15.86	44	14.24	27	8.74
	Female	55	17.80	30	9.71	55	17.80	21	6.80
	Total	83	26.86	79	25.57	99	32.04	48	15.53
Q25j Extensive science curriculum for year	Male	29	9.39	14	4.53	55	17.80	50	16.18
	Female	33	10.68	11	3.56	57	18.45	60	19.42
	Total	62	20.06	25	8.09	112	36.25	110	35.60
Q25k No plan to introduce ICT in the school	Male	4	1.29	26	8.41	66	21.36	52	16.83
	Female	10	3.24	33	10.68	55	17.80	63	20.39
	Total	14	4.53	59	19.09	121	39.16	115	37.22
Q25l Insufficient time to acquire ICT skills	Male	9	2.91	9	2.91	48	15.53	82	26.54
	Female	17	5.50	8	2.59	53	17.15	83	26.86
	Total	26	8.41	17	5.50	101	32.69	165	53.40
Q25m Technical constraints in using ICT	Male	42	13.59	32	10.36	39	12.62	35	11.33
	Female	32	10.36	23	7.44	73	23.62	33	10.68
	Total	74	23.95	55	17.80	112	36.25	68	22.01
Q25n Concerns of ICT competency in class	Male	75	24.27	31	10.03	25	8.09	17	5.50
	Female	73	23.62	26	8.41	47	15.21	15	4.85
	Total	148	47.90	57	18.45	72	23.30	32	10.36
Q25o Insufficient pre-service training in ICT	Male	24	7.77	15	4.85	54	17.48	55	17.80
	Female	29	9.39	12	3.88	67	21.68	53	17.15
	Total	53	17.15	27	8.74	121	39.16	108	34.95

As analysis of table 6.40 shows, the ten primary limitations impeding ICT implementation in Jeddah's intermediate science classes are identified and discussed below.

- 1 Q25l *Insufficient time in the weekly schedule to acquire ICT skills*. The results from the participants place this as the strongest barrier that limits science teachers in using ICT in science classes, as more than 91 per cent of participants (283) reported this as a limiting factor. Over half nominated it as their greatest concern; while just 8 per cent (9 male and 17 female teachers) stated that time was not of concern.
- 2 Q25a *Shortage of ICT equipment at school*. This factor shows that the greater majority of teachers (280) reported inadequate ICT equipment limited their ability to use ICT, with over half the respondents reporting that it significantly limited their ability to use ICT in the science classroom. This factor ranked first for male teachers and as a second-level issue for female teachers.
- 3 Q25d *Large numbers of students in classes limit the use of ICT*. As noted in section 6.1.2, respondents report a high average number of students. This factor of class sizes as a limiting factor ranked third for men and fifth for women teachers. Slightly less than one half of respondents gave this as of great concern, with over 80 per cent declaring it a significant limiting factor. This may be linked to the following item.
- 4 Q25c *Lack of sufficient room to use ICT in the classroom*. This factor is likely to be related to the concerns reported in section 6.1.2 that rented buildings are inadequate for school use. Lack of space and narrow rooms impede classroom procedures involving ICT. This item ranked fourth as a barrier for both male and female teachers. Table 6.40 shows that 88 per cent of science teachers agreed on the space barrier (slightly, somewhat, and greatly limiting); whilst the remainder had no such concern. Whilst insufficient room is a significant barrier for a percentage of respondent who are accommodated in purpose-built schools, there may be space limitations in older Ministry school buildings, which become overcrowded due to population pressure.
- 5 Q25b *Insufficient technical support for using ICT*. This factor was of immediate concern to both genders, with 125 male and 136 female teachers (85%) referring to higher limitations (somewhat and greatly limiting) on ICT integration due to

the lack of technical support for using ICT, while just 21 reported they experienced no limit.

- 6 Q25k *There is no plan to introduce ICT in the school.* Seventy-six per cent of teachers noted this as a high limitation to integrating ICT into their science curricula. Men and women respondents were relatively equal in this result.
- 7 Q25f *Internet speed is not suitable educational usage.* Dial-up connection is the predominant method of internet connectivity in Saudi Arabia (see section 3.4.2), thus 71 per cent (210 respondents) were quite concerned or highly concerned on the perceived barrier to use through speed of connection and waiting time for screens to load.
- 8 Q25e *Internet connection is not available.* The Ministry of Education began connecting schools to the internet in 2003. For this question, 19 male and 23 female science teachers said that a lack of internet connection did not limit ICT usage, whilst three-quarters of the sample showed considerable concern. Due to the number of respondents who were also affected by internet speed, it is likely that this high response to unavailability relates to specific instances, or arguably, that a land line is not available for a dial-up internet connection. This aspect also relates to table 6.10 Summary of ICT infrastructure (see section 6.2.3).
- 9 Q25o *Inadequate ICT training pre-service.* Three-quarters of respondents, 229, reported that insufficient pre-service training impacted their ability to use ICT in the science classroom. One quarter of the respondents were therefore not affected or mildly affected by inadequate training before they started to teach. Slightly more women reported a higher concern (120) than men teachers (109).
- 10 Q25h *There are no Arabic software programs.* Table 6.40 shows that nearly 90 per cent of the participants (277) reported the limited number of Arabic software programs that related to science education impeded integration of ICT into science education. Whilst the curriculum includes English subjects in intermediate schools, fluency is not expected in a scientific vocabulary. Thus there is a need for translation or Arabic-dubbed programs.

In general, the average of the means for all parts of Q25 was higher than the midpoint of a 4-point scale, with the exception of Q25n *Concerns of ICT competency in class.* This result shows a considerable number of perceived barriers that impeded teachers from using ICT in their science classes; however, there was little difference in the perceptions of the

teachers in boys' schools, and those in the girls' schools. All had basically the same concerns. These matters are also discussed in the following chapter.

6.7 Summary of Questionnaire Data Analysis

This chapter presented the findings of the science teachers' questionnaire, which investigated the integration of ICT into education and the professional development needs of science teachers. The questionnaire was structured in the following order:

1. participants' information (characteristics)
2. ICT infrastructure in the participants' schools
3. teacher training programs
4. participants' ICT skills
5. science teachers' attitudes toward ICT
6. participants' use of ICT
7. factors impacting integration of ICT in science.

The research sample consisted of 311 science teachers (148 males and 163 females) who taught at intermediate schools in Jeddah province in Saudi Arabia at the time of the survey. The mode for the age groups was 31 to 40 years of age, comprising nearly two-thirds (63%) of the participants. Of these teachers, the majority (89%) had bachelor's degrees. The mode for experience was 11 to 20 years (about 60%), and 25 per cent of these taught between one and 10 years. Nearly 90 per cent of the participants came from schools in Jeddah City. The majority of the participants taught in the morning (see 5.3.2), and more than half in rented schools. Nearly 90 per cent of participants reported the average number of students in the range of 21 and 30, and 31 and 40 students.

The second part of the chapter gave the results of the ICT infrastructure in the participants' schools. This includes computer laboratories, computer networks, internet access, data projectors, and electronic microscopes in science laboratories. In general, the results showed less than optimal ICT infrastructure and equipment. The third part of the chapter presented an analysis of the teacher training programs, including the barriers that prevent science teachers from attending training. According to the results, 66 per cent of the participants (172 had no ICT training, 32 had no training in the previous three years) reported they had not taken part in any ICT training programs during the previous three years. Although this was attributed to various reasons, the top three barriers that prevented

attendance of the ICT training program were unsuitable times of the programs, unavailability of ICT training, and inadequate ICT resources in the school.

The next section explored the participants' ICT skills relating to computer-based equipment, such as computer functions, Microsoft Office programs, and competency with the internet and emails. In this study the participants' ICT skills were ranged based on the average of the means of the survey responses. No participants had ICT skills in either the "excellent" or "very good" levels. Only one participant's skills were at a "good" ICT skill level and the analysis shows that, for the participants, basic computer functions only are ranked as satisfactory common ICT skills. However, there is an indication that teachers are embracing forms of ICT, as female teachers consider they can prepare multimedia presentations. Whilst at a level of "poor", and uncomfortable with the communications ICT of emails and voice over the internet, men may have more confidence than the women teachers in their ability to utilise these valuable ICT resources. As noted, for science teachers, basic computer management skills are insufficient to introduce ICT into the curriculum.

The fifth part of the chapter examines the attitudes and experiences of the participants in the use of ICT in classrooms and science laboratories, and at the impact of ICT on teaching methods. In general, the results of the analysis of all 16 items indicate that the majority of science teachers have a very positive attitude toward the use of ICT in science teaching, as well as toward further training to improve their ICT competencies.

The sixth part examined the participants' use of ICT, such as their use of computers and the internet for educational purposes. The general results indicate that more than 77 per cent of participants use the computer for educational purposes, while nearly 50 per cent of science teachers used the internet for purposes unrelated to classroom procedures. The last part of the questionnaire investigated the factors that participants can encounter when integrating ICT into science education, with the result that there are many obstacles on which teachers from girls' schools and teachers from boys' schools basically concur.

The following chapter begins the discussion of the integration of the literature chapters with the results of the qualitative analysis of chapter six and the quantitative analysis of this chapter.

Chapter 7 Discussion

This study investigated integration of ICT in the Saudi intermediate schools' science curriculum, and science teachers' professional development. The study takes into account factors that may impede the use of ICT for science pedagogy and factors that may act as obstacles in accessing ICT training for the teachers. These factors were examined from the perspective of the policy makers in the Ministry and the science teachers. The study explored the teachers' attitudes, experiences and views regarding integration and use of ICT in the science curricula; further, the teachers' ICT perceptions of their competencies were examined and evaluated to determine differences between the professional development needs of male and female science teachers in regards to using ICT in their teaching. It is intended that the findings of this study should provide recommendations to address the issues that are raised through the research. This thesis was guided by the following research questions:

5. What actions have been taken by the Saudi Ministry of Education to integrate ICT into teaching and learning particularly for the intermediate science curriculum?
6. What programs has the Ministry introduced to provide professional development for male and female teachers to employ ICT in their classes?
7. What are the skills, beliefs and attitudes of intermediate male and female science teachers regarding ICT?
8. What are the professional development needs of science teachers regarding ICT use in the intermediate science curriculum?

To achieve the objectives of the study and answer the research questions a mixed methods approach was employed. The first method involved collection of qualitative data for analysis: using open-ended, semi-structured interviews with policy makers in the Saudi education system to inform this study of the views and intentions of the decision makers. The second method involved collection of quantitative data using self-administered questionnaires distributed to male and female science teachers at intermediate schools. The questionnaire, in parts, intended to evaluate the ICT competencies, attitudes and experiences of science teachers in gender separated schools; it also aimed to identify the issues teachers encounter when they access ICT training. In the first part of this chapter, the matters arising from the

research questions are presented for discussion. This is followed by the themes and contradictions that result from these findings, which form the final part of this chapter.

The first and second questions of this study relate to ‘actions taken by the Saudi Ministry of Education’ in integrating ICT into teaching and learning and in planning for teacher professional development, particularly in relation to the intermediate science curriculum’. To address these matters, Ministry documents were reviewed to identify the planning, policies and practices used for the integration of ICT into the Saudi education system (see section 3.2). Interviews were then arranged and conducted with Ministry policy makers in Al-Riyadh and senior officials in Jeddah province administration. These interviewees were selected as representatives who were directly involved both in the integration of ICT and the professional development of male and female science teachers (see section 4.3.2). The matters are discussed as discrete sections, first within the context of the Ministry’s performance in implementing its ICT integration plans, followed by the teachers’ professional development requirements and Ministerial delivery of training.

7.1 Ministry Actions on ICT Integration

7.1.1 Lack of Coordination in Policy and Planning

An objective of this study, as the first support research question, is to identify and assess ‘actions taken by the Saudi Ministry of Education in integrating ICT into teaching and learning, particularly the intermediate science curriculum’. This section discusses structural and operational issues rising from the Ministry’s directives and its actions when putting these programs into effect: the Ministry’s integration strategy including in relation to misconceptions of the stakeholders on the purpose of ICT integration; procedural and functional issues in implementation; and the monitoring and evaluation of the various programs.

The absence of, or inability to communicate, a systematic ICT policy and accompanying strategy impedes integration (see sections 3.2 and 3.3; Wozney, Venkatesh & Abrami, 2006). The interview participants offered several responses on the Ministry’s ICT

strategy. Of note, there were differing awareness positions by the policy makers regarding the Ministry's executive committee for integrating ICT into Saudi schools as part of the National ICT Plan. Two participants spoke briefly about the master plan for the integration of ICT into the Saudi education system, its aims and programs, and of the various committees that participated and designed it. Two other participants said they did not know if there was a strategy for the integration of ICT into Saudi schools; however, they knew of a Ministry ten-year master plan with a vision and aspirations, and parts of this plan concerned ICT. The other two participants reported that there was no master plan to integrate ICT into education; that each educational region, administration or department has developed a plan for ICT according to the group's timetable and goals. Where there should be a clear direction and known targets for ICT implementation, these responses indicate that the Ministry's master plan is not well-known within its departments and educational regions.

Also related to the Ministry's integration strategies is the variability in the conceptualisation of ICT integration by the interviewee stakeholders, that is, their perceptions of its integration into Saudi curricula and pedagogy. There appears to be a considerable disconnect between the aims of ICT integration and the implementation process, such as the Ministry's aim to adopt electronic textbooks, at a time when there were many schools without computers. Further, Saudi families frequently do not have computers in their homes and the students have little access to ICT (see section 1.1). The Ministry is also following international practice with changes to pedagogical practices to utilise ICT to change the focus from the teacher to student learning (BouJaoude, 2003). This arguably requires large-scale retraining of teachers, their professional development, in an environment where there were insufficient training opportunities for ICT competencies (cf. Abuzaid & Singh, 2008). There is evidence that aims of the Ministry's plan were frequently policy-based, such as "developing the infrastructure of ICT and using it in the processes of teaching and learning" (Charp, 2000); however, the policy was not used to establish a framework where the aspiration could be fulfilled. The interview study participants added that, after a program launch, there was often a withdrawal of support for full implementation, especially when there were management changes. It is a conclusion of this study that, unless policies are determined through detailed planning and implemented through responsible leadership, there is little opportunity for decision-making on appropriate infrastructure and a staged development process.

The policy maker interviewees found benefit from ICT integration into the classroom environment: extending the curriculum and assisting teachers and students, a stance which is frequently raised in the literature (Semenov, 2005; Vrasidas & Glass, 2005; Roblyer, 2006). The majority of them regarded ICT as no longer a luxury, that it is a basic classroom teaching aid. However, they noted misconceptions concerning integration of ICT into education as teachers and supervisors frequently misconstrued the purpose of ICT, for example, the novelty of ICT involved a risk that the internet, emails and chat rooms could seize teachers' and students' attention from the Ministry's aims of servicing its curricula. ICT becomes the object of attention in the teaching and learning process rather than a means to achieve the real educational goal. In a study on issues of ICT integration in science teaching, Gomes (2005) found that:

Some misconceptions still exist concerning the use of ICT in educational context ...the majority of teachers continue to look for ICT as something that is good for motivating. Others, in turn, mention that ICT methods are effective to motivate students for learning but they aren't for teachers to reach certain goals (p.4).

To address this issue, the Ministry distributed material regarding ICT integration, explaining the concept and objectives to integrate ICT into the curricula (see section 5.2.5); however, this response was believed to be unsuccessful, articulated by a participant who said "there is an urgent need for the spread of ICT culture to the community; this includes teachers, managers, students, and parents" (see section 5.2.5; Leach & Moon, 2000). Despite its intentions to build an ICT infrastructure to serve the Saudi education system (see section 3.2.1), there is little evidence from this research that the Ministry had an integrated approach to the many aspects involved in ICT integration, particularly as the concept introduces changes in pedagogical principles (UNESCO, 2002; Lawless & Pellegrino, 2007; Kozma, 2005). Further, there was no agreement within the Ministry on the manner of integrating ICT into education, and the majority of schools and administrations in Saudi Arabia pursued their own ICT plans (Maroun et al., 2008; Oyaid, 2009). According to the findings of this study, and a majority of interviewees, this response is inadequate to successfully utilise the considerable resources that were placed in ICT (Watani, 2006).

This notion of the policymakers was not, however, reflected in the teachers' survey where more than 93 per cent of teachers said that ICT had a positive effect on their teaching methods (table 6.2).

7.1.2 Procedural and Functional Issues in Implementation of ICT Integration

The policy makers who participated in this study nominated several issues in the many projects and programs to integrate ICT into the Saudi educational system. These factors were common for all levels of schooling (primary, intermediate and secondary), for both boys' and girls' education, and for all curricula including science.

Through analysis of interview data (see section 4.3.4), these factors were identified and classified as themes (see section 5.1). With regard to section 5.2.3, External issues in implementing ICT in schools, the themes that emerged were:

- insufficient computer equipment,
- inadequate funding,
- inadequate communications and coordination,
- inadequate technical support, and
- inappropriate school structures.

The interviewees saw a strong relationship between inadequate ICT equipment and infrastructure, and insufficient finance (Ololube, 2007). Moreover, the rapid increase in school locations each year, which by 2007 had reached 32,000 (see section 2.3), means that new schools continually require ICT finance, impacting on deteriorating or inadequate equipment at existing schools (Oyaid, 2009). Also, the increase in technological developments relates to cost issues for complex ICT infrastructure, especially in the educational environment where students are ultimately prepared for competency in the job market. The teacher participants confirmed this view, reporting that although the majority used computers (87%), just over half were using a computer at school. This is consistent with the teachers' views that insufficient ICT equipment was available in their schools. Researchers who have studied this issue include Pelgrum (2001), who presented a cross-national report on similar issues facing Saudi Arabia and relating to integration of ICT in education, and Jones (2004) who also found that inadequate ICT infrastructure hampered implementation.

It is nearly a decade since the decision to merge the gender-separated education administrations under the responsibility of the Ministry of Education, now responsible for all Saudi education, gender-based, and both public and private sectors and explained in section 2.3. The decision, as explained by the participants, did not determine the mechanism for the

merger, and the roles and responsibilities for many departments and agencies within the expanded Ministry were never clarified. Thus, whilst the groups remained largely intact, the relationships and lines of control were masked, and this may explain the changing administrative structures during the last few years. The interviewees' collective opinion was that the merger was not successful and that communication channels and cooperation between girls' and boys' administrations did not meet the expected outcomes. This structural issue within the Ministry is therefore possibly instrumental in the inability of the Ministry to capitalise on the ICT resources it expended over the last decade, and continues to pour into education. Whilst there is a balance of the allocation of resources by gender, the views of the female interviewee reflected those of the male participants; the issues they raised were common to both administrations.

Another barrier mentioned by the participants was a lack of technical support for the existing ICT equipment in both gender-based school systems. Saudi Arabia, as noted in section 2.1.1, is a country of extreme climate. Combined with the large number of rented schools (see section 3.2.3) which are not conducive to accommodating sensitive ICT equipment, maintenance is an issue of priority (see section 5.2.3). This was confirmed by the teachers, 84 per cent of whom reported that they were limited or severely limited in their access to technical support (table 6.40). The absence of timely technical support is of concern in previous studies as a barrier to integrating ICT into the curricula (Ertmer et al., 1999; Semenov, 2005; Bingimlas, 2009).

The last of the external barriers noted by the interviewees relates to the inappropriate rented school buildings for both genders. Issues raised were the small and narrow classrooms, the number of students, which frequently exceeded 30 per class, and the lack of suitable sites for science laboratories and computer laboratories. In general, these buildings were not designed for use as schools; however, as noted in section 2.3, the Ministry of Education required additional buildings to accommodate the rising numbers of students each year; just over half of the boys' schools are rented, and 60 per cent of girls' schools. The teacher participants agreed, with over half (53%) reporting that they worked in rented buildings. The rental schools issue will continue for many years, as the student numbers continue to increase rapidly, especially in the larger cities of Makkah, Jeddah and Al-Riyadh, and establishment costs for each new school can reach 10 million riyals which can exceed budget allocation for the planned number of schools.

The conclusion for this study, and answer to the first research question regarding ‘actions taken by the Saudi Ministry of Education in integrating ICT into teaching and learning, particularly the intermediate science curriculum’ is that implementation issues for the integration of ICT included inadequate funding, insufficient resources, lack of technical support, large classes and often room configurations that constrained teachers in the delivery of the science curriculum using ICT. These specific factors were also affected by the overarching matters of inadequate communication of Ministerial aims, and less than optimum integration of the Ministry’s organisational structure, leading to inefficiencies in the use of resources, and in policy control.

7.1.3 Monitoring and Evaluation of ICT Programs

As outlined in section 2.3, the Saudi government spends a quarter of the national budget on education and the Ministry uses these funds in a rapid expansion of physical and human resources, including ICT (Lal & Al-Jondy, 2003). It was noted that ICT integration became policy when the General Administration for Educational ICT was formed in 1991 as part of the Fourth Development Plan (see section 3.2.2). The Ministry has since implemented many programs to provide the infrastructure for integration of ICT into the educational environment, such as the Watani Project, Learning Resource Centres and Technical Halls (see section 2.6.1; Al-Omran, 2007). Some programs are directed specifically to science education such as the Comprehensive Project to Develop Curricula and the computerisation of the laboratory in secondary schools (see section 5.2.2). However, the interviewees observed that these programs lack an evaluation process to ensure quality of purpose and that they achieve their goals and outcomes. On analysis, there appears poor alignment between the stated purpose of ICT integration, the means by which ICT programs are delivered, and an evaluation process, including feedback. In order to align this system significant efforts are needed to ensure that extensive documentation in terms of teachers' guides; training sessions for teachers and supervisors, and relevant evaluation instruments must be designed for systems analysis (Gaad, Arif, & Scott, 2006).

All participants stated that they knew of no specific monitoring systems, that this was a function of the educational supervisors. There was a lack of strategy and criteria for assessment of practical as well as cognitive outcomes. Christophersen (2002) considered this an issue also for Victorian high schools in Australia (see section 3.5). Further, according to Oyaid (2009), Saudi teachers’ ICT use is more influenced by schools’ policy than Ministry of

Education policy which they are either unaware of or do not fully understand because of difficulties in implementing it; thus ICT supervisors are not pursuing this aspect during their inspections. Noting an issue on policy and program monitoring, an interviewee referred to insufficient numbers of ICT supervisors for the rapid pace of schools being established (see section 5.2.2).

Interviewees observed that the current system by ICT supervisors of monitoring and reporting ICT hardware and software effectiveness had some merit, as the equipment and programs were evaluated in other countries and proven successful before adoption in the Saudi system; however, the appropriateness of importing systems from other contexts was questioned by educational researchers such as Cuban et al. (2001). Researchers emphasise the value of the evaluation process to review and adapt a program to focus on successful outcomes in each context (Anderson & Becker, 2001). Overall, it is the conclusion of this research that the unquestioning acceptance of global ICT hardware and software is inappropriate to effectively integrate ICT in the intermediate science curriculum in Saudi Arabia.

7.1.4 Summary in Regard to Saudi Actions to Integrate ICT

This section has discussed issues arising from data obtained during the interviews with policy makers in the Ministry of Education regarding the introduction of ICT, such as computers and the internet, to answer Research Question 1. The issues concern the Ministry's ICT integration strategy. It is the conclusion of this study that, unless Ministerial policies are determined through detailed planning and implemented through responsible departments coordinated with each other, there is little opportunity for formation of an appropriate ICT infrastructure and integration process.

Specifically, there were found to be a lack of coordination in policy and planning leading to ignorance and misconceptions on Ministerial ICT policy throughout the organisation, and the Ministry could consider adopting a stronger position on its policy to integrate ICT into the Saudi education system. Next, implementing the ICT policy was found to be impacted by inadequate funding, insufficient resources, lack of technical support, and classroom aspects, which were largely supported by the teachers through the study survey. For monitoring and evaluation of ICT projects and programs, the conclusion of this research was that acceptance of global ICT hardware and software is insufficient to effectively integrate ICT in the intermediate science curriculum. The answer in part to Research

Question 1 is that the Ministry's level of implementation of their plans is insufficient to effectively integrate ICT into the intermediate science curriculum.

Next, the discussion moves to the role of Ministry professional development programs in the implementation process.

7.2 ICT Professional Development Programs for Science Teachers

The second research question asked was: 'What programs has the Ministry introduced to provide professional development for male and female teachers to employ ICT in their classes? The availability, standard and frequency of ICT training is examined, together with the accessibility to those programs for the teachers who were participants in this study. In the interview phase for the study, the Ministry's position was clear: the policy makers were adamant on the necessity for well-trained and committed teachers to implement the Ministry's ICT policies. This concerted reaction from the interviewee participants underscored their views that either on the ICT competency issue, where teacher training was a necessity, or taking a pedagogical stance where ICT is the mechanism for realignment of focus from the teacher to the student's learning, teachers' performance standards were critical (cf. Bingimlas, 2009; Albirini, 2007). The interviewees nominated the following grounds for their views: the changing role of teachers, the attitudes of teachers to ICT, and teachers' pedagogical standards and ICT competencies (see section 3.4; cf. Cheong & Kim, 2009). These are discussed in turn.

7.2.1 Pedagogical Role

The first argument for teachers' professional development is that of pedagogy evolution. The literature suggests that technological developments contribute to the emergence of new educational concepts and methodologies (Kozma 2005). This in turn can change the traditional methods of learning, in which a teacher was the only source of knowledge in the classroom, to modern methods of learning, in which there are multiple sources of knowledge and the teacher acts as a guide or facilitator of the learning process (Scheffler & Logan, 1999; Singh & Means, 1997). The roles and tasks of teachers should therefore change, as researchers assert. Shelly et al. (2006) and Makrakis (2005) state that ICT assists teachers to vary their teaching style and encourages changes in teaching methods so that new pedagogy, supported by ICT, enriches and facilitates teaching and subject knowledge. However, participants noted during school visits that the majority of male and

female Saudi teachers, including science teachers, do not have a clear concept of ICT-based curricula opportunities and do not understand the objectives of integrating ICT into the educational process. This finding accords with Bingimlas (2009) and Blackmore et al. (2003), who noted that full use of ICT in schools depended on teachers' attitudes toward ICT and their competencies which are responsive to training and professional development.

The policy makers, who were adamant on the necessity for well-trained and committed teachers to implement the Ministry's ICT policies, are well supported in their views in the literature (cf. Blackmore et al., 2003; Busacco, 2001; Charp, 2000; Shelly et al., 2006). The conclusion of this study is that there is considerable support for the notion of professional development for teachers to understand changes in pedagogical principles and practices.

7.2.2 Teacher Attitudes to ICT

The majority of interview participants asserted that teachers' attitudes were an obstacle to integrating ICT into classroom practices, particularly in science. Having visited schools that had a good ICT infrastructure, interviewees said there were teachers who would not use the ICT equipment at their disposal. These teachers appeared to have little interest in ICT, or to encounter pressure to incorporate internet-based information or programs into the science curriculum in the educational field; further, they did not desire to use ICT in their teaching. Their opinion is supported by previous studies, such as Ertmer et al. (1999), Cuban et al. (2001), and Jones (2003). These researchers argued that teacher attitudes to ICT, teaching, and ICT; their established classroom practices, and their unwillingness to change were examples of barriers to the integration of ICT (see section 3.4). Also, Wozney et al. (2006) suggest that teachers should develop their attitudes and positive views on ICT as a tool for teaching and the learning process. Therefore, one can conclude that in Saudi Arabia, as elsewhere, there is a strong belief that teachers are generally unwilling to change and embrace the integration of ICT in the science curriculum. However, the survey results tell a different story.

In the survey, teacher attitudes to using ICT in the classroom and science laboratory were examined. The survey questions were in the negative and, over 70 per cent of the teachers reported that they disagreed with the statements that using ICT in classes wastes time, and that it was difficult to manage students whilst using ICT tools. A similar percentage disagreed that ICT was not of use in the science laboratory. However, there was a large

neutral response, which may reflect indecision regarding the framing of the questions. In this study, just 11 to 15 per cent of survey respondents supported the view of the policy makers. Thus this study does not support the research findings on a generally negative attitude of teachers to ICT.

7.2.3 Teacher ICT Competencies

Educational researchers such as Pan (1999), Jones (2003), and Higgins and Packard (2004) assert that teachers are expected to be skilled in ICT skills and capable of its effective use in the classroom. They continue that teachers should also use ICT administratively: lesson planning and preparation of teaching materials, recording student assessments, and other tasks (Harrison et al., 2002; Osborne & Hennessy, 2006). In this study, interview participants reported that the majority of teachers prefer not to use ICT in the curriculum, presumably as their competencies are not to standard. Thus the need for training becomes paramount. Interview participants highlighted the diversity of required ICT skills, especially computer competency and information literacy skills, to employ ICT in their teaching process; however, the interviewees differed on skills priorities. For example, some participants focused on the skills to use Microsoft Office applications, others on presentations, photo processing, and the skills to prepare educational materials using computers. An interviewee elected a standard based on certification for ICDL (International Computer Driving Licence) for all male and female teachers (see section 3.4.2). This comment emphasises that the Ministry has no common ICT skills standards for teachers, and thus cannot determine the level where teachers can engage with its ICT policies.

In contrast, education systems in many countries have designed a model or standard for teacher ICT skills; for example, the Australian educational system has identified two ICT skill levels for teachers, the basic ICT skill level which includes 13 basic skills, and advanced ICT skills level which includes 13 advanced computing skills. The Australian standards were adopted in this study as a means to determine the competency of Saudi teachers through the questionnaire. It is recommended that, with regard to standards, I believe that the Ministry of Education could adapt some of these standard to improve the competency of science teachers which be appropriated to Saudi environment.

7.2.4 ICT Training Program

The Ministry's large capacity-building ICT program for its teachers was noted by all participants. Further, there were apparently regional training courses available for educational supervisors, and all male and female teachers could be trained in these centres. The following discussion considers how training needs were determined, the relevance of ICT training courses, and impediments to training, including attendance issues, the limited number of training programs, inadequate or inappropriate course content, and finally gender-based training needs.

The first issue regards **determining training needs**. As reported in section 2.6, the Ministry's revised organisation in 2005 included two gender-based teacher training groups, responsible for design and preparation of all relevant training courses and teacher career development (see section 3.4; Al-Omran, 2007). As noted in the analysis of interviews (see section 5.2.4) and asserted by Alhamd, Alotaibi, Motwaly, and Zyadh (2005), the Ministry employed a complex and centralised approval process for new training courses. It was observed that the process was highly bureaucratic and its lack of flexibility resulted in courses that were soon outdated and irrelevant to current events, particularly as current information and procedures were always available from the internet. Further, teachers who were time-short would not pursue training if they felt the material was outdated or irrelevant to their needs. This in turn reacted on the teachers' attitudes to training, especially if they returned to school and discussed the training standards with colleagues. Whilst teacher respondents rated ICT training as a priority (73%), the issues involved in attending courses were difficult to surmount. Three-quarters reported that course times were inappropriate; two-thirds said that such courses were not available; half said they had insufficient time to attend the courses; whilst over a quarter of the teachers said they knew more on the topic than the instructor. This indicates that courses are not sufficiently robust, frequent, or timely to serve the purpose of the Ministry in providing professional development to its teachers.

It is therefore concluded that ICT training needs for teachers could be determined from two sources: Ministry-promulgated skills standards discussed above (see section 7.1.2.3), and those the teachers sought for themselves (see section 2.4; Sidiya, 2009).

In regard to the second issue, relevance of ICT training courses, the interviewees emphasised that ICT training programs were directed to all teachers from grade one to twelve in different subjects including, of course, science. However, they also admitted that the

content of ICT competency training is generalised; there is no specific science-based material. Further, the course apparently has no direct pedagogical content. This may be a result of responsible Ministry administrators not being aware of the nature of ICT competency on the one hand, and its pedagogical value when integrated with the various curricula on the other.

Science teachers' ICT skills standards (at entry level, satisfactory, or advanced) are also of consequence. In the research literature poor ICT competencies, low motivation and lack of confidence for use of ICT by teachers were found to be significant determinants of their levels of engagement in ICT (Balanskat, Blamire, & Kefla, 2006). In addition to basic ICT skills, Saudi science teachers may need specialist ICT skills as described by Wellington and Ireson (2008), such as using a digital microscope, using and designing simulation software programs, and using technical devices such as computers and the internet in science laboratories to record data of scientific experiments (see section 3.3.1). However, whilst teacher in-service training in Saudi Arabia is assumed to take place only at teacher in-service training centres, there are options to attendance in other ways and places; for example, Sales, Al-Barwani and Miske (2008), developed an on-line teacher training course in Oman to enable teachers to design curricula, including science. In this study, teacher participants reported unexceptional levels of ICT competency (see section 7.1.4), whilst the specialist ICT skills noted by Wellington and Ireson (*ibid.*) were relevant to less than one-fifth of teachers who reported that they had digital microscopes and computers in their schools' science laboratories. Of those who had received ICT training, nearly all had attended in-service courses, the remainder received training prior to accreditation.

It is a conclusion of this study that teachers may become active agents in their own learning process which require a professional environment and culture that encourages this (Cheng, Cheng, & Tang, 2010). Using ICT flexibly in everyday practice is believed to be an important factor in increasing teachers' pedagogical competence (Daly, Pachler, & Pelletier, 2009). In this case, the Ministry may consider diversifying training programs so that rural or urban regional factors are considered, the training content adapted to the particular needs of teachers, and that the in-service training centres' administrations are permitted to be proactive in leading teacher interest. For Saudi science teachers, continuous professional development could assist them to pursue career objectives (*cf.* Gewirtz, Cribb, Mahony, & Hextall, 2006). Attendance-style courses may be supported or enhanced by online tutorials with practice-oriented projects for the classroom (*cf.* Suthers, Yukawa, & Harada, 2007). Initial teacher

training for ICT, not addressed in this study, is also an important area together with concrete measures to improve in-service teacher training.

7.2.5 Impediments to Training

Researchers find that the professional development of teachers is not straightforward, with a range of intrinsic and extrinsic factors impinging both competency-building and career development (Cuban, et al., 2001; Deetz, Tracy, & Simpson, 2000; Jones, 2004; Tozer, 1997). In a survey of the Arab Near-East region, including Saudi Arabia, Matthews (2007) found that there was little organisation or regular actions brought to bear on teacher in-service training, so that teachers tended to sink in their professional competence, easily fall behind the times, and lose morale. Matthews asserted that school inspection is rarely directed toward improving teacher competency. Plans are needed throughout the region for regular summer and full-year courses for teachers and for capable principals who can then assist teachers to attain and maintain competency in their subject-specific ICT pedagogical standards. The author in question suggested educational publications that were addressed to teachers' career aspirations and the introduction of in-service examinations.

The policy makers in this study stated that the success of teacher training was subject to many factors related mainly to attendance issues, including time constraints, limited training sessions, inadequate technical course content, and gender-based training needs. These are discussed below

The first factor impeding training was lack of attendance because of time constraints. Previous research in developed economies note that time is an issue for teachers seeking to access training. In a UK survey, Jones (2004) found that teachers reported that time constraints were impacting their ability to integrate ICT into classroom practices, and also was an obstacle in further ICT training (see section 3.4.1). Bauer and Kenton (2005) also found in their study that, without enough time to train on new ICT equipment, teachers were less likely to use ICT. In this study, the policy makers referred to a perceived issue in appropriate times that training sessions were available which may clash with class times and the fact that most male and female teachers have a full weekly schedule. Training sessions were provided after school hours, although it should be noted that teachers were not obliged to attend training, especially outside school hours. Training and career development are entirely voluntary for in-service teachers (see section 5.3.2). Half the teachers reported in the survey that they had insufficient time to attend training courses.

Secondly, the participants mentioned the limited number of training programs in teacher training centres in all regions, attributing this to impediments in standards, such as few qualified professional trainers, and lack of training rooms and equipment, in addition to the lack of diversity in training programs. ICT training programs improved at the time with Ministry partnerships with Microsoft and Intel (see section 5.3.1); however, with 42 General Educational Regions each for girls' and boys' teachers, these are not expected to serve nearly half a million teachers (see section 2.3).

To address this issue, Sales et al. (2008), as noted in the last section, recommend that initiatives in on-line training be adopted for those with access to computers; this is particularly interesting in the case of women with their culturally-based restraints on travel. Further, Sahab (2005) noted that the Ministry was seeking information from King Abdul Azziz University to offer distance education teacher training programs. This would be useful to over one-quarter of teacher respondents who said that they were too far from a training centre to access the courses. Sahab noted that, due to budget limitations and high travel expenses, the Ministry was having difficulty maintaining face-to-face training programs for its teachers.

The third factor raised by policy-makers in relation to training was inadequate or inappropriate technical course content. The responsible entity for drafting training material, the Educational Training Department at the Ministry apparently has insufficient capacity for quality material for in-service teacher training, especially ICT (see section 5.3.2). A respondent noted that the people who deliver the courses are usually educational supervisors with teaching experience, and they also draft material to deliver at these courses. The interviewee commented that there was little quality control or academic rigour in this training material, certainly not at the level of professional development. This was endorsed by the quarter of teacher respondents who said that they knew more than the instructor at such courses (section 7.2.4).

Interviewees also reported that the Ministry frequently commissions international in-service teacher course preparation; however this is prone to generalisation and inadequately addresses Saudi culture and social restraints in its execution. There is also an agreement with Saudi universities to provide advanced training courses for school principals and educational supervisors; however, this has not yet delivered the quantity of professional development that the country requires.

Study participants anticipated that Microsoft and Intel advanced ICT course material would solve the issue of the inadequate technical content in teachers' competency courses. In a Microsoft Corporation report in January, 2008, the strategy of the Ministry of Education in Saudi Arabia to train teachers in vital ICT skills was enjoying great success. The partnership enables teachers to attend training centres to learn basic ICT skills and the means to use ICT in the classroom. The program quickly became popular with the country's teachers. In three years, 30,000 teachers attended training courses and training places were filled as soon as they were announced, with many teachers expressing interest for further training.

Interestingly, the report claimed that, prior to the program's introduction in 2003; ICT was rarely used in the classroom because teachers were embarrassed if they did not know how to use it. An important aspect of the training is that no previous ICT experience is required. All 84 districts across Saudi Arabia are involved in the program. With 500,000 teachers across the country, the Ministry entered a new partnership agreement with Microsoft to increase the number of trainers and training centres to reach as many teachers as possible (Microsoft Corporation, 2008)¹¹.

The Microsoft program integrates pedagogical skills and ICT skills to change attitudes of teachers towards using ICT in the teaching process. This suggests that those responsible for designing training programs recognise the inadequacy of previous training experiences. Thus engaging consultants and training delivery from Saudi universities and global corporations may reduce the problem.

The final factor seen as being an impediment to ICT training was gender-based training needs. The findings indicate that the integration of ICT in boys' schools is more advanced than in girls' schools, and that male teachers are more advanced in integrating ICT. Specifically, teachers at boys-only schools in Saudi Arabia have significantly more experience (in years of teaching) than teachers at girls-only schools, although Wiseman (2008) did not consider that differentiated gender-based education was of sufficient consequence to impact results. The author stated that an overarching egalitarian global culture, presumably driven through ICT, could reduce female exclusion in traditional societies such as Saudi Arabia over time:

¹¹ The program Partners in Learning was launched in 2003, renewed in 2008.

In the 21st century, the concept of gender equality pervades world culture . . . The effects of world culture go beyond the more obvious explanations of overt or conscious social phenomena to include historically incremental social alignment of individuals, organizations, societies, and institutions. In other words, world culture embeds nations and national education systems in wider cultural meanings and contexts . . . egalitarian values lead to widespread gender parity in many educational contexts even though gender equality may not now (or ever) be firmly within the grasp of either schools or societies around the world (Wiseman, pp.196-197).

In apparent contradiction with Wiseman's philosophy of a 'cloak of equality', or egalitarianism, all participants in this study confirmed that ICT resources were superior in boys' schools, the experiences available in boys' education were greater, and the male teachers were better prepared. The factors noted by the interviewees for this difference were first, computers were introduced into the curriculum in boys' schools earlier (see section 2.4.3), and secondly, the Saudi male teachers have greater opportunities to access ICT training. However, interestingly, this did not necessarily appear to translate into a corresponding difference in skill levels. The teacher participants reported no such clear differentiation in their ICT skills levels. At table 6.28, women reported good or satisfactory skills for five factors, and for preparation of multimedia presentations, whilst the men so rated their skills on only the first five factors. Nevertheless, whilst men rated their skills as very poor for four factors, women set this rating for seven factors.

Women are constrained by culture and have no afternoon training opportunities; further there are more women teachers than men. However, there are possible answers to the religious constraints including women educators visiting schools, virtual workshops using ICT, or self-directed training using a Ministry intranet. In the long term, this cultural division should at least emulate other Muslim countries, including the Gulf countries, where women feel more comfortable in their daily routines.

Whilst the views of the largely male group of interviewees reflected that of the Islamic society, there is an open conclusion on this matter. This is due to the Ministry's aim of "Education for All" and its determination to educate Saudi women for employment to reduce the unacceptably high unemployment rate (ILO, 2008). In this study, the responses of the women teacher participants differ little from those of the men, and this may reflect some success in the Ministry's endeavours.

The conclusions for teachers' impediments to professional development in integration of ICT in the science curriculum therefore comprise issues largely affecting attendance.

These included time constraints and the limited number of training programs. As well, the content of supervisor-delivered ICT training material was not of a high technical standard but it was thought this may be resolved by the Ministry's employment of external providers. Lastly, although the interviewees asserted that boys' schools were superior in the integration of ICT in the intermediate science curriculum, this finding does not necessarily lead to the conclusion that girls' schools would remain under-resourced, although the finding stands. As technologies converge, and as access to computers and high speed networks increase, it will become increasingly possible to provide learners with any course and anywhere they need it. It is critical for the Ministry to work towards this goal, because in an age where information and knowledge is the basis of economic growth, those societies that successfully harness information technologies to the learning processes could be more successful (cf. Amumpe, 2002). A conclusion of this study is that professional development is important for teachers to understand changes in pedagogical principles and practices.

7.2.6 Summary and Implications Regarding MoE policies and programs

The findings of this study relating to the first two research questions regarding ICT integration and teacher professional development lead to the conclusion that the issues raised which impede the integration of ICT in schools are structural in nature. There is a high correlation between the Arab and international literature on the one hand, and the observations and views of the Ministry policy makers on the other, in identifying structural issues in the Ministry model. First, the Ministry is highly bureaucratic and inflexible in its procedures, if not its policies; which arguably are irregularly enforced. The Ministry controls all aspects of education resources, including provision of buildings, ICT, teacher training and curricula content and delivery. Yet there is evident frustration from the interviewees at the rate of change in Ministry elements where policy is made, resources allocated, programs implemented, and then rapidly dissipate under new policy, new resources and new programs. The patchy knowledge of ICT policy is an excellent example of this, as changes to policy and new programs are inadequately promulgated throughout the large and diverse organisation. In Saudi Arabia's rapid population growth with its accompanying socioeconomic development, there simply is not enough time to embed ICT initiatives and ensure a satisfactory integration in an increasing number of schools. Thus the Ministry's model of oversight and control is resulting in missed opportunities and waste of resources; further, it is unlikely to be successful in its primary objective of educating Saudi children to achieve competency in the

global job market, as they will not be able to compete with expatriates on ICT-related skills and knowledge, or indeed through a range of disciplines. A model for the Ministry could be the US or Australian federation model, where the Ministry dispenses policy, standards, and resources and the education regions use these guidelines and standards for the curricula and schools, adapting them to meet regional or local needs. This should lead to greater efficiencies.

In Saudi Arabia, the evolution to mass schooling is evident in the Ministry's "changing inflexibility", where it permits rapid head office organisational change but countenances no lessening of its regional control. Whilst the Ministry model absorbed the General Presidency for Girls' Education in 2003, a doubling of its responsibilities in a country where 38 per cent of the population is under the age of 15 years, and with a half million teachers, has perhaps become unwieldy for the Ministry structure. The Ministry restructure into head office and regional divisions was a long term proposition. The Ministry is in fact resourcing ICT in girls' schools, and to fulfil its aims and policies it should at least encourage and facilitate women's education to gain the benefit of the ICT equipment. There are socio-legal reasons as well as religious for women's inability to access training.

7.3 Teachers' Beliefs, Skills and Attitudes Regarding ICT

This section addresses the third research question, 'What are the skills, beliefs and attitudes of intermediate male and female science teachers regarding ICT?' The discussion relates to the issues arising from the analysis of the teacher questionnaire and is aimed at investigating the integration of ICT into the science curriculum, and competencies of science teachers to implement the ICT. The initial matters investigated were the characteristics of the teachers and the pedagogical and technological environments in which they worked. Issues related to teacher competencies in ICT and their knowledge and skills are explored in the following section to gain insight and draw implications about their competencies and needs in using this ICT effectively. This leads to a discussion of the interview participants' attitudes toward ICT's value in the classroom environment and their usage of such learning systems.

For the survey, questionnaires returned by 311 science teachers were analysed, 148 questionnaires from male and 163 from female science teachers. The responses showed that the large majority (89%) had bachelor's degrees; nearly two-thirds were aged from 31 to 40 years; and consequently, 60 per cent had been teaching from 11 to 20 years.

7.3.1 Teacher Characteristics and Environment

Data analysis of teaching practices for the teachers showed that one third (32%) per cent of the survey sample had 16 classes scheduled each week, and this represented twice the number of women teachers than the men; and 39 per cent of the sample had 20 classes, a third more men than women (in number, 68 men and 47 women). Large class sizes were acknowledged by the interviewee participants also, noting that ICT resources were difficult to maintain with increasing class sizes, and this was going to continue (section 5.2.3). This trend toward male teachers having a heavier class load continued as nearly double the number of male teachers than women had 24 classes per week, 11 and 6 per cent of the sample, respectively. However, this load assessment may be balanced out with women assuming a greater role with school-based tasks other than science curricula, with 30 per cent of the sample being women reporting further tasks, against 22 per cent of males reporting further tasks in the sample. Thus, whilst female teachers on average have a lower weekly class burden than the males, there is no clear trend in the analysis that would lead to women having more time during the school week to undertake ICT training (see section 3.2.3; Beggs, 2000; Jones, 2004).

The numbers of students taught in each class were similar for male and female participant teachers, and student numbers were high. Eighty-nine per cent of respondents had classes of more than 20 students; these may have been city-based, as 11 per cent of the participants in the study sample reported working in rural locations. Of the large class sizes, nearly 50 per cent (49%) of the sample reported they had 21 to 30 students, and 40 per cent of the teachers reported 31 to 40 students. Altinok and Kingdon (2009), in a survey of TIMSS¹² data for 45 countries, found that class-size effects are smaller in developed countries than in developing countries:

We find that class-size effects are smaller in resource-rich countries than in developing countries, supporting the idea that the adverse effect of larger classes increases with class-size (Altinok & Kingdon, p. 1.).

Altinok and Kingdon's findings are therefore germane to this study: that there are adverse effects on students in developing countries as class sizes grow. It is a conclusion of this study that larger than optimal student numbers impacts on the teachers' time to integrate ICT into the science curriculum.

¹² Trends in International Mathematics and Science Studies

Class size also relates to accommodation: that is, classrooms are designed or acquired for a given number of students. As the student numbers increase, classrooms are either subject to greater usage, or more classrooms are acquired, frequently through renting and converting buildings (Bendak, 2006). As noted in section 7.1.3, 54 per cent of respondents in this study were teachers accommodated in rented school buildings that usually consisted of refurbished residential buildings; these were inadequate for ICT infrastructure, and room dimensions made science class use of ICT difficult. Further, the health and safety of school students is a major concern to parents, teachers, school administration, government agencies, and researchers. Various aspects of the school physical environment have been reported as potentially contributing to risk factors resulting in unintentional injuries, as well as inefficiencies and restrictions on students and teachers alike (see section 3.4.1; Bendak, 2006; Wellington & Ireson, 2008). A conclusion of this study is that rented school buildings should be appropriately proportioned and adequate for integration of ICT into the science curriculum.

7.3.2 ICT Resources

Inadequate ICT infrastructure and equipment in schools is a fundamental impediment to ICT usage in the curricula (Bauer & Kenton, 2005; Jones, 2004). Participants were questioned regarding the state of ICT infrastructure in their schools. Only half of the sample (51%) said they had computer laboratories, slightly more male teachers, with 27 per cent of the sample. Of those who responded that they did not have computer laboratories, 28 per cent of the sample were women teachers, and 21 per cent were male. Further indications of inadequate ICT and a gender imbalance favouring males were that more than 70 per cent, including 36 per cent of the sample who were female teachers, reported that they had no computer network; and more than 55 per cent of participants reported that they had no internet access in their schools. Surprisingly, in the last instance of internet access, more women teachers than men reported having internet access (28% of the sample to 16%, respectively). Classroom ICT resources were reported as inadequate for over 85 per cent of respondents, and, apart from data projectors in the science laboratories, where 30 per cent of respondents replied in the affirmative, there was little evidence of computers (18 per cent had computers in their science laboratory); internet access (2%); or digital microscopes (17%). Thus the results reported favoured men teachers with computer laboratories and computer

networks at their schools; and favoured women teachers with internet access and ICT science laboratory equipment. Overall¹³, only 20 per cent of respondents reported that their science curriculum was adequately supported by ICT resources. The resource issue was readily agreed by interviewee participants, who detailed areas where, despite a massive government commitment, intermediate schools severely lagged behind secondary schools in physical ICT resources and teacher training resources (section 5.2.3).

The inadequate ICT resources can be explained as being due to insufficient funds, but there are other factors involved. As noted at section 2.2, girls' education was brought under the responsibility of the Ministry earlier in the decade and the technological standard of girls' education remains slightly under that for boys. The policy maker participants reported that a further issue was the frequent restructuring in the Ministry and the lack of communication and coordination between the girls' and boys' administrations. This impacted severely on the ICT implementation, as further iterations of ICT projects were introduced before the previous projects were complete, thus there was a sense of the projects being incomplete and inefficient (section 5.2.3). Another issue is resourcing sufficient schools and teachers to maintain parity with the birth rate and subsequent demand. The nature of rented schools is such that appropriate ICT infrastructure may not be possible; if this is the case, more suitable rented accommodation should be found for students. The UK study of BECTA (Jones, 2004) found that sometimes non-availability of ICT relates to inadequate scheduling of equipment for classes, inappropriate hardware and software applications, or a physical lack of access to the equipment. Neither is Saudi Arabia alone in reporting inadequate ICT: Korte and Husing (2007) reported that one third of European schools do not have broadband internet access. As interviewees in this study rated inadequate ICT infrastructure highly (see section 7.1.1.3), a conclusion of this study is that there is disconnect formed by funding, technological advancement, and administrative and technical shortcomings. The implications are that the Ministry could consider a stock take of its ICT resources, place the data on an appropriate database that could register agency ICT requirements, allocations, compatibility issues, maintenance, and disposal.

¹³ Apart from half the respondents who reported no computer laboratories or internet access to their schools.

7.3.3 Participants' ICT skills

This section takes regard of research question 3, 'the skills, beliefs and attitudes of intermediate science teachers toward ICT in the classroom'. The position of the Ministry policy makers was, and is, that ICT is no longer a luxury in a curriculum, but a basic tool (see section 5.2.1). Based on the literature (see section 3.4; UNESCO, 2002), fourteen basic ICT skills for science teachers were self-evaluated by the respondents to the survey using one of four option levels: not familiar, entry, adaptation, and transformation. In section 6.3 the results of the ICT skills assessment show that the mean for all of the participants' answers for all ICT skills was 2.20 (55%), which is slightly higher than the midpoint of a 4-point Likert scale, between "entry" and "adaptation" levels. The mean for the ICT skills of male teachers was 2.23 with 10 skills rated higher than the mid-point, and for women teachers the mean was 2.17 with seven skills above the mid-point. The results indicated that whilst ICT skill levels of participants were low in general, the ICT skills of female teachers were slightly lower than the ICT skills of male teachers. Factors leading to this result may include the merger of girls' education into the Ministry in 2003 and subsequent lack of resources required to gain parity with boys' schools, and the teacher training opportunities available to men which cannot be accessed to the same degree by women. This suggests that the Ministry should accept that there is a difference in ICT skills between men and women teachers, and should increase the training opportunities for female teachers to integrate ICT into their teaching practices. This response is also in part answer to the fourth research question, assessing 'What are the professional development needs of science teachers regarding ICT use in the intermediate science curriculum?'

The mean response rate of 2.2 for teachers' self-assessed ICT skills should be considered inadequate for implementation of ICT into the Saudi intermediate science curriculum, since the teachers rated poorly in the majority of the fourteen basic ICT skills. This leads to the conclusion that this skills inadequacy will adversely impact integration of ICT into teaching practices unless there is significant intervention by the Ministry. A recent Taiwanese study (Wu, Chang, & Guo, 2008) of a sample of 226 middle school science teachers indicated perceived usefulness and computer self-efficacy were critical determinants of science teachers' intentions about ICT integration. Computer self-efficacy and perceived fit were important antecedents of both perceived usefulness and perceived ease of use.

A conclusion of this study is that unless teachers receive both training and adequate positive reinforcement for using ICT, access to software and internet for science classes in Saudi Arabia will be difficult to achieve. An intervention could be allocating a laptop to each intermediate science teacher.

No intermediate science teacher skill level mean was rated excellent or very good, while both genders rate “using the operating system” at the level of good. At the satisfactory skill level, there were four ICT skills common to both genders: using computers, organising and saving files, preparing text documents, and collecting information from the internet. Another of the basic skills for female teachers was preparing multimedia presentations. Table 7.1 shows a comparison between the ICT skills of male and female science teachers in the six levels of ICT.

The skills self-assessed as adequate are administrative responses. Turning on a computer, navigating to text programs and writing text and saving files, plus navigating through the internet were the levels, on average, that the teachers felt comfortable. Somewhat surprisingly, women were comfortable with preparing multimedia presentations. Equally surprising was the teachers’ avoidance of a basic tool of accessing and sending emails, which suggests that internet speeds are inadequate for this form of communication. A study of Saudi broadband adoption by Dwivedi and Weerakkody (2007) found that the slow rate of acceptance was due to factors related to cultural influences. Their findings were that the factors with the main influence on attitude towards adoption of broadband were usefulness, service quality, age, usage, type of connection and type of accommodation. Whilst the authors were studying Saudi consumers, their factors seem applicable to schools. Thus the factors are impediments to adoption of broadband, and by definition, integrating ICT into the science curriculum.

A conclusion of this study is that cultural and structural factors, including perceived usefulness, service quality, user’s age, type of usage, type of connection as dial-up or broadband, and type of accommodation may have impeded integration of ICT into the science curriculum. To mitigate this threat, wireless technologies may be deployed.

Table 7.1

ICT Skill Levels: Gender Comparison

ICT skill level Percentage value of a 4-pt scale	Male science teachers	Female science teachers
Very Poor <50%	Using graphics & drawing programs Using data tables (Excel) Using science programs Designing web pages	Using graphics & drawing programs Using data tables (Excel). Using science programs Designing web pages Managing emails and emails groups. Using internet chat programs Sending and receiving emails
Poor 50 to 59%	Preparing multimedia presentations Setting up and deleting software Sending and receiving emails Managing emails, emails groups Using internet chat programs	Setting up and deleting software.
Satisfactory 60 to 69%	Using a computer Organising and saving files Preparing text documents Collecting information from internet	Using a computer Organising and saving files Preparing text documents Collecting information from internet. Preparing multimedia presentations
Good 70 to 79%	Using the operating system	Using the operating system
Very good, Excellent >80%	No skills reported	No skills reported

The part answer to the fourth research question, assessing ‘What are the professional development needs of science teachers regarding ICT use in the intermediate science curriculum?’ is that the Ministry should accept that there is a difference in ICT skills between men and women teachers, and should increase the ICT training opportunities for female teachers. A further conclusion is that unless all teachers receive both training and adequate positive reinforcement for using ICT, integration of ICT into the science curriculum will be difficult to achieve.

7.3.4 Attitudes Toward Using ICT

This section partly answers the part of the third research question relating to teachers' attitudes to ICT. Intrinsic factors such as teachers' attitudes play an important role in the teaching and learning process, and can form an actual barrier to integration of ICT into the classroom (Chen, 2008; Ertmer et al., 1999; Pelgrum, 2001). In this study the policy makers reported that integration of ICT was impeded because teachers were not convinced about the value of integration of ICT, especially the older teachers and this finding was apparently supported by the literature. According to the Dwivedi and Weerakkody (2007) findings, social and cultural aspects could also be expected to impact teachers' attitudes towards ICT. In a Syrian study Albirini (2006) similarly explored the cultural perceptions of high school "English as a Foreign Language" teachers toward ICT. The findings again point to a notable conservatism in participants' perception of ICT in education and society at large. Teachers were said to be mainly concerned about the morally damaging effect of ICT (particularly the internet), its inattentiveness to their cultural and language needs, and its growing primacy at the expense of other societal needs. Hence, participants urged for the creation of local computers and software that would better serve Arab identity and culture.

However, in the survey analysis, an opposite finding appeared. Two groups of items were incorporated to examine male and female teachers' attitudes towards ICT in education; these were related to using ICT in class, and ICT training experiences and intentions (see section 6.4.1). The results showed that the majority of teachers were eager to integrate ICT into the teaching and learning processes if they have the appropriate ICT equipment at their disposal. Also the results of all items in the second group, relating to ICT training, shows that the majority of teachers were positive in their attitudes towards professional development by means of ICT training.

Hence, the findings of this study do not support recent findings on Arab societies, including Saudi Arabia, that cultural and social factors largely regulate against the integration of ICT into the science curriculum (Albirini, 2006; Dwivedi & Weerakkody, 2007). However, the findings support those of Oyaid (2009), which may indicate a shift in sentiment toward ICT as computer use becomes more widespread. The perceptions of the policy maker interviewees that "a high proportion of teachers in Saudi schools might need more awareness than they have now to change their previous views and to overcome resistance to change" (see section 5.2.4) was not borne out by the majority of teachers' self-assessments. Thus,

according to the questionnaire participants, teachers' attitudes to integration of ICT into the science curricula should not be considered an obstacle to the integration of ICT into Saudi education system. The conclusion for teachers' attitudes, which partly answers research question 3, is that intermediate science teachers' perceptions and attitudes of ICT are not an impediment to the integration of ICT into the science curriculum.

7.3.5 Using ICT for Education

This section also addresses part of Research Question 3 in that it looks at the teacher participants' willingness to use ICT in the science curriculum. To determine the current status of science teachers' use of ICT, and to identify whether they use it for educational purposes or otherwise, they were asked about their use of computers and the internet. The results showed (see section 6.4.3) that 87 per cent (276) of the participants reported they use a computer, 128 male teachers and 148 female teachers. Of this sample (276), just five teachers reported using a computer only at school; however, 110 used a computer only at home and 156 (or half the original sample of 311) used computers at home and at school. This result indicates that although the majority of science teachers in the original sample were using computers, just over half were using a computer at school, thus the remainder had no access to, or preferred not to use, a computer at school. This is consistent with the teachers' views that insufficient ICT equipment was available in their schools and with this being an impediment to access training (see section 6.2.2). It also confirms the existence of extrinsic factors which may impede integration of ICT into the science curricula (see section 3.3.3; Jones, 2004).

Regarding the use of computer for educational purposes, 242 participants (78% of the full sample), reported that they used the computers for educational purposes, thus they use a home computer for educational purposes, presumably research, training or communication. Although ICT integration in girls' education commenced later than boys' education and thus lagged behind boys' schools as stated by policy makers, the results showed that 138 (44% of sample) of the female science teachers reported that they use a computer for educational purposes. In contrast, only 104 (33% of sample) of the male science teachers reported using a computer for educational purposes, thus women teachers appear to adopt computers for educational purposes at a higher rate than the men. For the internet, 58 per cent of the participants affirmed they had access, although 39 per cent actually reported using it for educational purposes, such as preparation of lessons, seeking resource relevant to the subject,

using multimedia in class presentations, or communicating with students through e-mail. There was little gender differentiation, with a slight bias towards male teachers.

In a manner, these survey findings underpin the policy makers' concerns on teacher attitude, noting the changing role of the teacher who now becomes a guide, supervising and directing students toward information and learning (section 5.3.1). The interviewees stated that the advent of technology changed educational concepts, and new approaches and methodologies were emerging, thus the role and the classroom practices of teachers altered. The interview respondents stated that there was a substantial difference in ICT skills between teachers and students, and found fault with many Saudi teachers who did not accept this change and avoided using ICT in their classes. The study's conclusion for teachers' use of ICT, relevant to research question 3, is that they are constrained by access to ICT at school; however, the greater majority used ICT either home or at school. Women teachers apparently employ computers for educational purposes at a greater rate than men. Given that there is a surprising lack of skills relating to e-mail, it may be assumed that teachers use computers and the internet in a limited manner and their positive attitude toward further use and training is an indication that they see opportunity in ICT in the science curricula. Thus this finding is that extrinsic factors, such as access to internet speed, cost and email opportunities, and not intrinsic factors such as teachers' attitudes, are the impediments to integration of ICT into the science curriculum for intermediate schools in Saudi Arabia.

7.3.6 Integration Impediments

Answering another part of the second research question, this section explores the finding from the teachers' survey questions on their perceptions regarding the factors that impeded integration of ICT into education. Whilst broadly in concert, there was differentiation in the ranking by the genders as indicated by Table 7.2, which compares gender perceptions on issues which impede integration of ICT. The most highly ranking issues for both genders merit particular attention: time to acquire ICT skills, ICT resources, teachers' ICT competency levels, technical support, availability of the Internet, and the availability of Arabic software. These will each be looked at in turn.

As can be expected from discussion relating to policy-makers experience in section 7.2.5, over 90 per cent of respondents reported that they did not have time to acquire ICT skills; the primary constraint for women and second for men science teachers. The severe time constraints were possibly allied with the issue of teacher competence in ICT but were

also likely to be related to rosters, class sizes, accommodation, and lack of access to professional development.

This result confirms findings in the literature on the issue of lack of time for training as a significant barrier for the integration of ICT into education, for example, Snoeyink and Ertmer (2001) and Bingimlas (2009). Jones (2004) pointed to the need for providing sufficient time to train teachers and enhance their abilities to integrate the ICT with their teaching practice, suggesting teachers undertake ICT training during school time. In a recent study, Galatis and Williams (2009) report that the lack of perceived time for professional development of teachers was a primary factor in preventing Australian schools effectively integrating ICT into their curricula. The conclusion at section 7.3.1 is pertinent: that better provision needs to be made for professional development for teachers to gain sufficient knowledge and skills to integrate ICT into the science curriculum.

Table 7.2
Impediment Ranking to ICT Integration: Gender Comparison

Ranking	Male science teachers	Female science teachers
1	Shortage of ICT equipment	Insufficient time in the weekly schedule to acquire ICT skills
2	Insufficient time in the weekly schedule to acquire ICT skills	Shortage of ICT equipment
3	Large numbers of students in classrooms	Insufficient technical support
4	Small classrooms	Small classrooms
5	Insufficient technical support	Large class numbers
6	There is no plan to improve ICT in the school	There is no plan to improve ICT in the school
7	Internet connections are not available	Internet speed is not suitable
8	There are no Arabic electronic software programs	Internet connections are not available
9	Internet speed is not suitable	Insufficient ICT training for pre-service teachers
10	Insufficient ICT training for pre-service teachers	Time constraints from extensive science curriculum
11	Time constraints from extensive science curriculum	Limited number of Arabic web sites
12	Limited number of Arabic web sites	There are no Arabic electronic software programs
13	The science curriculum is not suitable for using ICT	Concerned of ICT equipment failure
14	Concerned of ICT equipment failure	The science curriculum is not suitable for using ICT
15	Afraid of failure in using ICT in front of students	Afraid of failure in using ICT in front of students

Similar in ranking to time as a primary constraint (first for male teachers, second for female teachers), the survey participants claimed shortage of ICT equipment as a barrier to ICT integration. The conclusion of this study, supported in the literature, is that lack of ICT resources is a significant impediment to integration of ICT into the science curriculum (cf. Altun, 2006; Oyaid, 2009). Noting the funding issue and progressive deployment of ICT through the education system, the implication is that the Ministry's centralised decision making structure could be expected to manage ICT databases and audits of schools equipment. Further, the rented buildings may be better equipped if the lessor fitted them to

the Ministry's specifications before the lease begins. Arguably, this is a central issue, impacting ICT integration and teacher training alike. Although the study participants, both interviewees and survey respondents, nominated several matters that they perceived as crucial, access to operational equipment and software is undoubtedly a primary factor in integrating ICT into science curriculum in Saudi Arabia, as it is elsewhere. The educational systems in any country, including UK, Australia, Turkey, and the Gulf countries share this issue of technological inadequacy due to funding allocation (Altun, 2006; Christophersen, 2002; Jones, 2004; Oyaid, 2009; Pelgrum, 2001). Again, whilst funding is an issue, a database of existing ICT equipment through the educational regions is a starting point to identify where future allocation of funds is appropriate.

Several researchers nominate a number of factors which contribute to the resource issue (see section 3.3.3; Brush et al., 2003; Jones, 2004; Semenov, 2005). These are population pressures, rapid technological change, increasing complexity of software programming and thus higher costs, and maintenance and technical support. Consistent with research findings, the policy makers nominated the rate of growth of student numbers and thus schools; the inadequacy of leased accommodation for schools; and thus the need to service new schools, including inadequate buildings, with ICT infrastructure (cf. Agency for Buildings and School Equipment, 2008; Victoria Auditor-General, 2008). The issue of rented school premises and inadequate ICT infrastructure is expected to continue for many years in the Saudi education system. In a study exploring the future for the Saudi education through to 2014, Al-Jabry, Biaumy, and Al-mohaissin (2008) state that the country will experience high growth in education needs, with 35 per cent more girls' schools than in 2004 required by 2014 and 29 per cent more boys' schools. The authors noted that this rapid growth rate may affect the quality of education, with increased leased schools, issues in maintaining science and computer laboratories, reduced educational aids in classrooms, health and safety issues with accommodation maintenance in a range of building types.

Responding to the questionnaire, over half the teachers (54%) in the Jeddah educational region said they were accommodated in rented schools. This apparently resulted in cramped conditions with large classes in small rooms, and lack of space to permit use of ICT for class presentations. As noted in section 7.2.1, the response should be to ensure that adequate accommodation is leased to meet school standards. There is little point in acquiring inappropriate buildings which are then too expensive to fit out and maintain. Perhaps this aspect should return to the lessor for resolution.

Lack of training impacts teacher competencies, as the teachers acknowledged (see section 7.1.2.3). Science teachers need to acquire many basic ICT skills and pedagogical training to increase their competencies to employ ICT effectively in the science curriculum. An interviewee reported that, whilst there was little available in specialised ICT training for intermediate science teachers, availability of such training for secondary school teachers may lead to appropriate professional development for intermediate teachers when funds become available. UNESCO (2008) advises that increasing ICT competency should be aimed to improve teachers' practice in all areas of their work, combining ICT skills with innovations in pedagogy, curriculum, and school organisation. It is also aimed at teachers' use of ICT skills and resources to improve their teaching.

The conclusion for the training issue is that teachers' skills levels are affected by their inability to access adequate training. The implication is that innovative means should be sought to address this issue. Online training, performance incentives, in-school training and science educators as mentors are innovations which are cost-effective, respect cultural and social aspects, yet deliver training and career development which can be accessed by teachers as they have the time. This aspect does not require a change to the Ministry model as an operational issue; it requires knowledge of the issues confronting the teachers, provision of ICT in the form of laptops and wireless technologies, intranet security to distribute training programs, and a mentor system to assist science teachers.

Studies find that the successful introduction of ICT requires adequate technical support, and the more complex technologies require greater support (Graham & Martin, 1998). Hoffman (1996) states that success in ICT implementation in schools requires both staff development and technical support; together they provide the skills and knowledge that teachers need for technological advancement. Hoffman found that technical support was a success factor for the integration of ICT into education (see section 3.1.2). Without adequate technical support, teachers may become discouraged by equipment failures (Blackmore et al., 2003).

There was widespread dissatisfaction from the survey respondents with schools' technical support for ICT. Over one-third of the teachers implied that the matter was important to ICT implementation, with 85 per cent reporting that inadequate support impeded their ability to use ICT (see sections 6.6.1; 5.2.3). The interviewees' views were consistent with those of the teachers, noting that the issue of maintenance had deteriorated to the extent that computer repairs for boys' schools now involved depositing a computer at a central

facility to reduce travel time for technicians. However, the service was proving inadequate for the number of schools it was expected to serve (see section 5.2.3). The Ministry was employing specialist technical support in secondary schools, and during the previous two years more than a thousand technicians had been deployed.

The issue of breakdowns exemplifies the significant financial losses for the Ministry in its inadequate implementation policy and practices, caused through an inadequate model to encompass management and administration. This in turn impacts regional operations and the regional administrations' ability to manage matters at their schools. Owston (2007), in an international survey of ICT innovation in secondary schools, found that contributing factors for sustainability were supportive plans and policies, funding, innovation champions, and internal and external recognition and support (see section 5.2.3). Ertmer (1999) connected the extrinsic factor of technical support to the intrinsic variable of teacher confidence, for example, teacher confidence is directly affected by level of access to ICT, level of available technical support and the amount and type of training available. The conclusion is that inadequate implementation policy and practices through the Ministry's organisations impact regional operations and the regional administrations' ability to manage matters at their schools, which in turn affect teacher access and confidence.

The implication for this study is that to effectively utilise its resources and to provide basic ICT services, the Ministry should set standards for ICT hardware services for regional administrations, and that these should be funded from a single ICT allocation so that equipment is fully utilised. This may involve leased equipment maintained by the lessor for four years, or purchased equipment which involves maintenance contracts. Further, regional educational help desks should be established to permit all school ICT users to work through their issues, and this help desk concept is backed by onsite assistance, charged to the school to avoid overuse.

This issue of technical support was critical to integration of ICT into the science curriculum, and was being addressed by the Ministry. The conclusion is that an inadequate implementation policy and practices through the Ministry's organisations impact regional operations and the regional administrations' ability to manage matters at their schools.

The implication for this study is that to effectively utilise its resources and to provide basic ICT services, the Ministry should set standards for ICT hardware services and delegate implementation.

With regard to availability of the Internet, the Ministry of Education introduced internet availability to its schools in 2003, although the interviewees noted that its availability in Learning Resource Centres was 'very' limited (section 5.2.2). As the internet has several delivery systems, the original, dial-up telephone service was deployed through the country, given the state of the ICT at the beginning of the decade (see section 3.1.2; Government of Saudi Arabia, 2007). However, broadband became the global default service and a recent study by Oxford University, in association with Cisco Corporation, used a broadband quality score (BQS) standard to measure a country's access (66 countries) (Sutton, 2009). Useful in this context, the study also looked at broadband services in relation to the country's stage of economic development, and the difference between services in rural and urban areas. The researchers set a threshold BQS of 30 to be able to handle today's applications such as file sharing, social networks and video streaming, while applications for the next three to five years such as video streaming, telepresence and visual networking would require a score of 50. In the Gulf countries, Qatar lead the region on 25, Bahrain and Saudi Arabia both rated 24 while the UAE was ranked 23. Government, policy makers and regulators were advised to set national broadband agenda with goals for availability, penetration and quality, and to encourage private investment. Whilst internet connectivity lags in the region due to government concerns of inappropriate material available in the homes of devout Muslims, access to science curricular programs readily available elsewhere is constrained on the Arabian Peninsula (Mohamad et al., 2008).

In the survey analysis, participants noted that internet was frequently not available (55%) and the speed of the internet connection was inadequate for educational purposes (see section 6.1.3). In the interview results, policy makers confirmed the inadequacy of internet services, that there is no access to the internet in many of the learning resource centres in schools, noting that this relates to cost of provision and inadequacies of service providers (see section 5.2.3). Whilst line and cabling broadband are useful, future broadband will undoubtedly be wireless. International and Gulf wireless broadband/mobile suppliers are developing a competitive market in Saudi Arabia, by the end of 2009, the largest, Mobily/Bayanat intended to have coverage of 20 cities by end-2009 with 1,800 base stations. It launched a WiMAX service for residential subscribers in September 2008 at speeds up to 2Mb/s. Coverage was initially available in Riyadh, Jeddah, Dammam and Khobar and by June 2009 Bayanat claimed to have 30,000 subscribers. The Ministry is therefore in an

excellent position to utilise these emerging services to integrate ICT into the science curriculum of intermediate schools.

The findings for this study suggest that the Internet was frequently not available and the speed of the internet connection was inadequate for educational purposes. This related to inadequate competition among service providers, which, again, the government was addressing. The conclusion of this study is that wireless broadband coverage of regional education districts should be competitive with land-based broadband internet services and that the Ministry is in a position to access wireless broadband, given the number of schools and the fact that the majority are leased. This will also provide teachers with access to many services such as telepresence and visual networking for future improved science delivery to intermediate science classes in Saudi Arabia. Further, it would assist rural village users.

Arabic software **was seen as** an important but less highly-ranked impediment to ICT integration by the teacher participants. Arabic-language software is not readily available, as noted by the interviewees (see section 5.2.2). Whilst English is taught in intermediate schools, the majority of teaching and learning occurs in Arabic; thus English-based or English only ICT content constitutes an impediment for ICT integration into the science curriculum (see section 3.1.4; BouJaoude, 2003). Further, technical English, especially in ICT, is replete with jargon and acronyms, which further hinder understanding. Whilst teachers have years of English tuition, they are taught the language in an Arabic environment, which is entirely different from the multi-level experience of learning the language in an English-speaking country (BouJaoude). Availability of Arabic software is thus arguably fundamental to science teachers in intermediate schools, given that the Ministry supplies the curriculum materials. Further, observation shows that Arabic programs are not of good quality, are not linked to the curriculum and are expensive. These comments support Jones (2004) who argued that the lack of software programs inhibits teachers' use of ICT, that commercial software licenses are costly, and also that there is a lack of time available for staff to evaluate software. The conclusion of this study is that the language issue is impeding integration of ICT into the science curriculum. The implication is that there is a case for developing a science-curricula website for intermediate schools. As a suggestion, this website could comprise the science curriculum, including electronic books and educational programs, to integrate ICT into intermediate schools' science.

In summary, there were found to be several important impediments to ICT integration for the teachers surveyed. The highest ranking concerns of the teachers regarding their ability

to integrate ICT into the science curriculum included *insufficient time to acquire ICT skills, lack of ICT resources, a low level of ICT Competencies, poor technical support, lack of Internet access and a lack of Arabic language software.*

7.3.7 Summary for Teacher Skills, Beliefs and Attitudes

Of these intrinsic and extrinsic barriers to ICT implementation in schools, it appears that the primary barriers of failure of ICT integration in Saudi schools are the structural and operational issues of the Ministry's General Administration for Educational Technology, and a minority of science teachers who display a negative attitude to integrating ICT into their class activities. An overwhelming majority, over 96 per cent of the teacher respondents to the survey stated that they wanted to learn more about ICT for career and pedagogical purposes. There is therefore an underlying basis of teacher support for ICT for the Ministry to mitigate the effects of inadequate policies and practices in integrating ICT in the science curriculum.

The answer to the third research question about the attitudes, beliefs and skills of intermediate science teachers regarding ICT in the classroom can thus be summarised by the following: whilst teachers' attitudes toward ICT are generally positive, their ICT competencies appear not to be at a standard that can strongly support the integration of ICT into the science curriculum.

More specifically, the characteristics reported by the teachers show that larger than optimal student numbers are perceived to impact on the teachers' time to integrate ICT into the science curriculum. Also, rented school buildings are perceived not to be appropriately proportioned and adequate for integration of ICT into the science curriculum. The next issue, lack of ICT resources, was found to be caused by funding, technological advancement, and administrative and technical shortcomings.

Participants' perceived ICT skill levels were influenced by cultural and structural factors, including perceived usefulness, service quality, user's age, and internet connections. Based on the findings, a conclusion of this study is that, as teachers' attitudes toward ICT are not considered an impediment, unless they receive professional development, adequate positive reinforcement for using ICT, access to appropriate software, and broadband internet, integration of ICT into science classes will be difficult to achieve.

In using ICT for education, the conclusion is that they are constrained by access to ICT at school; however, the greater majority reported using ICT either at home or at school.

Women teachers employ computers for educational purposes at a greater rate than men. Again, extrinsic factors, such as access to internet speed, cost, and email opportunities, and not intrinsic factors such as teachers' attitudes, are perceived to be the greater impediments to integration of ICT. There is therefore an apparent underlying basis of teacher support for ICT for the Ministry to use to mitigate its perceived effects of inadequate policies and practices in integrating ICT in the science curriculum.

7.4 Teachers Professional Development Needs Regarding ICT Use

The fourth question, 'What are the professional development needs of science teachers regarding ICT use in the intermediate science curriculum?' was addressed by the parts of the questionnaire relating particularly to opportunities for access in relation to training in ICT as well as to their expectations, and attitudes.

7.4.1 Teacher Characteristics in Relation to Training

Improving the quality of education depends on improving the quality of teachers, and teachers must have access to professional development programs that enable them to gain multiple skills (see section 3.4; Glennan & Melmed, 2000; Hasselbring et al., 2000). However, survey respondents confirmed that less than half (45%) had attended any ICT training, with a bias to more women teachers receiving training (66% of the sample of 139 trained respondents). Of this 45 per cent, one quarter had not undertaken ICT training in the previous three years. This is of concern, as teachers require access to continuous skill and knowledge opportunities to maintain their positions in the evolving standards in pedagogical and technological fields, and this factor is recognised by all capable educational authorities (UNESCO, 2002). In the interviewee data analysis, policy makers noted issues in training access for all teachers included that training courses were limited at the educational centres for in-service teachers and that they considered the content irrelevant or of low standard (see section 7.2.5).

As an aspect of the research question relating to differences in ICT training for male and female teachers, the majority of male science teachers reported that they were trained in public institutions, whereas the majority of female teachers received their ICT training in a private institution. This outcome may point to less public training opportunities offered to women teachers, or that they prefer the private facilities (see below). The interviewee respondents also noted issues for Saudi women in accessing training: timing of ICT training

sessions, necessity for travel, or inappropriate course content standards (see section 7.2.5). In a recent Booz and Company commercial report, M. Al Munajjed, Senior Adviser, made the following recommendations to restructure girls' education (Dyes, 2009):

- implement a national educational strategy for girls and women that takes into consideration women's social and economic needs;
- revise, evaluate and reform women's curricula for all phases of education; it should emphasise foreign languages, mathematics, science, health, computer science, information technology and programs for physical and national education, community services and environmental education;
- replace traditional methods of girls' teaching such as rote learning and memorisation with good learning techniques and skills; and
- recruit and evaluate quality teachers on the basis of ICT and skills.

Whilst Dyes' recommendations are aspirational, the items relating to curricula reform, traditional teaching methods, and qualitative evaluation are reflected in the literature and the findings of this study (McKenna et al., 2000; Semenov, 2005; Shelly et al. 2006).

7.4.2 Training Access Issues

The survey for this study, based on the literature review and secondary literature sources, included questions relating to perceived obstacles and issues which concern training. Seven of the ten items at section 6.2.2 were assessed as impeding the respondents' ability to attend training, similar for both genders. As with the policy-makers the primary constraints to attending training reported by science teachers were time, the restricted number of course programs during the year, and the low standard of training course content. However, the teachers also reported that training was impeded by inadequate ICT resources at their schools and Ministry indifference to teacher training. In a recent Australian study, some of these points were also noted: specifically time constraints to attend professional learning, appropriate course content, and the ICT resources at school to impart that learning in class (Galatis & Williams, 2009). A discussion of the issues of time constraints, availability of courses at school, insufficient ICT resources, perceived Ministry indifference to teacher training and development, and unsatisfactory course standards follows.

The survey questions relating to time constraints were "the timing of the ICT training programs did not suit me", and "I do not have the time to attend any training programs". Policy makers (see 7.2.5 above) noted that teachers of both genders find difficulty in attending training programs, because the timing is unsuitable for them, and most teachers do

not have sufficient time in their weekly schedules to attend training. Thus both methods of analyses, interviews and questionnaires, provide time restraints as a key obstacle to teacher training and this is confirmed adequately in the literature (Bauer & Kenton, 2005; Jones, 2004; Lim & Khine, 2006; Pelgrum, 2001).

With regard to courses available, participants, particularly female science teachers, noted that few relevant courses were offered by the education centres. There are two teacher training centres in the Jeddah Educational Region: one for training more than 17,000 male teachers and the other for more than 23,000 female teachers (see section 2.4.2). This severely restricts the training opportunities offered to teachers.

Whilst there are more women teachers in the Jeddah Educational Region; their centre does not offer after-school training, unlike the centre for men. As there is less opportunity to attend training for female science teachers, this also explains the higher proportion of women who attend private training institutions. Women survey participants reported lack of courses as the second important constraint to training, and this is confirmed by the policy makers in the interview analysis.

A conclusion of this study is that teacher training should be a higher priority for the Ministry of Education, and that urgent attention is required to source appropriate courses, preferably delivered in the schools.

Whilst insufficient or inappropriate ICT resources in the intermediate computer or science laboratory can be attributed to a lack of funding, there is nevertheless a range of administrative and access issues as well (see section 3.3). Both male and female science teachers reported issues relating to hardware and software as impeding their ability to access training, as they were unable to utilise skills learned at courses (see section 6.2.2). This result is supported by Jones (2004) with complex interrelationships between extrinsic elements such as ICT infrastructure and intrinsic matters such as teachers' attitudes or teachers' unwillingness to change (see section 3.3.3). Two policy maker interviewees concurred: they believed that after attending ICT training, teachers need to practice on ICT equipment when they return to their schools. The conclusion is that if the schools' resources are not related to that used in training, teachers may be disinclined to attend such training.

Both male and female science teachers reported a perception that the Ministry of Education did not encourage training and also noted a lack of school administrative support. In the teachers' survey, over 60 per cent of teacher respondents reported that the Ministry did

not support their training, whilst 51 per cent said that the school administration did not. This resulted in ICT skills that comprised very poor to good (four categories) only on a six-point scale. Arguably, these perceptions may be attributed to lack of communication for its policies by the Ministry (see section 7.1.2). Interview participants noted teachers and supervisors frequently misconstrued the purpose of ICT, which could become the object of attention in itself rather than a means to achieve the real educational goal. As a conclusion of this thesis, despite the Ministry's intentions (see section 3.2.2) there is little evidence that ICT integration is proceeding with its revolution in pedagogical principles and this is repeated through the Saudi educational community (see section 5.2.1).

In the survey the respondents' perceived lack of Ministry administration support relates partly to the role of the school principal. However, this may not be of negative attitudes towards ICT on the part of the principal. The Ministry sets quotas for all teachers in the Saudi education system, and thus the centralised control prevents local school principals from adjusting the teacher rosters to accommodate training. Furthermore, the participants reported that there is no incentive for teachers in the Saudi education system to attend training programs. These points again relate to the Ministry's bureaucratic structure, where all resources and decision-making are centralised.

Thus the Ministry of Education could consider strengthening its policy for Saudi Arabia to have skilled and knowledgeable teachers by addressing inadequate in-service training resources, accessibility issues, and incentives. Further, interest in teacher training could be improved with a performance bonus through career progression or immediate financial reward for certifications and qualifications, particularly in ICT; however, this requires official performance standards and allocation for training in the teachers' weekly schedules. It is a conclusion of this study that the Ministry's level of commitment to the availability of ICT training for science teachers is inadequate.

Survey participants' responses for the standards of training were mixed, with only 40 per cent of the teachers approving the knowledge and skills of the trainers and indicating that they benefited from attending training programs, and that the content of the training programs met their training needs. There were however, relatively equal proportions: those with no opinion, and those who had concerns with the quality of the course presenters (30% each) (see section 6.2.2). However, there were more than half of respondents who had not attended ICT training programs, and this percentage absorbs the 30 per cent of respondents with no opinion, but also encompasses a further 25 per cent, who answered in the positive or the

negative. Thus the outcome of this question is unclear, as there is a disparity between these responses and attendance claims.

Regardless of the number of valid survey responses regarding perceived quality of trainers and courses, there was general agreement with the interviewee who said that the Ministry is inexperienced in writing ICT courses: “Training and development courses for the specialised ICT requirements of Saudi teachers were not subject to rigorous assessment” (see section 5.3.2). The policy makers considered the training course standards obstructed the professional development of teachers. This was in accord with a Jordanian study by Hasanain (2005), who explained that a range of training was required, dependent on the knowledge and experience of the teachers, and pedagogical and technological change. There is insufficient evidence on course standards for a conclusion.

To summarise, teacher ICT-related training access as reported by teachers on the survey, was adversely affected by a number of extrinsic issues; intrinsic issues appear to be minimal. Less than half reported having attended any ICT training, with a bias to more women teachers, and nearly one quarter had not attended ICT training for three years. The study concludes that greater accessibility to professional development for teachers to integrate ICT into the science curriculum; teacher training should be a higher priority for the Ministry, and that appropriate courses are required. Schools’ ICT resources should reflect those of teacher training centres, or training should be held in schools. Evidence from this study shows an inadequate level of commitment by the Ministry to ICT training for science teachers. This partly answers research question 2 regarding ‘programs the Ministry [has] introduced to provide professional development for male and female teachers to employ ICT in their classes’. The ICT course content, delivery, and availability appear to be inadequate to improve teachers’ ICT skills to integrate ICT into the science curriculum.

7.5 Chapter Summary

This chapter has addressed the research questions, using the findings from the analysis of policy maker interviews primarily for the first and second questions and the analysis of the intermediate science teachers’ perceptions for the third and fourth questions, and part of the second. The following summarise the answers to the research questions.

Regarding Research Question 1 regarding actions taken by the Saudi Ministry of Education to integrate ICT into teaching and learning, particularly for the intermediate

science curriculum, implementation issues reported for the integration of ICT included inadequate funding, insufficient resources, lack of technical support, large classes, and often room configurations that constrained teachers in the delivery of the science curriculum using ICT. These specific factors were also affected by the overarching matters of inadequate communication of Ministerial aims, and less than optimum integration of the Ministry's organisational structure, leading to inefficiencies in the use of resources, and in policy control.

Regarding Research Question 2, programs provided by the Ministry of Education for science teachers' professional development in integration of ICT appear to be inadequate, due to insufficient courses, and frequently inappropriate content. Further, the delivery of ICT training material was reportedly not of a high technical standard. Teachers' training attendances were reportedly adversely impacted by the low access rates. Less than half reported attending any ICT training, and of those, nearly one quarter reported that they had not attended ICT training for three years. Extrinsic factors were found to be of greater significance than intrinsic factors in teachers' ability to access professional development to integrate ICT into the science curriculum; teacher training should be a higher priority for the Ministry.

Regarding Question 3 regarding the skills, beliefs and attitudes of intermediate science teachers toward ICT in the classroom, whilst teachers' attitudes toward ICT appear to be generally positive, their reported ICT competencies are not at a standard that can support the integration of ICT into the science curriculum.

Regarding Research Question 4 regarding the professional development needs of science teachers regarding ICT use in the intermediate science curriculum, all teachers should have training available to attain clear standards of ICT competencies, preferably online and perhaps at their school's Learning Centre, to achieve the classification. Given resource limitations, more effective planning and allocation of ICT resources advised by the policy makers should ease these constraints for teachers. The Ministry should also accept that there is a reported difference in ICT skills between men and women teachers, and should increase the training opportunities for female teachers to integrate ICT into their teaching practices.

The following three issues were thought to be most significant: the Ministry's performance in integrating ICT into intermediate science classes, matters pertaining to teachers' competencies in ICT, and professional training available to them.

The government of Saudi Arabia has consistently allocated over a quarter of its annual budget to education, and supported learning and skills development, with free education for all citizens, copious numbers of national and international scholarships, and acceptance of international ranking through TIMSS. The government has undertaken sequential projects to deliver new ICT to schools; nevertheless, where there should be clear direction and known objectives for ICT implementation, the Ministry's master plan is apparently not well-known within its departments and educational regions.

The Ministry of Education administers for 5 million students and a half-million teachers in 42 districts. It assumed responsibility for girls' education several years ago without a rationalisation of its policymaking or lines of command. and this may explain the changing administrative structures during the last few years. The merger appears not to have been a success and not to have met the expected outcomes. An implication is that this structural issue within the Ministry requires resolution so that the unwieldy bureaucracy maintains policy and quality control, particularly for the larger ICT projects, and it is suggested that it devolves decision making and responsibility to the regions to encourage effective decision making closer to the schools.

The Ministry has apparently not taken a holistic approach to the many aspects involved in ICT integration, particularly as the concept introduces a potential revolution in pedagogical principles (see section 3.2). Integration of ICT into a curriculum requires a purpose for the new tool, requiring training for teachers' user proficiency and professional development for the new pedagogical practices. The conclusion of this study is that, the purpose of ICT integration into the curriculum was not clear to the teachers, particularly as they were issued with all subject materials by the Ministry, and they almost certainly lacked ICT competency, and were largely unable to access appropriate training. Thus the Ministry's stated aim of pedagogical reform of student learning rather than didactic teaching was not at that time attainable.

On a regional and school level, there are issues related to the consequences of inadequate structural reform. The major findings included inappropriate school buildings,

with half of the boys' schools rented and 60 per cent of girls' schools; high student numbers in classes, and inadequate science and computer laboratories.

Teachers, and some Ministerial officers, were apparently unaware of the Ministry's policies, and interviewees reported that the objectives of integrating ICT into the educational process were not widely understood. This result accords with previous research (Albirini, 2006; Bingimlas, 2009). Teachers with longer experience apparently did not deviate from their curriculum; however, as noted, the curriculum is delivered from the Ministry and therefore would be expected to include matters pertaining to ICT if that in fact was what the Ministry desired (cf. Cuban et al., 2001; & Jones, 2003). This then is an argument for devolution of responsibility to the educational districts that were in a better position to assess the status of the local ICT infrastructure

Teacher training and development are also part of the Ministry's responsibility and it produces all teacher training curricula for all subjects, including the ICT training programs (see section 2.6.1; Alhamd et al., 2005). However, school inspections were rarely directed toward improving teacher competency, as the General Administration of Educational Training did not determine whether a teacher was required to attend courses; this was strictly a decision by the teacher (see section 5.3.2; Mathews, 2007). An implication from this finding of teacher reticence towards attending training is that a thorough assessment of ICT course content for teacher training is required to ensure it is of an appropriate standard and that it is tailored for specific uses, such as science classes, computer and science laboratories. Training programs should be oriented toward regional needs and teacher characteristics, encompassing any cultural factors which may exclude women's access. Of importance, training and career development were entirely voluntary for in-service teachers, thus pedagogical reform may not be fulfilled. This needs to be reconsidered.

Gender issues are concluded to be a particular structural constraint to integration of ICT into the science curriculum, due to the inability of the Ministry to offer adequate training to women teachers. The Ministry should note the experiences of other Muslim countries, including the Gulf countries, where women can travel with more freedom than Saudi Arabia (see section 7.2.1). In this regard, Dyes' (2009) recommendations include a national educational strategy for girls and women; a re-evaluation of women's curricula for all phases of education; pedagogical reform; and teacher recruitment and evaluation teachers on the basis of competence and skills.

Despite gender constraints, the findings of this study do not support research that the Arab culture, including Saudi Arabia, does not encourage integration of ICT into the science curriculum (cf. Albirini, 2006; Dwivedi & Weerakkody, 2007). This research does support Oyaid (2009), who indicated a shift in sentiment toward ICT as computer use becomes widespread. The greater majority of teacher respondents used ICT either home or at school. Women teachers employ computers for educational purposes at a greater rate than men. Extrinsic factors, including internet cost and speed, may have a greater influence over ICT integration than teacher attitude, which may fade as factors such as responding to TIMSS' international standards gain primacy. With the advent of effective broadband access, the Ministry's priority may be in developing a comprehensive science-curricula website, including electronic books and educational programs for each curriculum, to facilitate delivery of the intermediate science curriculum, and to integrate ICT into intermediate schools' science.

Interviewees raised issues on a range of programs to embed ICT in schools, which were often product-based rather than support-based. Teacher training programs that were part of previous ICT programs were not effectively administered. The teacher respondents confirmed this observation; less than half had attended any ICT training and of these, one quarter had not attended training in the last three years. This is of concern, as teachers require access to continuous skill and knowledge opportunities to maintain their positions in the evolving standards in pedagogical and technological fields, and this factor is recognised by all capable educational authorities (UNESCO, 2002). Educational researchers such as Pan (1999) emphasised that any plan for the integration of ICT into education has to include appropriate teachers' professional development and ICT infrastructure. Blackmore et al. (2003) and Bingimlas (2009) also noted that full use of ICT in schools depended on teachers' ICT competencies and their professional pedagogical training. This led to a conclusion that ongoing and substantial professional development is an important but often-neglected aspect of ICT projects and programs.

A conclusion of this study is therefore that better provision needs to be made for professional development for teachers to gain sufficient knowledge and skills to integrate ICT into the science curriculum. More specifically the Ministry should accept that there is apparently a difference in ICT skills between men and women teachers, and should increase the ICT training opportunities for female teachers. Further, there are implications for the

second research question regarding the nature of ICT training and development and the teachers' ability to access this.

Day courses, workshops or generalised training off-site are adequate for keyboard skills' acquisition, but instructors are not knowledgeable of the classes, science laboratories or indeed the curriculum followed by the teachers. This moves the argument on to the nature of professional development for in-service teachers in Saudi schools, and therefore this study concludes that an assessment of training needs and applications, primarily based on the science curricula, then on gender considerations, is required.

The implication is that innovative means should be sought to address this issue. Whilst UNESCO (2008) emphasises that science teachers need to acquire many basic ICT skills and pedagogical training to increase their competencies to employ ICT effectively in the science curriculum; this study concludes that there are several impediments to attend training that could be managed more effectively through trainers visiting schools and access to innovative training online and through the schools' learning resource centres.

A further conclusion for this study is that an assessment of ICT course content for teacher training is required to ensure it is of an appropriate standard and that it is tailored for specific uses, such as science classes, and for computer and science laboratories. The policy maker participants agreed, with an interviewee advising that there was a science and mathematics curricula project under way to address the low standing of Saudi students in the TIMSS program, and that it would include training for selected teachers (section 5.2.2). Whilst commercial programs which raise teachers' keyboard skills and guide ICT implementation into curricula are useful, there is a significant need for teachers to integrate ICT into science curricula and they require training on this aspect. Training courses must be redrafted to include science-related technological content; access science programs on the internet and use CD/DVD science-based material as part of the learning process.

Chapter 8 Conclusion

This chapter concludes the thesis. It begins with a review of the study which encapsulates the study aim and outcomes for each chapter. This is followed by the conclusions from the research and implications for ICT integration in the science curriculum for intermediate schools in Saudi Arabia. The strengths and limitations for the research are noted, recommendations are made and further relevant research is explained. The thesis has a final comment.

8.1 Review of Thesis

This study investigated integration of ICT in the Saudi intermediate schools' science curriculum and teachers' professional development needs. The research questions were therefore the following:

- 1- What actions have been taken by the Saudi Ministry of Education to integrate ICT into teaching and learning particularly for the intermediate science curriculum?
- 2- What programs has the Ministry introduced to provide professional development for male and female teachers to employ ICT in their classes?
- 3- What are the skills, beliefs and attitudes of intermediate male and female science teachers regarding ICT?
- 4- What are the professional development needs of science teachers regarding ICT use in the intermediate science curriculum?

This study of integrating ICT in education in Saudi Arabia is the first which examines ICT integration in the context of the Ministry's expanded role in assuming responsibility for girls' schools administration, and the first to evaluate teachers' ICT skills, and attitudes to ICT and training in integration of ICT in the intermediate school science curriculum. The outcomes of this research may assist in identifying issues relating to the integration of ICT into all schools and curricula, as well as barriers to technological reform in education, and suggest approaches to surmount them.

The context-setting Chapter 2 discussed the socio-economic changes over the last few decades for the traditionalist population which, although profound during the last century,

appear to be accelerating, affecting both education and the way ICT is viewed. The antecedents to the current educational system in Saudi Arabia were briefly examined, noting the central role of the Ministry of Education. The Saudi teaching environment was discussed, also noting teachers' position as reflecting social values, their new qualifications and training needs, and the Islamic considerations for women teachers.

At the same time as these evolutionary changes to Saudi education were taking place, elsewhere in the world frameworks and practices for teaching and learning were similarly evolving, and these contributed to the theoretical framework of this study, as presented in Chapter 3. The literature chapter supports the research aim concerning integration of ICT in the Saudi intermediate schools' science curriculum and teachers' professional development. This was an exploration of the literature in the intersection between the related fields of science pedagogy and ICT to show that which was already known in this area. The literature review concerned 1) the integration of ICT into education, particularly science subjects, and 2) the professional development needs of science teachers in regard to ICT integration. The successful integration of ICT into education was found to be multi-dimensional and complex, depending on interlinking variables, such as teachers' competencies, financial and skill resources, curriculum issues, and teachers' and principals' attitudes, and the performance record for Saudi Ministry of Education's policy to integrate ICT into the education system. This literature chapter described the advantages and issues inherent in ICT-based educational strategies, planning, and implementation which underlie the primary research for this thesis.

A mixed methods design (cf. Creswell, 2009; Sydenstricker-Neto, 1997) was employed in this study, as described in chapter 4. Firstly, a qualitative data collection and analysis method (Sarantakos, 2005) was adopted to explore the parameters of ICT integration into science curricula in intermediate schools in the Jeddah area, and the Ministry's policies, practices, and projects in this regard. Prior to this, in chapter 2, secondary data sources in the form of Ministry of Education documents were used to identify methods used by the government to introduce computers into schools, and subsequent programs implemented to widen this strategy as new educational technologies and pedagogical trends evolved. Open-ended, semi-structured interviews were held with six policy makers in the Ministry of Education's central office in the capital, Al-Riyadh, and the Jeddah provincial administration policy makers. Data from these interviewees were classified according to the first two research questions (see section 4.3). A matrix was developed according to the responses and the major issues that emerged from the coding were used to address the research questions

(see figure 4.2). The second research method employed used a self-administered questionnaire to evaluate the computer-related knowledge, skills and training experiences of science teachers in intermediate schools. The questionnaire included participants' demographic data, attitudes toward ICT in the curricula, their ICT access, self-assessed ICT skills and exposure to training opportunities, and factors impeding integration of ICT into science curriculum (see section 4.4.1). Triangulation of sources and of methods was employed to assist validity and reliability (Patton, 2002). Different sources of data (primary and secondary) were compared and contrasted.

The interview findings were presented in chapter 5, and divided into ICT integration factors and professional development matters. The policy maker participants propounded benefits from ICT which they stated extended the curriculum in important ways and assisted teachers with lesson construction and students in their learning capacity. There was agreement that ICT was no longer a luxury or debatable; ICT were seen as an educational tool that brought another dimension into the curriculum and raised students' motivation to learn. They believed that ICT opened opportunities for cooperative and constructive learning; that students could acquire a deeper understanding of the subject because the curriculum could be better explained and presented. This was a major finding for this study. For teachers, the policy makers considered that ICT minimised time required for planning and conducting classes, improved the range of material available (although this was under the control of the Ministry) and teachers could exchange educational experiences, enhancing the flow of ideas. They were confident that these factors could improve the quality of education (see section 5.2.1).

According to the interviewees, as reported in chapter 5, the Ministry had plans and resources for ICT implementation in networking, regional and specialist infrastructure, equipment and systems. Training and support were part of the ICT project development; however, among the policy makers monitoring or assessment of ICT projects and programs was apparently lacking on the whole. Policy makers seemed to assume that teachers were not convinced of the benefits of ICT integration and considered it crucial that the Ministry communicated its ICT policy to the teachers, particularly for science. Interviewees noted structural and operational issues such as inadequate systems, equipment and support; lack of space in rented school buildings; inadequate finance; lack of communication and coordination between educational administrations, and between boys' and girls' agencies; and Ministry restructuring issues (see section 5.2.3). The funding matter also related to girls'

schools, which were thought to be under- resourced, and Saudi Arabia's high birth rate which resulted in many new schools opening every year and these also required ICT systems in place (see section 5.2.3). The provision of ICT infrastructure and equipment so that elements of these technologies could be used in the science curriculum was thus compromised.

The views of the teachers in chapter 6 relating to ICT integration and their professional development needs were assessed using surveys. The teachers tended to be aged in their thirties, to hold bachelor's degrees, to have 11 to 20 years' teaching experience, and to deliver more than 16 classes per week. Significantly, the majority (53%) worked in rented school buildings and 40 per cent had over 31 students in each class. Only half reported having computer laboratories at their school and less than half reported having the internet at school. Further, less than half of the survey participants reported attendance at any ICT training, whilst some three quarters of the remainder attended one or more ICT courses over the previous three years. Reasons for non-attendance for women teachers in service appeared to be cultural, and related to course timing, as the sessions were held in the afternoon, after hours, when they did not wish to attend. For all teachers, time was an issue as they worked full-time with heavy work loads. There was another matter regarding the perceived lack of quality of the training which was adapted from international commercial courses and delivered by non-professionals (see section 6.2.3). Nevertheless, over 80 per cent of teachers felt they had at least the basic skills to use ICT in the classroom, and a similar proportion reported that they wished to learn more. With regard to internet-related skills, two-thirds of men professed levels of competency accessing the internet and using e-mail; however, two-thirds of all respondents reported being unfamiliar with website management. For scientific data analyses, only half of all participant science teachers, reported being familiar with this form of software. Whilst the majority said that ICT assisted learning and had a positive impact on teaching (circa 90%), two-thirds apparently contradicted this statement, saying they preferred traditional classroom practices. In summary, 77 per cent of study participants reported using ICT for educational purposes, whether at school or home.

In chapter 7, findings relating to the research questions were discussed, firstly those relating to the Ministry of Education's plans and actions to integrate ICT into the educational system and provide relevant professional training, and secondly, those relating to teachers' skills, beliefs and attitudes of intermediate science teachers and the access teachers have to quality ICT training to allow full use of available ICT in science classes. It was noted that the government of Saudi Arabia has consistently allocated over a quarter of its annual budget to

education, and supported learning and skills development with its policies and programs. Although the Ministry experiences political, religious and cultural issues, this study finds that, where there should be clear direction and known objectives for ICT implementation, the Ministry's master plan is not well-known within its departments and educational regions. This was due in part to frequent Ministry restructures and change of administrators who introduced a different agenda. The Ministry of Education administers for 5 million students and nearly a half-million teachers in 42 districts. It assumed responsibility for girls' education; however, the merger did not meet the expected outcomes. This structural issue within the Ministry requires resolution.

Further, the Ministry has not taken a holistic approach to the many aspects involved in ICT integration, particularly as the concept introduces a revolution in pedagogical principles (see section 3.2). Whilst the purpose of ICT integration into the curriculum was not clear to the teachers, particularly as they were issued with all subject materials by the Ministry, the majority had only basic ICT competency, and were largely unable to access appropriate training. The conclusion of this study is the Ministry's stated aim of pedagogical reform towards student learning rather than didactic teaching was not at that time attainable, given the unresolved issues. The consequences of inadequate structural reform within the Ministry were exacerbated by inappropriate school buildings, with over half of the school buildings rented and compromised for ICT integration; high student numbers in classes, and inadequate science and computer laboratories.

Teacher training and development are also part of the Ministry's responsibility and it produces all teacher training curricula for all subjects, including the ICT training programs (Alhamd et al., 2005). However, school inspections were rarely directed toward improving teacher competency (Matthews, 2007). Of importance, training and career development were entirely voluntary for in-service teachers, thus pedagogical reform may not be fulfilled.

Gender issues are a further structural constraint, impacting teachers' professional development. Dyes (2009), for example, advocates for a national educational strategy for girls and women; a re-evaluation of women's curricula for all phases of education; pedagogical reform; and teacher recruitment and evaluation teachers on the basis of competence and skills.

Chapter 7 addressed the research questions through conclusions informed by findings from chapters 5 and 6 and these are discussed below. To summarise the conclusions; firstly, it

was concluded that the Ministry of Education's ICT master plan was not well-known to either of the participant groups. Secondly, the structural merger of boys' and girls' education did not appear to produce the efficiencies that were expected to flow to the Ministry and the education sector, and the improvements in education outcomes through ICT integration were therefore slow to occur. Teachers were unfamiliar with the Ministry's directives on ICT integration into education and unconvinced by the Ministry's performance record with its ICT resource allocation and attention to their ICT training. The majority of teachers had only basic ICT skills, and found difficulty sourcing and attending appropriate training. Other conclusions from the findings involved inappropriate school buildings, compromised ICT integration through lack of technical and administrative support; high student numbers in classes, and inadequate science and computer laboratories.

Further, teachers' professional development was the Ministry's responsibility; school inspections did not routinely advise on teacher competency and teacher training was not mandated. Following from that, women teachers were found to be particularly at risk from adequate training access, which impacted their professional development to a greater extent than for their male colleagues.

8.2 Conclusions and Recommendations

The study's conclusions and recommendations are drawn from the findings in chapter 7. The fundamental issue that emerges from this study is that the integration of ICT into science curriculum of intermediate schools is impeded by structural and operational factors relating to the Ministry of Education's programs and policies. The conclusions and recommendations that follow this finding are presented under three headings which represent the three major findings of this study: 1) inadequate ICT resources, 2) management of ICT integration, and 3) teacher ICT training and skills issues.

8.2.1 Inadequate ICT Resources

The performance of the Ministry in ICT integration into Saudi education (research question 1) appears as a low priority; or, given an initial priority, other projects and programs now appear above it on the Ministry's agenda (see section 7.1.1). Policy makers spoke about the Ministry's ICT integration master plan; there is also an over-arching ten-year plan which contains proposals which were aspirational in nature rather than practically-oriented (see section 5.2.5). Whilst the Computer and Information Centre is responsible for ICT within the

Ministry, policy makers appeared to be critical of its programs which are layered and multi-directional, with policy not being directed towards a coherent planning framework where such aspirations could be fulfilled.

An implication which arises from this conclusion is that there needs to be a greater coordination of resources towards basic ICT services. As a suggestion, the Ministry could set standards for ICT hardware services for regional administrations, funded from a single ICT allocation. For example, leased equipment can be maintained by the lessor, or purchased equipment should include maintenance contracts; both contracts having regional educational help desks (see section 7.2.7).

Developing a science-curricula website which includes electronic books and educational programs for each curriculum would facilitate delivery of the intermediate science curriculum. However, for this to be effective, wireless broadband coverage of regional education districts would be advisable, cost-competitive with land-based broadband internet services, given the number of schools and the number that are leased. Particularly with rural users, this would assist educators with download times, teleconferencing and science-based content.

Despite its communication issues, the Ministry has a long-standing commitment to educational reform and to ICT integration into schools (see section 2.6.1). Whilst program priorities change and some authors have reservations about how this may be achieved in practice, there is broad agreement in the literature, from the policy makers and from the science teachers that ICT is and will continue as, a significant factor in education. Reports of expensive internet access and inadequate resources for science curricula (see section 5.2.1) suggest that educational ICT infrastructure planning is required to ensure services are secure, compatible, and functional. Further, a quality assurance function for procurement would ensure the inclusion of technical assistance and a periodic monitoring and feedback process for the life of the facility or equipment (see section 7.1.1).

8.2.2 Management of ICT Integration

Continuing with the research question concerning the Ministry's level of commitment to build an ICT infrastructure for pedagogical purposes, there is little evidence that the Ministry of Education has taken a holistic approach to reform (see section 3.2). Clarity in purpose is fundamental to all endeavours, and this is especially the case for education. Study interviewees noted that the majority of Saudi teachers appeared not to

have a clear concept of ICT-based curricula opportunities and do not understand the objectives of ICT integration; this agrees with the majority of the literature (see section 7.2.1). The inadequate strategy leads to the implication that there is disconnect between the Ministry's aims regarding ICT integration and its implementation (see section 5.2.3). This disconnect is found to be partly caused by a lack of ICT training in a society where the majority of Saudi families do not have computers and children have little access to ICT (see sections 3.1.2 & 6.4.3). This could be addressed by training of teachers and their students on basic service laptops available to lease or purchase from the intermediate school.

Unless extant Ministry policies are adopted through detailed planning and leadership in its schools, and appropriate pedagogical and subject-based professional development, this study concludes that there is little hope of ICT integration into the curricula. Assuming that functional educational ICT becomes available, a responsible entity within the Ministry could act as policy administrator to coordinate the various head office departments in delivering ICT outcomes: procurement, training, integration, and maintenance (see section 5.2.5). This entity can then coordinate an orderly, integrated distribution of resources to the regional administrations.

8.2.3 Teachers' ICT Training and Skills Issues

A conclusion of this study in relation to research question two is that teachers' commitment to ICT integration was affected by the issues confronting them in accessing ICT training. The policy maker participants' majority opinion was that the Ministry's teacher training procedures were inflexible and frequently unable to meet changing priorities. As an example, cultural differences including limited travel preclude women teachers from accessing training from external sources, as Al-Munajjed (1997) noted (see section 7.2.3). Policy makers reported that ICT training courses were generalised, did not reflect the range of hardware or software available in schools, and specific science-based training was not available from the training centres. Nevertheless, the Ministry was addressing these issues for intermediate schools, as advanced ICT science curricula together with training programs were becoming available in 2008 to address computer literacy issues in teachers.

In the quantitative research, teachers' awareness of the Ministry's ICT agenda and attitudes to ICT training included reports of insufficient time through busy schedules to undertake in-service training, as the Ministry sets teacher quotas which prevent school principals adjusting teacher rosters to accommodate training. As noted, there is no career

incentive for teachers to attend training, and training is discretionary (see section 7.2.3). Interest in teacher training could be improved through career progression or financial reward, if performance standards were in place and there was allocation of time for training in the teachers' weekly schedules.

This study's findings do not fully support recent findings on Arab societies, including Saudi Arabia, that cultural and social factors adversely impact integration of ICT into the science curriculum (cf. Albirini, 2007; Dwivedi & Weerakkody, 2007). Despite a questionnaire majority response toward traditional science teaching methods, the findings support those of Oyaid (2009), which indicate a shift in sentiment toward ICT as computer use becomes widespread. Further, the perception of the policy maker interviewees that "a high proportion of teachers in Saudi schools might need more awareness than they have now to change their previous views and to overcome resistance to change" (see section 5.2.4) was not borne out by the majority of teachers' self-assessments. Thus, the findings of this study are that teachers' attitudes to integration of ICT into the science curricula should not be considered a significant obstacle to the integration of ICT into the Saudi education system. Over time, science teachers' ICT skills have grown and they are using more ICT in the science curriculum.

The implications arising from this finding that teachers' attitudes are not a significant barrier to integration of ICT into the science curriculum are that the Ministry of Education could focus on improving the quality of teaching through better access to comprehensive training opportunities for teachers. Further, alluding to research question 3 and 4, both male and female teachers reported indifferent ICT skills, generally on similar levels, with differences in the rating of the items (see section 6.3; section 7.5.4; UNESCO, 2002). Their commitment to ICT was higher than reported by Dwivedi and Weerakkody (2007) and findings support those of Oyaid (2009), which, as noted, may indicate a shift in sentiment toward ICT as computer use becomes widespread.

In addition, school curricula must reflect the future demands of a modern private economy (see section 2.1). ICT skills standards for teachers could be based on international examples, such as the two-level Australian ICT competency standard. With regard to training access for women teachers, if the quality of training offered through physical attendance at the regional training centres is not assured, ICT itself is a means by which women can access skill acquisition, initially through the schools' Learning Resource Centres when these are widespread and sufficiently resourced.

8.3 Strengths of Study

The strengths of this study are that it is an exploration of a traditionalist education system and the issues encountered in the government's adoption of a new pedagogical model based on ICT. Whilst many of the issues arise from the participants' attempts to adjust to rapid change and the dislocations to accommodation, resources, curricula, and teaching and learning principles; these factors are inherent in education systems anywhere. This is particularly relevant to developing economies as the factors of change are imported and the stakeholders cannot readily relate to the cultural assumptions inherent in foreign language-based programs.

This empirical study investigated teachers' perspectives on their competencies regarding ICT, and access to ICT training and development. Their views on barriers to and issues around attaining these competencies are also identified, and the interest they may have in pursuing pedagogical change. Further, perceptions of Ministry policymakers on the study questions were sought to enrich the study and provide an understanding of the Ministry's experiences integrating ICT into Saudi public education. Whilst the focus is on Saudi science teachers, the findings of this research may have significance in educational change in all developing economies, especially Arab.

8.4 Limitations of Study

Any research methodology has its limitations. While a mixed methods approach can combine different perspectives, it may not have the depth of a more extensive qualitative study, or the generality of an extensive quantitative study. Any study is also limited in time and place. The primary research took place in Jeddah Province between 2007 and 2009, and, whilst there was an acceptable return rate for the survey, there may have been a self-selection bias, and, while the population sampled was comprehensive, the overall sample represents under 10 per cent of all science teachers at intermediate public schools in Saudi Arabia. Hence, the findings may be particular for the participants in this study and may not generalise to education systems and the science teacher population in other places. However, the sample did include a range of teachers, both male and female, in terms of age, experience teaching, and attitudes to ICT, and this will dictate whether findings are transferable to another context.

Another limitation of survey and interview studies is that of timing, as respondents tend to dwell on matters of immediate concern, particularly when completing a questionnaire.

This is an inherent limitation in research and must be balanced by reference to a significant literature search and cross-referencing through qualitative research and the subsequent analysis. Conclusions of this study therefore seek structural recommendations rather than procedural responses which can change over time.

8.5 Further Research

Subsequent research is recommended to explore in more depth and other contexts trends and constraints on ICT integration in the science curriculum in Saudi Arabia, and could include observational studies which were beyond the scope of this study. Given the growing body of evidence to be extracted from the TIMSS material, science and mathematics at Grade 8 meet the criteria for progress at Saudi intermediate schools and ICT should be an excellent source of functional data in this respect. A comparative study of the Computer and Information Centre's ICT assets in Saudi schools with similar organisations in the Gulf countries, and world averages, would be useful to determine the effective usage of the existing ICT resources. A comparative study of the Ministry itself against Gulf countries' Education ministries and world trends in education infrastructure would be useful in testing the effect of decentralisation of education into central policy and regional implementation (see section 7.2.2). Finally, the theoretical issues in integrating ICT into the science curriculum and the teachers' enhanced role through professional development provide interesting pathways for further research.

8.6 Final Comments

This thesis began in the trust that research can lead to improvements in an education system and that it will then lead to improvement in outcomes for Saudi students; that its findings and recommendations may assist the teaching and learning experiences for all stakeholders. It is a unique work, dedicated to the future of Saudi Arabia's education system, and written with the aim of scholarly investigation of the structure and process of change in relation to the larger project of integrating ICT into the curriculum, and the charting of a route toward the best outcomes.

I commend the work to readers and hope that it fulfils its intention of placing new knowledge in your grasp. Undertaking a PhD and writing a thesis is a path I have been privileged to travel.

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Appendixes Research Documentation

- Appendix 1.1 Ethical Approval Letter
- Appendix 1.2 Plain Language Statement for Interviews (English Version)
- Appendix 1.3 Plain Language Statement for Interviews (Arabic Version)
- Appendix 1.4 Consent Form for Interviews (English Version)
- Appendix 1.5 Consent Form for Interviews (Arabic Version)
- Appendix 1.6 Plain Language Statement for Questionnaire (English Version)
- Appendix 1.7 Plain Language Statement for Questionnaire (Arabic Version)

Appendix 1.1 Ethical Approval Letter



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Human Research Ethics Application

The Design and Social Context Human Research Ethics Sub-Committee, has received your amended application entitled “An evaluation of the integration of ICT into science teaching and the Professional development needs of science teachers in Saudi Arabia”

I am pleased to advise that the committee has approved your application as level 2-risk classification.

This now completes the Ethics procedures.

This approval is valid for three (3) years and expires: **August 2009**

You are reminded that an Annual/Final report is required to be submitted by 1st of December each year for the duration of the approval period. This report is available from: URL:

http://www.rmit.edu.au/rd/hrec_apply

Should you have any queries regarding your ethics application please seek advice from the Chair of the sub-committee Assoc. Prof. Heather Fehring on 9925 7840,

heather.fehring@rmit.edu.au or contact me on (03) 9925 7877 or email

heather.porter@rmit.edu.au

I wish you well in your research.

Yours sincerely

Heather Porter
Secretary

Design and Social Context

Human Research Ethics Sub-Committee Operational Unit - Bundoora

Appendix 1.2 Plain Language Statement for Interviews (English Version)

Integration of ICT into science curriculum and the Professional development needs of science teachers in Saudi Arabia

Dear participant,

My name is Abdullellah Alsulaimani; I work for the General Educational Director of Jeddah Province. Currently, I am undertaking a Ph.D. study at the School of Education Portfolio of Design and Social Context at RMIT University, Melbourne - Australia. The title of the thesis is Integration of ICT into science curriculum and the professional development needs of science teachers in SA. This study under the supervision of Dr Mary Hanrahan and Associate Professor Heather Fehring. The study aims to develop and improve of science teachers competences to integrate the ICT into their practice. To complete this study, I need to investigate specific areas of the integration of the ICT into science curriculum in intermediate schools. I will be gathering data through a combination of questionnaires and interviews.

I would like to invite you to be part of this important study. Through interviews I aim to explore ideas, beliefs, and the experiences of senior policy officials regarding the topic of the study. During the interviews I will seek to discover information from policy makers about the use of ICT within the education system of SA, the level of ICT skills of science teachers and their success in integrating ICT into the education, and the professional development needs of science teachers in relation their ICT skills

Your contribution in this interview is very valuable because the findings from this project will assist in understanding ways to improve the quality of education in the SA. Questions will not cause you any discomfort or potential risk. The interview will be audio-taped and it will be takes 60 to 90 minutes to complete. All information obtained from the interview will be used for research purposes, No personal identifying information will be collected. Thus, the privacy of you and your organisation will be kept absolutely confidential. and will be stored in the locked cabinet in my supervisor office for five years as prescribed by RMIT University regulations. Only my supervisors and I will have access to this data. In addition, the findings of this study might be published, and a thesis will be presented to RMIT.

This participation in this study is purely voluntary should you wish to withdraw you may do so at anytime and any processed data may also be withdrawn upon your request.

If you have any questions or would like to be informed of the aggregate research findings, please call me at phone number +61 3 9925 7480 or E-mail S3125940@student.rmit.edu.au. Or contact my Senior Supervisor Dr. Mary Hanrahan on +61 3 9925 7859 or E-mail mary.hanrahan@rmit.edu.au.

Researcher: Abdullellah Abdullah Alsulaimani

Should you have any complaint concerning how the questionnaire is conducted, please do not hesitate to contact the RMIT University Standing Committee on Ethics in Research Involving Humans at the following address: RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001, Phone: 61 3 9925 1745 www.rmit.edu.au/council/hrec

Appendix 1.3 Plain Language Statement for Interviews (Arabic Version)

دمج تقنية المعلومات والاتصالات في تدريس العلوم
وتحديد الاحتياجات التدريسية لمعلمي العلوم في المملكة العربية السعودية

عزيزي المشارك

السلام عليكم ورحمة الله وبركاته

أنا عبدالإله بن عبدالله السليمانى المبتعث حاليا من الإدارة العامة للتربية والتعليم بجدة لتحضير درجة الدكتوراه في تقنية المعلومات والاتصالات في مجال التربية والتعليم بكلية التربية بجامعة رMIT بمدينة ملبورن بولاية فيكتوريا بأستراليا. وعنوان بحثي هو تقويم دمج تقنية المعلومات والاتصالات في تدريس العلوم وتحديد الاحتياجات التدريسية لمعلمي العلوم في المملكة العربية السعودية. يشرف على البحث كلا من الدكتورة ماري هانراهان والبروفسور هيندر فهرنج. تهدف هذه الدراسة تطوير وتنمية قدرات معلمي ومعلمات مادة العلوم تربويا لدمج تقنية المعلومات والاتصالات في تدريس مادة العلوم في المرحلة المتوسطة في المملكة العربية السعودية. ولإكمال هذه الدراسة احتاج إلى البحث بشكل خاص في كل ماله علاقة بدمج تقنية المعلومات والاتصالات بتدريس مادة العلوم وتطوير وتنمية قدرات معلمي ومعلمات العلوم في المرحلة المتوسطة، وسوف أقوم بجمع المعلومات بمشيئة الله من خلال إجراء بعض المقابلات الشخصية بالإضافة لعمل استبيان مع معلمي ومعلمات العلوم في المرحلة المتوسطة.

يسرني دعوتك للمشاركة في هذه الدراسة من خلال مشاركتك في إجراء المقابلة الشخصية الخاصة بالبحث، والتي تهدف إلى استكشاف الأفكار والتوجهات والخبرات للمسؤولين ومن لهم علاقة بدمج التقنية بالعملية التعليمية بالإضافة للمسؤولين عن تدريب وتطوير مهارات المعلمين والمعلمات بوزارة التربية والتعليم خلال الفترة ما بين 15-30 /11/ 1427 هـ.

إن مساهمتكم في البحث من خلال الإجابة على أسئلة المقابلة والتي تتراوح مدتها من (60-90 دقيقة) مهم جدا لموضوع البحث حيث أن إجابتك سوف تساعد في فهم الطرق التي تؤدي إلى الرقي بالعملية التعليمية. كما أود أن أوضح لسعادتك نوعية الأسئلة لن تسبب أي إزعاج أو مخاطر محتملة لكم والمعلومات المستخلصة من المقابلات سوف تستخدم لأغراض البحث العلمي فقط ولن يطلع عليها سوى الباحث والمشرفين على البحث و يتم تخزينها لمدة لا تقل عن خمس سنوات طبقا لنظام جامعة (RMIT)، وفي حالة نشر نتائج هذه الدراسة سوف يتم المحافظة على سرية المعلومات الشخصية بحيث تضمن عدم ذكر (الاسم، العنوان، اسم الإدارة) في نتائج الدراسة.

إن مساهمتكم في هذه الدراسة مفيدة ومهمة لإكمال دراستي وتعاونكم محل احترامي وتقديري وسيتم التنويه عن ذلك في رسالتي، وسوف يتم تفهم الوضع في حالة الرفض.

الباحث / عبدالإله بن عبدالله السليمانى

RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne,
3001 Australia, Phone: 61 3 9925 1745 www.rmit.edu.au/council/hrec

Appendix 1.4 Consent Form for Interviews (English Version)

Integration of ICT into science curriculum and the Professional development needs of science teachers in Saudi Arabia

Name of participant:

1. I have received a statement explaining the interview.
2. I consent to participate in the above project, the particulars of which interview have been explained to me.
3. I authorise the investigator to interview me.
4. I give my permission to be audio taped Yes No
5. I give my permission for my name or identity to be used Yes No
6. I acknowledge that:
 - (a) Having read Plain Language Statement, I agree to the general purpose, methods and demands of the study.
 - (b) I have been informed that I am free to withdraw from the project at any time and to withdraw any processed data previously supplied.
 - (c) The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.
 - (d) The privacy of the personal information I provide will be safeguarded and only disclosed where I have consented to the disclosure or as required by law.
 - (e) the findings of this study might be published, and a thesis will be presented to RMIT
 - (f) The security of the research data is assured during and after completion of the study. The data collected during the study may be published. Any information which will identify me will not be used.

Participant Consent

Name:

Signature: Date:

Appendix 1.5 Consent Form for Interviews (Arabic Version)

دمج تقنية المعلومات والاتصالات في تدريس العلوم
وتحديد الاحتياجات التدريبية لمعلمي العلوم في المملكة العربية السعودية

استمارة موافقة على المشاركة في المقابلة الشخصية لمشروع بحث

أوافق إنا الموقع اسمي أدناه على المشاركة في مشروع البحث المقدم من الباحث / عبدالإله بن عبدالله السليمان من جامعة آر إم آي تي بولاية فيكتوريا بأستراليا. حيث أن مشروع البحث قد تم شرحه لي من الباحث وقرأت الرسالة التوضيحية للبحث والتي احتفظ بنسخة منها في سجلاتي ، كما وإنني اعرف بأن هذا البحث يهدف إلى تطوير وتنمية قدرات معلمي ومعلمات مادة العلوم تربويا لدمج تقنية المعلومات والاتصالات في تدريس مادة العلوم في المرحلة المتوسطة في المملكة العربية السعودية.

إنني على دراية كاملة بأن موافقتي على المشاركة في هذا البحث تعني:

- استعدادي للقيام بمقابلة شخصية لمدة تتراوح بين ستين وتسعين دقيقة،
- موافقتي على تسجيل المقابلة صوتيا،
- المعلومات سوف تستخدم لمشروع هذا البحث فقط،
- البيانات المستخلصة سوف تعامل بسرية تامة مع عدم ذكر أي بيانات تشير إلى هوية المشارك أو الإدارة التي يتبعها في حالة نشر نتائج الدراسة،
- إن مشاركتي تطوعية وبإمكاني الانسحاب من المقابلة بدون أي التزامات تترتب على ذلك.

موافقة المشارك:

الاسم:

.....

التوقيع:

التاريخ:

.....

Appendix 1.6 Plain Language Statement for Questionnaire (English Version)

Integration of ICT into science curriculum and the Professional development needs of science teachers in Saudi Arabia

Dear science teacher:

My name is Abdullellah Alsulaimani, I am undertaking a Ph.D. study at the School of Education Portfolio of Design and Social Context at RMIT University, Melbourne Victoria, Australia. The title of my PhD is integration of ICT into science teaching and the professional development needs of science teachers in Saudi Arabia (SA). I will be doing this study under the supervision of Dr Mary Hanrahan and Associate Professor Heather Fehring. The aim of my study is develop and improve the ability of science teachers to integrate information and communication technology (ICT) into their teaching, and determine the professional development needs of science teachers in relation to ICT and pedagogical understanding skills in SA To complete this study, I need to investigate specific areas of the integration of the ICT into science teaching in intermediate schools. I will be gathering data through a combination of interviews and questionnaires.

I would like to invite you to be part of this important study. Through the questionnaire, I aim to explore ideas, beliefs, and the experiences of science teachers who teach at the intermediate schools regarding the topic of the study. During the survey questions I will seek to discover information from you about the use of ICT within the education system of SA, the level of ICT skills which you have, your success in integrating ICT into the education, and the professional development needs in relation to your ICT skills

Your contribution in this questionnaire is very valuable because the findings from this project will assist in understanding ways to improve the quality of education in the SA. Questions will not cause you any discomfort or potential risk. The questionnaire will take about 30 minutes to complete it and no identifying information will be collected from participants. The name of schools will not be identified or mentioned in the study. All information obtained from the interview will be used for research purposes, thus, the privacy of you and your organisation will be kept absolutely confidential. and will be stored in the locked cabinet in my supervisor office for five years as prescribed by RMIT University regulations. Only my supervisors and I will have access to this data. In addition, the findings of this study might be published, and a thesis will be presented to RMIT.

This participation in this study is purely voluntary should you wish to withdraw you may do so at anytime and any processed data may also be withdrawn upon your request.

If you have any questions or would like to be informed of the aggregate research findings, please call me at phone number ----- or E-mail S3125940@student.rmit.edu.au. Or contact my Senior Supervisor Dr. Mary Hanrahan on ----- or E-mail mary.hanrahan@rmit.edu.au.

Researcher: Abdullellah Abdullah Alsulaimani

Appendix 1.7 Plain Language Statement for Questionnaire (Arabic Version)

دمج تقنية المعلومات والاتصالات في تدريس العلوم
وتحديد الاحتياجات التدريبية لمعلمي العلوم في المملكة العربية السعودية

عزيزي معلم/ معلمة العلوم بالمرحلة المتوسطة

السلام عليكم ورحمة الله وبركاته

أنا الطالب عبدالإله بن عبدالله السليمانى المبتعث حاليا من الإدارة العامة للتربية والتعليم بجدة لتحضير درجة الدكتوراه في تقنية المعلومات والاتصالات في مجال التربية والتعليم بجامعة رMIT (RMIT) ملبورن - بأستراليا، عنوان البحث "دمج تقنية المعلومات والاتصالات في تدريس العلوم وتحديد الاحتياجات التدريبية لمعلمي العلوم في المملكة العربية السعودية". ويشرف على البحث كلا من الدكتورة ماري هان هانراهان والبروفسور هيذر فهرنج. تهدف الدراسة إلى تطوير وتنمية قدرات معلمي العلوم لدمج تقنية المعلومات والاتصالات في تدريس مادة العلوم في المرحلة المتوسطة في. ولإكمال الدراسة احتاج إلى البحث في كل ماله علاقة بدمج تقنية المعلومات والاتصالات بتدريس مادة العلوم، وسوف أقوم بجمع المعلومات من خلال إجراء بعض المقابلات الشخصية بالإضافة لعمل استبيان مع معلمي ومعلمات العلوم .

يسرني دعوتك للمشاركة في هذه الدراسة من خلال مشاركتك بالإجابة على الاستبيان الخاص بالبحث والذي يهدف إلى استكشاف الأفكار والتوجهات والخبرات لمعلمي ومعلمات العلوم في المرحلة المتوسطة وخصوصا في مجال دمج تقنية المعلومات والاتصالات تربويا في تعليم مادة العلوم للوصول إلى تحديد الاحتياجات التدريبية والتطويرية في هذا المجال.

إن مساهمتكم في البحث من خلال الإجابة على الاستبيان مهم جدا لموضوع البحث حيث أن نتائجه سوف تساعد في فهم الطرق التي سوف تؤدي إلى الرقي بالعملية التعليمية في المملكة العربية السعودية ، كما أود أن أوضح لسيادتكم بأن تعبئة الاستبيان سوف يستغرق ثلاثون دقيقة تقريبا، ونوعية الأسئلة لن تسبب أي إزعاج أو مخاطر محتملة لكم. إن المعلومات المستخلصة من الاستبيان سوف تستخدم لأغراض البحث العلمي ولن يطلع عليها سوى الباحث والمشرفين على البحث و يتم تخزينها لمدة لا تقل عن خمس سنوات طبقا لنظام جامعة (RMIT) ، وفي حالة نشر نتائج هذه الدراسة سوف يتم المحافظة على سرية المعلومات الشخصية بحيث تضمن عدم ذكر (الاسم، العنوان، اسم المدرسة) في نتائج الدراسة.

علما بأن الوقت الذي يستغرقه تعبئة الاستبيان من المعلم او المعلمة ثلاثون دقيقة تقريبا. في حالة وجود أي استفسار بخصوص الاستبيان أرجو الاتصال على التلفون داخل المملكة (000000) وللاستفسار عن نتائج الدراسة مراسلتي

على البريد الإلكتروني S3125940@student.rmit.edu.au

إن مساهمتكم في هذه الدراسة مفيدة ومهمة لإكمال دراستي وتعاونكم محل احترامي وتقديري وسيتم التنويه عن ذلك في رسالتي، وسوف يتم تفهم الوضع في حالة الرفض.

الباحث / عبدالإله بن عبدالله السليمانى

Appendix 2 Interview Questions and Responses

- Appendix 2.1 Semi-structured Interviews: Questions for Policy Makers
- Appendix 2.2 Sample of Semi-structured Interviews Responses with Policy Makers (English Version)
- Appendix 2.3 Sample of Semi-structured Interview Responses with Policy Makers (Arabic Version)

Appendix 2.1 Semi-structured Interviews: Questions for Policy Makers

Introduction questions:

- Qualifications, specialization, training courses, and experiences.

- المؤهل، التخصص، الدورات التدريبية، الخبرة.

Part one: integration of the ICT into education.

الجزء الأول: دمج التقنية في التعليم.

- According to your experience, what does the concept of the integrating of ICT into education process?

- ماذا يعني مفهوم دمج تقنية المعلومات والاتصالات في عملية التعليم والتعلم؟

- What is the significance of using ICT in teaching and learning practice?

- ما أهمية استخدام تقنية المعلومات والاتصالات في عملية التعليم والتعلم؟

- What is the importance of integrating (ICT) in the process of education and learning for both teachers and students?

- ما أهمية دمج تقنية المعلومات والاتصالات في التعليم بالنسبة للمعلم (ة)، الطالب (ة)؟

- What is the importance of integrating (ICT) in educating science?

- ما أهمية دمج تقنية المعلومات والاتصالات في تعليم مادة العلوم؟

- Through your educational field observation, can you mention some examples or applications of integrating (ICT) in education and learning?

- خلال مشاهدتك للميدان التربوي اذكر بعض الأمثلة على دمج تقنية المعلومات والاتصالات في عملية التعليم

والتعلم؟

- What are the efforts of Ministry of Education and education administrations to integrate (ICT) into education and learning, as for curriculums, infrastructure and teachers?

- ما هي الجهود المبذولة من قبل وزارة التربية والتعليم أو إدارة التعليم لدمج تقنية المعلومات والاتصالات في عملية التعلم والتعليم بالنسبة للمنهج الدراسي، البنية التحتية، تدريب المعلم (ة)؟

- Are there any programs or projects to integrate (ICT) into these subjects or curriculums individually? If "Yes", indicate that.

- هل هناك برامج أو مشاريع لدمج تقنية المعلومات والاتصالات موجهة بشكل خاص لمراحل التعليم المختلفة كل على حده؟ إذا كانت الإجابة بنعم. ماهي المشاريع الخاصة بتعليم المرحلة المتوسطة؟

- Are there any programs or projects to integrate (ICT) into science teaching.

- ما هي البرامج و المشاريع الخاصة بدمج تقنية المعلومات والاتصالات الموجهة لتعليم العلوم في المرحلة المتوسطة؟

- What are the agencies or administrations that participate in preparing the general plans for integrating (ICT) into education and learning in KSA?

- من هي الجهات أو الإدارات التي تشارك بوضع الخطة العامة لدمج تقنية المعلومات والاتصالات في عملية التعليم والتعلم في نظام التعليم السعودي؟

- Who are those concerned with integrating (ICT) into education (boys education, girls education, or both)?

- من هم المعنيين بخطة دمج تقنية المعلومات والاتصالات في عملية التعليم (تعليم البنين، تعليم البنات أم الاثنين معاً)؟

- What are the aims that the Saudi education System attained in integrating ICT in teaching and learning until the end of 2006 academic year?

- ما هي الأهداف التي حققها النظام التعليمي في دمج تقنية المعلومات والاتصالات في عملية التعليم والتعلم حتى نهاية العام الدراسي 2006؟

- What are the requirements to integrate ICT into science teaching for intermediate schools?

- ما هي متطلبات دمج تقنية المعلومات والاتصالات في تعليم مادة العلوم في المرحلة المتوسطة؟

- What are the factors that encourage science teachers to integrate ICT in teaching practice?

- ما هي العوامل التي تستحث معلم مادة العلوم على دمج تقنية المعلومات والاتصالات في التعليم؟

- Have the aims of integrating ICT in science teaching for intermediate schools been achieved?

- هل تم تحقيق أهداف دمج تقنية المعلومات والاتصالات في تعليم مادة العلوم في المرحلة المتوسطة؟

- Are there any advantages or barriers to using ICT in teaching and learning process in Saudi Arabia?

- هل هناك مميزات او عوائق لاستخدام تقنية المعلومات والاتصالات في عملية تعليم مادة العلوم في المرحلة

المتوسطة؟

- Do science teachers consider these as obstacles? If so, what kind of obstacle?

- هل معلمو مادة العلوم في المرحلة المتوسطة أحد هذه العوائق؟ ما نوع هذه العوائق؟

Part tow: the professional development needs of male and female teachers

- What are the strategies to improve the professional development needs of science teachers in teaching practice?

- ما هي الخطة المتبعة في تطوير قدرات معلمين مادة العلوم المهنية

- What is the role of teacher in the plan of integration ICT in teaching and learning practice?

- ما دور المعلم في خطة دمج تقنية المعلومات والاتصالات في عملية التعليم والتعلم؟

- Are there any programs in place that are used in developing the professional needs to implement the plan of integration ICT in teaching and learning practice? What are these?

- ما هي الخطة المتبعة في تطوير احتياجات المعلمين في تنفيذ خطة دمج التقنية بالعملية التعليمية؟

- What are the standards that are used to measure the skills that science teachers must have to integrate ICT in science teaching for intermediate schools?

- ما هي المعايير المستخدمة لقياس المهارات الواجب توفرها لدى المعلم لدمج تقنية المعلومات والاتصالات

في تدريس مادة العلوم في المرحلة المتوسطة؟

- What do you think are the professional development needs of intermediate school science teachers in relation to ICTs?

- ما هو رأيك في احتياجات التطوير المهنية لمعلمي العلوم في المرحلة المتوسطة فيما يتعلق بدمج تقنية

المعلومات والاتصالات في العملية التعليمية؟

- What are the programs that were implemented by the Saudi Education System to develop the performance of science teacher in intermediate school to integrate ICT in teaching and learning?

- ما هي البرامج التي نفذها نظام التعليم السعودي لتطوير أداء معلم العلوم في المرحلة المتوسطة لدمج تقنية

المعلومات والاتصالات؟

- Are there any differences between the professional development needs of male and female science teachers? If so, what are these?

- هل هناك اختلافات بين الاحتياجات التطويرية لمعلمي ومعلمات العلوم في المرحلة المتوسطة لدمج التقنية في

التعليم؟

- Do you have any suggestions that may help in developing the use of ICT skills for science teachers?

- هل لديك اقتراحات تساعد في تطوير مهارات استخدام تقنية المعلومات والاتصالات لدى معلمي

العلوم؟

Appendix 2.2 Sample of Interviews Responses (English Version)

Identity Card

Name:

Qualification:

Specialization:

Occupation:

Training Courses and Experiences:

Many training courses in science education, educating biology for 5 years at the secondary stage, different courses in comprehension tests, student guidance, computers, training preparation of educational leaders in Japan, educational planning, educational supervision, and integrating (ICT) in education (for 6 years).

- **According to your experience, what does the concept of integrating (ICT) in the process of education and learning mean?**

As for this concept, it is a way to improve the environment of education and learning. It also means the use of specific means to improve that environment. That means to use specific means in a well-known methodological way in order to improve the environment of education and learning for both teachers and students.

This means that the concept of education technology is higher than that of educational media. Sometimes it is wrongly believed that providing schools with specific equipments means that you applied such a concept. We have to understand and spread the culture of awareness, I mean the technical culture. This includes teachers, managers, students and parents. Surrounding environment is dramatically changing with the introduction of the internet and communication revolution. Currently, the student became able to practice many things outside his school. As a result, there may be a gap between teachers and students in favor of the latter. For example, the teacher used to acquire his experiences through different educational stages and reading books in libraries.

Nowadays, there are many modern techniques, including the internet, where the world became a universal open village. This means that you can easily get any kind of information through a computer at home. So, it depends on the individual effort. Many students have the ability to employ such a technology, while many teachers are not used to it, and there is a gap between them and computers. Current generation of students can be called a technology generation, as many students opened their eyes to see their parents and older siblings using computers at home and became able to use this technology. This means that unless the teacher tries to develop his abilities in this field, a digital gap between him and his students will result.

- **Through your educational field observation, can you mention some examples or applications of integrating (ICT) in education and learning?**

As for our visits, they are devoted to educational administrations and their educational technology centers and some schools. It is observed that understanding this concept differs from one administration to the other. With respect to the Ministry, it is still not clear-cut defined. But some administrations are greatly interested and apply the so-called electronic education and learning. Some schools have programs and projects to apply these technologies, such as smart classes. We applied an experiment called (Computerized Labs), to use computers in science experiments, including physics, chemistry and biology. In fact, some administrations were greatly enthusiastic, while others were conservative. This situation will surely change with time.

- **What is the importance of integrating (ICT) in the process of education and learning for both teachers and students?**

For me, the situation can be similar to a comparison between one driving an old car and another driving a new one. The old car becomes obsolete, and you have to get a new one so as to go more effectively and efficiently. This is to say that the teacher was obliged to use specific means at a specific time, as such modern technologies were not yet available. Now, they became available, and many people are using them everywhere. When you need to make contacts with the world, you have to be able to use the same technologies they use.

Then, how to develop yourself, while you are not able to use computers? How to make a research, while you are not able to use available information sources. So, you have to

be able to use the computers, the internet, and the available encyclopaedias in an attractive way. This is a very important point, because whenever we talk about curriculums, it is suggested to add a new subject, which is not right. As you said, it is a matter of philosophy and culture. Specifically, it is how to get good educational outputs by using (ICT) to improve the environment of education and learning, and this is the most important point in my belief.

As for students, we have to take care of the concept of "Attractive School". This means that when you want to present something to students, you have to make this in an attractive way. Now, we have televisions and internet at home. They present information in very attractive ways. So, we have to present information to students at school in such ways, otherwise the student will become bored. We are in great need of making the student the core of the educational process through integrating (ICT).

- **You mentioned that (ICT) is not attractive; would you make it clearer?**

I mean that this happens when it becomes a burden on both students and teachers due to lack of preparation and suitable conditions. This can be the case with any experiment whether technical or not. We have to make good preparations and indicate the importance of such technology to make people realize that it is not a burden, and understand that it is a way to facilitate and develop the educational process. Otherwise, we may get negative results.

- **What is the importance of integrating (ICT) in educating science?**

First of all, science is different from other subjects due to its viability and relatedness to practical life. And this is one of the objectives of educating science. I mean when you explain something, you have to explain it attractively, otherwise you will not achieve your objectives. For example, when you explain the cell and do your best to describe its size and how small it is, without letting the student see it under microscope, such information will be similar to the date of any other thing that can be forgotten easily. So, integrating (ICT) in educating science will make education and learning more viable and attractive.

- **What are the efforts of Ministry of Education and education administrations to integrate (ICT) into education and learning, as for curriculums, infrastructure and teachers?**

There are many projects to achieve this objective. For example, there is a project to introduce computers into primary and intermediate schools. The objective of this project is to introduce computerized labs similar to that of secondary schools to let both students and teachers utilize them. At present, computer became available at home. Absence of this service at school becomes a kind of shortage. This project is designed to encourage students to use computers and utilize the experiences of available teachers to use the computer technology.

Also, there is a project to develop the curriculums of science and mathematics in collaboration with Al-Obaikan Company according to international standards for ten years. The agreement includes developing such curriculums for grade one at preparatory schools to grade three at secondary schools. It also includes printing books, preparing supporting educational materials using the internet, interactive tapes, and multimedia.

In addition, there is the "Comprehensive Project to Develop Curriculums", which includes the production of supporting educational materials such as printed materials, audio-video materials, and interactive disks, This project has specific standards determined by the Ministry, and presented as a tender for competition among private sector companies. It is divided into three stages for primary, intermediate, and secondary schools.

- **Are there any programs or projects to integrate (ICT) into these subjects or curriculums individually? If "Yes", indicate that.**

"Yes", there are many subject-specific projects, such as that devoted to develop the Arabic Language techniques and another one for the Holy Quran. It is an integrated training material including a web site and training courses for supervisors and teachers. The program and its materials are distributed to all schools at different educational regions.

AS for scientific subjects, there is the project of "Computerized Labs", which began three years ago. The idea was to apply that project at some schools as a trial project. It has been successfully applied and evaluated through necessary studies. Now, it is being applied at a large scale. The project includes providing computerized labs with computer sets and sensors serving the subject experiments in physics, chemistry, and biology. Sensors are connected to soft-ware giving measures and reports related to all scientific experiments of the subject. The program achieved a great progress and two training workshops were held for male and female supervisors form all educational administrations in KSA.

One more important thing is that all Ministry projects for integrating (ICT) into education and learning are directed to both boys and girls education at the same time, as the "Agency for Educational Development" supervises both the education of boys and that of girls. As for education technology, there is a process of restructuring, where the Administration of Education Technology was divided into three different administrations as follows:

- Administration for Developing Education and Learning Technology, which is affiliated to the Agency for Educational Development, that supervises this process for both boys and girls,
 - Administration for Education Technology for Boys, and
 - Administration for Education Technology for Girls.
- **What are the agencies or administrations that participate in preparing the general plans for integrating (ICT) into education and learning in KSA?**

Of course, there is a national plan at the country level as all ministries are participating in the process of integrating (ICT). It is called the National Plan for Information and Communication Technology. All ministries are participating in this plan which includes what is related to education.

- **Who forms the vision and orientation of the Ministry as for integrating (ICT) into education and learning?**

Now, there is a high commission, headed by Dr. Khalid Bin Meshary that is responsible for developing education technology and its uses. Most ministry administrations are represented in this commission, such as Centre for Information and Computers, Administration for Developing Education and Learning Technology, Administration for Educational Development, Administration for Educational Supervision, and Administration for Curriculums. Now, we are at the stage of Electronic Governmental Treatments, as we get rid of the old system to facilitate governmental treatments for citizens to get, communicate, or send information.

- **Who are those concerned with integrating (ICT) into education (boys education, girls education, or both)?**

We - Administration for Developing ICT, at Ministry of Education – prepare the plans for both boys and girls education at the same time, especially after integrating them under the Ministry.

- **What is the role of the teacher in the plan for integrating ICT into education and learning?**

All programs and projects of ICT have the objective of facilitating the process of education and learning for both teachers and students. Of course, the teacher is the agent who executes the projects and programs at their final stages in classrooms. In many cases, the Ministry encourages and adopts distinguished contributions made by teachers in the educational field at the level of ICT.

- **What are the programs included in the plan for integrating ICT to improve the performance of science teachers at the intermediate stage?**

In fact, we are greatly interested in training teachers through available technology centers. For example, any new program or project begins with training supervisors, who, in turn, provide training courses for teachers until we get the targeted level.

- **What is the mechanism adopted to follow-up the execution of programs and projects included in the plan?**

At present, this mechanism is to follow-up such programs and projects through field visits and writing reports by education administrations on the progress of work.

- **What are the kinds of obstacles faced during integrating ICT into the education and learning process?**

Those obstacles are the same ones faced by others in other countries, that is the shortage of finance. As you know, technology is relatively expensive, and feasibility means balance between costs of inputs and outputs. The Ministry spares no effort to supply suitable finance, but there is a large number of schools for boys and girls. This means a large sum of money. Accordingly, programs and projects are divide into annual stages according to available finance.

Another obstacle is that some officials and teachers are still not convinced with integrating ICT into education and learning. I think this can be faced by more efforts through mass media and increasing training of teachers. We can achieve this by joint efforts from different administrations at the Ministry in addition to educational administrations at different regions. In this regard, there is an information plan to indicate the importance of integrating ICT into education. We began publishing a series of booklets, newsletters, and pamphlets on different kinds of education, such as remote education, smart classes, and programmed education. Such materials have been distributed at different educational occasions to assure the importance of integrating ICT into education. It is no longer a luxury, rather it became a necessity. In order to have a productive environment, you have to provide the suitable circumstances, otherwise you will not be productive. So, to convince officials or teachers with this process, you have to indicate the importance of such programs and projects in order to decrease their resistance to change.

Also important is the obstacle of the heavy burden of teaching endured by teachers at schools, where it is difficult for the teacher to have free time to this process.

In addition, ICT - as an idea or an administration - is something new, it began a year or a year and a half ago. Now, we achieved a great deal of progress in the field of electronic education. In the near future, there will be a web site in the form of an electronic gate including all products of the Ministry. There are also some companies, such as SIMANOR, SIMATIC, and EL-MAGD, that provide educational soft-wares for students. There is another project with SIMANOR to present SIMANOR Explorer which includes all materials. It includes disks containing educational curriculums in addition to a scientific encyclopedia and links to web-sites. These disks are presented to students for free for a specified time-period. When the student and his parents find them suitable, they can buy them in the future.

- **How do you treat or face such obstacles?**

Facing such obstacles requires coordinating joint efforts among different administrations at the Ministry and the regional levels. As for our Administration for Educational Development, we cannot work without coordination with Administration for Teachers Affairs. We have our plans for ICT management, but without coordination with other concerned agencies, such plans may not succeed.

For example, I remember the project of Centers for Educational Sources at the national level, where we established and equipped many centers. Unfortunately, we could not provide the suitable human resources as secretaries for such centers, because the Administration for Teachers Affairs did not allow teachers to become free for the project as there was not enough number of teachers. This happened due to absence of coordination with that Administration to provide a suitable number of teachers before the project begins.

I also remember another obstacle that happened due to absence of coordination with other agencies, such as the communication company, to provide internet or telephone lines for schools. Until now, there are many centers for educational sources without separate telephone lines, so they do not provide the service of the internet.

I believe that the level of coordination is still unsatisfactory as for the planned objectives of integrating ICT into education and learning in spite of having joint committees among different administrations and departments.

- **How to evaluate the programs and projects of integrating ICT into the process of education and learning?**

First of all, we can say that most programs related to integrating ICT into the educational field have been evaluated in other countries, because they were applied in those countries before their introduction to KSA. Secondly, we encourage researchers to carry-out evaluative studies on the programs and projects of integrating ICT in the educational field. Now, we have many studies carried by researchers on computerized labs in the educational field.

- **What is the occupational description of the new tasks and roles imposed on the teacher at the age of ICT?**

Nowadays, the teacher is considered a facilitator and mentor to communicate information to students, rather than the information provider as he used to be in the past. The teacher is no longer an information provider, he is just an information guide.

- **Is the teacher aware of the new roles and tasks of integrating ICT into the education and learning process?**

I think the teacher may be in need for more awareness, even if he has some knowledge, in order to change previous viewpoints and overcome resisting change.

- **What are the procedures followed to determine the required skills for the teacher to integrate ICT into educating science at the intermediate stage?**

You are talking about the teacher skills in general. Unfortunately, such skills are not determined officially, but there are some individual efforts and suggestions done by some researchers to present some standards for the skills required to integrate ICT. This became of great importance as we hear about computer-illiteracy eradication in some developed countries. I think that the teacher who is not able to use computers will not be able to perform the educational process in the near future, due to the increasing importance of computers in this field.

- **What are the procedures adopted by the Ministry to eradicate computer-illiteracy?**

This case is in need of a general overview, not individual efforts by individual administrations. There must be a plan joining the efforts of administrations of teacher affairs, educational training, educational development, and educational supervision. First of all, we have to feel the presence of the problem, determine its dimensions, then form a comprehensive plan with specified time periods to face this problem. I think this necessitates forming ad-hoc committees at the Ministry and the educational administrations levels.

There are many studies and field observations indicating that there are many idle technological equipments and sets. These things can be activated by teachers, but sometimes teachers do not have the skills required to operate such equipments.

- **What are the factors that encourage teachers to integrate ICT into the process of education and learning?**

I think that one of the most important factors in this regard is to review the process of teacher evaluation. For example, the Ministry provided large amounts of lab materials for

intermediate stage, as a part of the program of activating school labs at that stage. Of course, this means a large amount of money. And unless it is activated, it will be useless. In the past, there were no incentives for teachers to activate such labs. Now, there is a plan coordinated by both educational supervision and teacher affairs for science teachers and scientific subjects. This plan includes a revision of the methods of science-teacher evaluation so as to devote specified marks to activate school labs and carry out scientific experiments. This will be reflected on both teachers and students. I think that, if there are similar plans to activate other programs, this will make teachers realize the importance of integrating ICT into the process of education and learning. Finally, this will help to distinguish between active and inactive teachers in this regard.

- **What is the plan adopted to develop teacher skills to participate in integrating ICT into the educational process?**

There are some steps in this direction, where the Ministry initiated a project to classify teachers according to having certificates in the field of computer and its skills. This classification and the related incentives will encourage teachers to develop their educational skills and capabilities, especially when there is a plan to follow-up in the educational field.

- **Are there any differences between male and female science teachers in the field of integrating ICT into education at the intermediate stage?**

I think that male teachers are more advanced in this regard, because boys' education is older than girls' education. Now, after integrating both boys' and girls' education into the Ministry of Education, the programs of integrating ICT into girls' education are improving greatly.

- **Are there any suggestions to improve the skills of science teachers in the field of using ICT?**

I repeat and concentrate on the process of raising awareness of the importance of using technology, it became a necessity, not a luxury. Teachers have to realize that those programs are for their interest as facilitators and mentors, as they make the educational process more exciting, attractive, and effective. We have to change the old and negative ideas and visions related to integrating ICT into education. This is the case not only in developing

countries, but also in some developed countries. In the past, the teacher was spending much time and effort to prepare educational materials. Nowadays, the smart board enables the teacher to prepare the whole curriculum with all means and programs in a very simple and attractive way. It became clear that adopting ICT facilitates the educational process for both teachers and students.

At the same time, programs of integrating ICT in education must be easy and simple to encourage teachers to adopt them. Again, suitable training for teachers on different programs and projects will play an important role in this regard.

- **Is it possible to cast more light on the projects of SIMANOR and INTEL?**

As for SIMANOR, the Company managed to change all curriculums and subjects for all grades into the digital form as electronic books. It made them available on an explorer, in addition to some links, where teachers and students can explore them without copying, because they are protected. The Ministry did not adopt that project in full, but the Company suggested to make its explorer available for free in the form of CDs for a limited number of hours. If parents and students find them convincing, they can buy them at their expense. In fact this project is based on an understanding memorandum between the Ministry and that Company, it is not compulsory. As for the project of INTEL, I have no idea

Appendix 2.3 Sample of Semi-structured Interview Responses (Arabic Version)

بطاقة تعريفية:

الاسم:

المؤهل: بكالوريوس علوم

جهة المؤهل: جامعة الكويت / كلية العلوم

التخصص: أحياء دقيقة

الوظيفة:

الدورات التدريبية والخبرات العملية :

عدة دورات في تدريس العلوم، تدريس الأحياء لمدة 5 سنوات بالمرحلة الثانوية، دورات مختلفة في الاختبارات التحصيلية، الإرشاد الطلابي، العديد من الدورات في الحاسب الآلي، الإخراج المسرحي، الإعداد التدريبي للقيادات التربوية في اليابان، التخطيط التربوي ، الإشراف التربوي. دمج تقنية المعلومات والاتصالات في التعليم ست سنوات.

من خلال خبراتك التعليمية:

• ماذا يعني مفهوم دمج تقنية المعلومات والاتصالات في عملية التعليم والتعلم؟

بالنسبة لمفهوم دمج تقنية المعلومات والاتصالات في عملية التعلم والتعليم هو طريقة لتحسين بيئة التعليم والتعلم، أنا من وجهة نظري من خلال إطلاعي على التعريفات الموجودة هي استخدام لوسائل معينة الهدف منها تحسين بيئتي التعليم والتعلم، يعني حتى تطور هذه البيئة توظف لها وسائل معينة بطريقة تكون ممنهجة ومقننة معروفة حتى تحسن البيئة التي تقدم فيها عملية التعليم والتعلم سواء للمعلم أو للطلاب.

هذه يعني إن مفهوم تقنيات التعليم ارقى من مفهوم الوسائل التعليمية ويخطئ من يظن انه إذا قدم تجهيزات معينة للمدارس قد وظف التقنية هذا الكلام منقوص وبجانبه الخطاء ، لابد من فهم ونشر ثقافة التوعية اقصد التنقيف التقني ويجب أن نبدأ من التنقيف التقني من المعلم للمشرف لمدير المدرسة للطلبة لأولياء الأمور ، الآن ليس كالوقت السابق (دخول الانترنت ، ثورة الاتصالات الموجودة حالياً) كون أن الطالب يطلع على الأمور هذه خارج المدرسة أصبح هناك فجوة في بعض الأحيان بين المعلم والطالب لصالح الطالب.

مثلا في السابق المعلم يكتسب خبرات معينة من خلال التدرج في مراحل التعليم وإطلاعه على الكتب وعلى المكتبات، الآن في الفترة هذه ظهرت وسائل جديدة منها وسيلة الانترنت أصبح العالم مفتوح قرية كونية واحدة إن لم تكن بيت واحد يعني تستطيع أن تحصل على المعلومة بطريقة سهلة وميسرة ومن خلال جهاز حاسب آلي موجود عندك في البيت أنت بتدخل على أي مكان وتحصل المعلومة. فأصبح تعتمد على جهد الفرد بذاته ففضية توظيف أو استخدام التقنية من قبل الطالب خاصة انه بعض المعلمين كان لفترات سابقة لم يتعود على استخدام الحاسب وبينه وبين الحاسب فجوة.

بينما الجيل الحالي من الطلاب نستطيع ان نسميه جيل تقنية فتح أعينه وجد الحاسب الآلي أمامه ووجد والده وأخاه الكبير يستخدموا الحاسب فاستفاد من وجود العملية هذه . معنى هذا إذا لم يعمل المعلم على تطوير قدراته في مجال الحاسب سوف يجد فجوة رقمية بينه وبين الطالب هذا الذي اقصده.

• من خلال مشاهدتك للميدان التربوي اذكر بعض الأمثلة أو التطبيقات على دمج تقنية المعلومات والاتصالات في عملية التعليم والتعلم ؟

بالنسبة لزيارتنا تكون لإدارات التعليم وما يتعلق بمراكز التقنيات التربوية وبعض المدارس. قضية دمج تقنية المعلومات والاتصالات في التعليم تختلف حقيقة من فهم إدارة إلى إدارة أخرى يعني إن كان من جهة مركزية اقصد الوزارة طبعاً لا يوجد ذلك التحديد الواضح حقيقة لكن نجد بعض المناطق أو الإدارات متحمسة للموضوع ومطبقة ما يسمى بالتعليم الالكتروني والتعلم الالكتروني ، بعض الإدارات لها مدارس مطبق فيها برامج ومشاريع لدمج التقنية مثل استخدام الفصول الذكية ونحن طبقنا تجربة اسمها المختبرات المحوسبة (استخدام الحاسب في تجارب العلوم مثل الفيزياء ، الكيمياء ، الإحياء) وحقيقة وجدنا تفاعل من بعض إدارات التعليم وبعض الإدارات يمكن لديه نوع من التحفظ يمكن مع مرور الوقت تتغير النظرة إلى عملية الدمج.

• ما أهمية دمج تقنية المعلومات والاتصالات في التعليم بالنسبة (للمعلم ، الطالب)؟

بالنسبة لأهمية دمج تقنية المعلومات والاتصالات في التعليم يعني الآن أنا أشبه العملية بمن يقود سيارة قديمة وآخر يقود سيارة جديدة فالسيارة القديمة لها زمن افتراضي موجود بعدها تضطر انك تنتقل إلى سيارة جديدة حتى تقوم بنفس الكفاءة أو أفضل هذا يعني المعلم كان يستخدم وسائل معينة في ظروف معينة يعني تقدر تقول عليها إجبارية لان هذا اللي موجود كان في السابق . الآن أنت تتعامل مع تقنيات التقنيات هذه ليس أنت الوحيد اللي تستخدمها في ناس في المقابل في أماكن أخرى يستخدموا التقنية هذه بكرة أنت تريد أن تتصل بالعالم هذا فتحتاج انك تكون نفس الأدوات التي يستخدمها الآخرون كيف تطور نفسك وأنت ما عندك خبرة يعني كيف تبحث وأنت لا تمتلك مهارة استخدام الحاسب الآلي كيف تبحث في الانترنت كيف تستفيد من مصادر المعلومات الموجودة كل ما يثار من وسائل وطرق في قضية الموسوعات الويكيبيديا وطريقة الموسوعات المستخدمة والأشياء التي تغذى في الانترنت كل هذه الأمور لازم الإنسان يصبح لديه معرفه بها ويوظفها بطريقة لا تكون منفرة وهذه نقطة مهمة جداً نحن الآن كل ما نكلم واحد قال المنهج نضيف مادة وهذا غير صحيح كل ما نريد شيء زدنا من حجم المنهج الدراسي والمقررات الدراسية لا هي عملية مثل ما ذكرت أنت ثقافة وفلسفة أنا كيف أصل إلى مخرجات تعليمية جيدة من خلال توظيف تقنية المعلومات والاتصالات في تحسين بيئتي التعليم والتعلم هذه أهم نقطة في اعتقادي.

بالنسبة للطالب طبعاً لازم نراعي قضية مهمة التي هي ما يسمى بمفاهيم المدرسة الجاذبة يعني لكي نقدم شيء لازم نقدمه بطريقة وبصورة جاذبة للطالب، الآن عندك البيت موجود فيه التلفزيون والمحطات الفضائية والانترنت هذه كلها تعرض بأسلوب جاذب فإذا لم تقدم المعلومة بصيغة فيها نوع من الجذب ومن التجديد راح تكون العملية مملة للطالب ونحن تعبنا من أسلوب التلقين في العملية التعليمية يعني الطالب مجرد مستمع مثل جهاز الاستقبال نحن نريد أن يكون الطالب محور العملية التعليمية من خلال توظيف التقنية ودمجها.

• **ذكرت أن تقنية المعلومات والاتصالات منفرة ممكن توضح أكثر؟**

إننا أقصد إن التقنية إذا كانت عبء سواء على المعلم أو على الطالب وهذا يحدث عندما لا تحدث لها تهيئة ولا تضع لها الظروف المناسبة لإنجاحها وهذا ينطبق على أي تجربة سواء كانت تقنية أو غيرها إذا لم تعمل لها تمهيد وتوطئة وتبين للناس أهمية هذه التقنية وإنها ليست عبء عليهم إنما هي وسائل مساعدة لتسهيل العملية التعليمية وتحسينها وتطويرها وإلا سوف تكون ردة الفعل عكسية .

• **ما أهمية دمج تقنية المعلومات والاتصالات في تعليم مادة العلوم ؟**

أولا مادة العلوم تختلف عن بقية المواد من ناحية الحيوية الموجودة بها ومن ناحية ما تطرحه من مواضيع تتعلق بطريقة مباشرة بالواقع وهذا من أهداف تدريس مادة العلوم هذا الشيء تشعر به في الحياة اليومية فالطالب عندما تطرح له موضوع مثير هل تطرح له بطريقة عادية أنا أقصد إن الموضوع مثير إذا لم تطرحه بطريقة مثيرة وجاذبة للطالب فقد هدفه مثلا عندما اشرح الخلية مهما شرحت الخلية ووصفت حجمها وصغرها دون أن يشاهد الخلية تحت المجهر أو يشاهد الخلية وهي تتحرك ولا يتعرف على أنواعها راح تكون المعلومات هذه عابرة مثل تاريخ أي شيء سوف ينساه بمجرد خروجه من باب الفصل، فيعني توظيف هذه التقنية ودمجها في تدريس مادة العلوم يعطيها حيوية أكثر وتشويق أكثر.

• **ما هي الجهود المبذولة من قبل وزارة التربية والتعليم أو إدارات التعليم لدمج تقنية المعلومات والاتصالات في عملية التعلم والتعليم بالنسبة (المنهج الدراسي، البنية التحتية، تدريب المعلمين)؟**

هناك الكثير من المشاريع بالنسبة لدمج تقنية المعلومات والاتصالات الآن مشروع إدخال الحاسب الآلي في المرحلتين الابتدائية والمتوسطة الفكرة من هذا المشروع هو إدخال معامل مختبرات الحاسب الآلي مثل المرحلة الثانوية ليستفيد منها الطالب والمعلم فالطالب في الوقت الحاضر يتعامل مع الحاسب الآلي في البيت فكون إن المدرسة لا تقدم الخدمة ولا تطورها يعتبر نوع من النقص. هذا المشروع يعتبر كنوع من تشجيع الطلاب على استخدام الحاسب الآلي وتوجيههم والاستفادة من خبرات المعلمين الموجودين في توظيف تقنية الحاسب الآلي.

مشروع تطوير مناهج العلوم والرياضيات وهناك شركة تم الاتفاق معها هي شركة العبيكان لتطوير مناهج العلوم والرياضيات لمدة عشر سنوات بمواصفات عالمية والاتفاقية تشمل تطوير مناهج العلوم والرياضيات من الصف الأول الابتدائي للصف الثالث الثانوي وتشمل هذه الاتفاقية طباعة الكتب والمناهج والمواد التعليمية المساعدة المصاحبة من مواقع انترنت وأشربة تفاعلية ووسائط متعددة.

إضافة إلى المشروع الشامل لتطوير المناهج في مرحلته الأولى وهذا المشروع يتضمن إنتاج المواد التعليمية المصاحبة يشمل بوابة الكترونية ويشمل مواد مطبوعة ومواد صوتية وأقرص تفاعلية وهذا المشروع وضعت الوزارة له معايير معينة ومحددة وطرح كمنافسة بحيث تتقدم له شركات القطاع الخاص لتنفيذه وهذا المشروع مقسم لثلاث مراحل المرحلة الأولى تخص الابتدائية والثانية للمرحلة المتوسطة والثالثة للمرحلة الثانوية.

- هل هناك برامج أو مشاريع لدمج تقنية المعلومات والاتصالات موجهة بشكل خاص لهذه المواد أو المقررات كل على حده؟ إذا كانت الإجابة بنعم وضح ذلك.

نعم هناك مشاريع مخصصة وموجهة للمواد مثل مشروع تطوير تقنيات اللغة العربية أيضا مشروع يخص مادة القرآن الكريم يسمى مشروع المقرئة وهو عبارة عن حقيبة تدريبية متكاملة بجميع وسائلها بموقع إلكتروني ودورات تدريبية للمشرفين والمعلمين وتم تعميم المشروع وتأمين الحقيبة وتوزيعها على المدارس بجميع المناطق التعليمية.

بالنسبة للمواد العلمية هناك مشروع يسمى بالمختبرات المحوسبة وبدأ المشروع قبل ثلاث سنوات كانت الفكرة أن تطرح في بعض المدارس للتجربة وبالفعل تم تجربته على بعض المدارس وتم تقييمه وعمل الدراسات اللازمة له والآن جاري تعميم التجربة.

المشروع عبارة عن توفير معمل للحاسب الآلي يشمل على أجهزة كمبيوتر وملحق به بعض المستشعرات تخدم تجارب في المنهج في جميع العلوم الفيزياء الكيمياء والأحياء ، المستشعرات مرتبطة ببرنامج سوفت وير يعطيك قياسات وتقارير وكل ما يتعلق بالتجارب العلمية الموجودة بالمنهج ، وقطعنا مشوار في هذا البرنامج وحتى الآن تم عمل ورشتين تدريبيتين لمجموعة من المشرفين والمدرسات من جميع أنحاء المملكة وسنويا يتم تأمين المزيد من هذه المختبرات المحوسبة لتوزيعها على المدارس.

علما بأن جميع مشاريع الوزارة الخاصة بدمج تقنية المعلومات والاتصالات موجهة لتعليم البنين والبنات في نفس الوقت لأن وكالة الوزارة للتطوير التربوي يشرف على تعليم البنين والبنات، أما بالنسبة لتقنيات التعليم فهناك هيكلية جديدة قسمت إدارة تقنيات التعليم إلى ثلاث إدارات، إدارة تسمى تطوير تقنيات التعليم والتعلم تابعة لوكالة التطوير التربوي وهي مشرفة على تطوير تقنيات التعليم والتعلم في البنين والبنات، إدارة أخرى تسمى إدارة تقنيات التعليم للبنين تتبع الشؤون المدرسية وإدارة أخرى مماثلة لها تتبع الشؤون المدرسية في تعليم البنات اسمها إدارة تقنيات التعليم.

- من هي الجهات أو الإدارات التي تشارك بوضع الخطة العامة لدمج تقنية المعلومات والاتصالات في عملية التعليم والتعلم في المملكة العربية السعودية؟

طبعاً هناك خطة وطنية على مستوى الدولة وجميع الوزارات مشتركة في وضع تصور لدمج وتوظيف التقنية وتسمى الخطة الوطنية لتقنية المعلومات والاتصالات. كل الوزارات في قضية الاستفادة من التقنية وموجود فيها ما يخص التعليم.

- من يضع رؤية وتوجهات الوزارة في دمج تقنية المعلومات والاتصالات

الآن يوجد لجنة عليا يرئسها سمو النائب الدكتور خالد بن مشاري وهي مسؤولة عن تقنية التعليم وتطوير تقنيات التعليم واستخداماتها وطبعاً يفترض يشترك فيها معظم إدارات الوزارة مثل مركز المعلومات والحاسب الآلي ، تطوير تقنيات التعليم والتعلم ، التطوير التربوي ، الإشراف التربوي ، المناهج كل الإدارات هذه تشارك في وضع الخطة كل فيما

يخصه خاصة نحن الآن في طور ما يسمى بالمعاملات الحكومية الالكترونية وتوظيف التقنية بحيث نتخلص من النظام القديم في قضية المعاملات والتسهيل على المواطن سواء في اخذ المعلومة او توصيلها أو إرسالها.

- من هم المعنيين بخطة دمج تقنية المعلومات والاتصالات في عملية التعليم (تعليم البنين، تعليم البنات أم الاثنين معاً)؟

نحن كإدارة تطوير تقنية المعلومات والاتصالات بوزارة التربية والتعليم خطتنا موجهة لتعليم البنين والبنات في أن واحد خاصة بعد عملية دمج تعليم البنين والبنات تحت وزارة التربية والتعليم.

- ما دور المعلم في خطة دمج تقنية المعلومات والاتصالات في عملية التعلم والتعليم؟

جميع برامج ومشاريع دمج تقنية المعلومات من ضمن أهدافها تيسير عملية التعلم والتعليم للمعلم والطالب، و المعلم يعتبر هو المنفذ في المرحلة الأخيرة للبرامج والمشاريع داخل الفصل الدراسي والوزارة في كثير من الأحيان تتبنى وتشجع التجارب المتميزة للمعلمين في الميدان التربوي في مجال تقنية المعلومات والاتصالات.

- ما هي البرامج التي تضمنتها خطة دمج تقنية المعلومات والاتصال لتطوير أداء معلم العلوم في المرحلة المتوسطة لدمج تقنية المعلومات والاتصالات؟

نحن في الحقيقة نحرص من خلال مراكز التقنيات الموجودة إننا نركز على قضية تدريب المعلمين. فمثلا أي برنامج او مشروع جديدة نبدأ بتدريب المشرفين ثم بعد ذلك ينطلق المشرفين لعمل دورات تدريبية للمعلمين حتى نصل لمرحلة الرضا او المستوى المطلوب.

- ما هي الآلية المتبعة لمتابعة تنفيذ البرامج والمشاريع التي تضمنتها الخطة؟

تتلخص الآلية في الوقت الحالي لمتابعة البرامج والمشاريع الخاصة بدمج التقنية على الزيارات الميدانية ورفع التقارير من قبل إدارات التعليم بالمناطق لسير العمل بهذه البرامج والمشاريع.

- ماهي المعوقات التي واجهت تنفيذ خطة دمج تقنية المعلومات والاتصالات في عملية التعلم والتعليم (مانوعها)؟

بالنسبة لمعوقات دمج تقنية المعلومات والاتصالات بالتعليم اعتقد المعوقات هي نفس المعوقات التي تواجه الآخرين في الدول الأخرى وهي قضية التمويل. أنت تعرف أن التقنية مكلفة بطريقة توظيف التقنية وبنفس الوقت يكون السعر يكافئ ما تنتجه من مخرجات وتحاول توظيفها بطريقة جيدة وفق الاحتياجات هذا من جانب التمويل مع العلم بأن الوزارة غير مقصرة من النواحي المادية ولكن نظرا للعدد الكبير جدا للمدارس الموجودة سواء كانت بنين او بنات والمبالغ تحتاج إلى مبالغ ضخمة ولتجاوز هذه المشكلة تم تقسيم البرامج والمشاريع على عدة مراحل تنفذ سنويا على حسب الميزانيات المتاحة

من المعوقات أيضا قضية قناعات بعض المسؤولين والمعلمين والمعلمات واعتقد هذه القضية تحتاج إلى توعية في الإعلام بشكل مكثف وزيادة تدريب المعلمين والمعلمات بالإضافة إلى تكاتف الجهود من جميع الإدارات التابعة لوزارة التربية والتعليم مع الإدارات التعليمية بالمناطق التعليمية، وفي هذا المجال تم عمل خطة إعلامية تثقيفية لإيضاح أهمية دور دمج التقنية في التعليم وبدأ إنتاج وإصدار سلسلة الوعي والتثقيف التقني وتم إصدار مجموعة كبيرة من الكتيبات والنشرات عن التعليم بأنواعه والتعلم عن بعد والفصول الذكية والتعليم المبرمج وغيرها وتم توزيعها في المعارض والمناسبات التعليمية وأكدت هذه الكتيبات أن دمج تقنية المعلومات والاتصالات ليست ترف بل أصبحت ضرورة فلكي تحصل على بيئة جيدة ومنتجة لابد أن توفر الظروف المناسبة لهذه البيئة وإلا سوف لن تنتج. فلكي يقتنع المسؤول أو المعلم بأهمية عملية الدمج يجب أن تقدم له توطئة وتوضح له أهمية مشاريع وبرامج الدمج لكي تقلل من عملية مقاومة التغيير.

أيضا من المعوقات التي تواجه مشاريع دمج تقنية المعلومات والاتصالات قضية تفريغ المعلم أصبحت شبه مستحيلة ونصاب المعلم من الحصص المسندة إليه

القضية الأخرى إن تقنية المعلومات والاتصالات كفكرة أو إدارة بدأت من سنة أو سنة ونصف فالإدارة العامة لتقنية المعلومات والاتصالات قبل سنة تقريبا والآن قطعنا شوط كبير في قضية التعلم الإلكتروني الآن يوجد موقع قريبا سوف يدشن عبارة عن بوابة الكترونية تحتوي على تيرا بايت والآن توظف على أن تكون ويب سايد لكل منتجات الوزارة بالإضافة لوجود شركات تتقدم مثل شركة سيمانور وشركة سيماتك وشركة مجد للتطوير في تقديم برمجيات تعليمية للطلبة ن ويوجد تجربة مع شركة سيمانور لطرح متصفح سيمانور يحتوي على جميع المواد والتجربة هذه مجانية تقدم للمدارس عبارة عن أقراص تحتوي على المقررات التعليمية بالإضافة لموسوعة علمية وروابط لمواقع انترنت هذه الأقراص تقدم مجانا للطلاب لفترة محددة وفي حالة أن الطالب أو ولي أمره يجد هذه الأقراص مناسبة قد يشتريها مستقبلا.

• كيف تم تذليل أو التعامل مع هذه المعوقات؟

أنا في اعتقادي لتذليل العقبات أو المعوقات في البداية لابد من تضافر وتنسيق الجهود كلها في جميع الإدارات على مستوى الوزارة أو على مستوى إدارات التعليم ، فمثلا نحن في التطوير التربوي لا نستطيع أن نعمل بمعزل عن شؤون المعلمين فقد تكون لنا خطط في إدارة تقنية المعلومات والاتصالات إذا لم نشرك معنا الجهات التي نعتقد ان لها علاقة سواء من قريب أو من بعيد سوف يتعثر تنفيذ هذه الخطة . بمعنى آخر لو وضعت خطة لمشروع ووضعت ضوابط ومعايير ثم لا أستطيع تنفيذه أو تحقيقه لان الأمور تتعلق بتفريغ معلمين ، أنا اذكر مثلا مشروع مراكز مصادر التعلم على مستوى المملكة تم إنشاء وتجهيز الكثير من المراكز وأصبحت جاهزة لاستفادة منها ولكن لم نستطع تفريغ كوادر بشرية كأمناء لمراكز مصادر التعلم لأن إدارة شؤون المعلمين لم تسمح لتفريغ معلمين كأمناء لمراكز مصادر التعلم لعدم وجود العدد الكافي من المعلمين وأيضا لعدم التنسيق المسبق مع إدارة شؤون المعلمين لتوفير الإعداد الكافية من المعلمين.

أيضا اذكر من المعوقات التي حدثت لنا في السابق وفي اعتقادي بسبب عدم التنسيق مع الجهات ذات العلاقة مثل شركة الاتصالات لتوفير خطوط الاتصال أو الانترنت في مراكز مصادر التعلم فحتى الآن الكثير من مراكز مصادر التعلم التي تم إنشائها لا يوجد بها خطوط هاتف مستقلة أو لا تتوفر بها خدمة الانترنت.

أنا في اعتقادي في الوقت الحالي درجة التنسيق غير كافية وغير مرضية ولا ترتقي للأهداف المخطط لها لعملية دمج تقنية المعلومات والاتصالات على الرغم من وجود لجان عمل مشتركة بين الإدارات والأقسام.

• **كيف يتم تقييم برامج أو مشاريع دمج تقنية المعلومات والاتصالات في عملية التعلم والتعليم؟**

أولا غالبية البرامج الخاصة بدمج تقنية المعلومات التي يتم طرحها في الميدان التربوي تم تقييمها في بلدان سابقة لأن معظم برامج ومشاريع الدمج نفذت وطبقت سابقا في دول أخرى سبقت المملكة في مجال الدمج. ثانيا نحن نساعد ونشجع أي باحث يأتي لعمل دراسات تقييمية عن البرامج والمشاريع الخاصة بدمج التقنية الموجودة في الميدان التربوي. ويوجد لدينا دراسات لبعض الباحثين عن المختبرات المحوسبة التي تم تنفيذها في الميدان التربوي.

• **ما هو الوصف الوظيفي للمهام والأدوار الجديدة المناطة للمعلم في ضوء عصر تقنية المعلومات والاتصالات المعلوماتية؟**

المعلم في عصر تقنية المعلومات يعتبر مسهل وميسر لوصول المعلومة للطالب وليس ناقل للمعلومة كما في السابق يعني هو دليل إرشادي وليس مقدم للمعلومة.

• **من واقع الميدان التربوي، هل المعلم على علم بالمهام والأدوار الجديدة المناطة به لدمج تقنية المعلومات والاتصالات في العملية التعليمية؟**

المعلم يحتاج إلى توعية ولا بد من عملية التوعية وحتى لو أن المعلم على علم بالمهام الجديدة وفي اعتقادي عملية التوعية بمهمة جدا لتغيير القناعات السابقة والتغلب على مقاومة التغيير.

• **ما هي الإجراءات المستخدمة لتحديد المهارات الواجب توفرها لدى المعلم لدمج تقنية المعلومات والاتصالات في تدريس مادة العلوم في المرحلة المتوسطة؟**

أنت تتحدث عن مهارات المعلم بصفة عامة للأسف الشديد لم يتم تحديدها رسميا ولكن هناك اجتهادات فردية واقتراحات من قبل بعض الباحثين لوضع ستاندر للمهارات اللازمة لدمج تقنية المعلومات والاتصالات على الرغم من أن هذا الأمر في الوقت الحالي مهم جدا فنحن الآن نسمع في بعض الدول المتقدمة عن مكافحة أمية الحاسب الآلي وأنا أتوقع المعلم الذي لا يستطيع أن يتعامل مع الحاسب الآلي لا يستطيع أن يتعامل مع العملية التعليمية في المستقبل القريب وهذا نظرا لأهمية دمج الحاسب الآلي في عملية التعليم والتعلم.

• **ما هي الإجراءات التي قامت بها الوزارة لمكافحة أمية الحاسب الآلي؟**

هذا الموضوع يحتاج إلى نظرة عامة وليس اجتهادات فردية من قبل إدارات منفردة ولا بد من وجود خطة تتضافر فيها الجهود من شؤون المعلمين من التدريب التربوي من التطوير التربوي وأيضا الإشراف التربوي. وفي البداية يجب الإحساس بهذه المشكلة وتحديد أبعادها وبالتالي وضع خطة شاملة لها مراحل زمنية لتنفيذها لعلاج هذه المشكلة من تشكيل لجان على مستوى الوزارة أو على مستوى إدارات التعليم.

هناك دراسات ومشاهدات من واقع الميدان التربوي من خلال الزيارات للميدان التربوي أن هناك الكثير من الأجهزة التقنية الموجودة بالمدارس تحتاج فقط لعملية التفعيل من قبل المعلمين وهذا يرجع في بعض الأحيان لافتقار المعلم لمهارات استخدامها.

• ما هي العوامل التي تشجع المعلم على دمج تقنية المعلومات والاتصالات في عملية التعلم والتعليم؟

من أهم العوامل في اعتقادي على حث المعلم على توظيف ودمج التقنية إعادة النظر في عملية تقييم أداء المعلم فعلى سبيل المثال برنامج تفعيل المختبرات المدرسية في المرحلة المتوسطة فالوزارة قامت بتوفير كميات كبيرة من أدوات المختبر ومواده كلفت الوزارة ميزانية ضخمة فإذا لم تفعل فلا يوجد فائدة من توفيرها أساسا ففي السابق لا توجد الحوافز التي تجعل المعلم يتجه لتفعيل المختبرات وتم عمل خطة بالتنسيق مع الإشراف التربوي وشؤون المعلمين فيما يخص معلمي مادة العلوم والمواد العلمية هذه الخطة تشمل إعادة طريقة تقييم أداء معلم العلوم بحيث تكون هناك درجات خاصة لتفعيل المختبر وإجراء التجارب العلمية به لضمان تفعيل المختبرات المدرسية مما ينعكس لمصلحة الطالب. وفي تصوري لو وضعت خطة مماثلة لتفعيل أي برنامج آخر من برامج الدمج بحيث يأخذ الصفة الرسمية وأيضا يعي المعلم بأهمية برامج دمج تقنية المعلومات والاتصالات وبالتالي يتم التمييز بين المعلم الذي يستخدم ويفعل التقنية في العملية التعليمية.

• ماهية الخطة المتبعة في تطوير قدرات المعلم للمشاركة في دمج تقنية المعلومات والاتصال في العملية التعليمية؟

الآن هناك بوادر في هذا الاتجاه حيث أعلنت الوزارة عن مشروع لتصنيف المعلمين ولكنه تحت الدراسة يأخذ بعين الاعتبار عملية إجادة وامتلاك المعلم أو المعلمة لشهادة الحاسب الآلي وخبراته. هذا التصنيف والحوافز التي سوف تنتج عنه لو وضعت خطة لمتابعته في الميدان التربوي في اعتقادي سوف يعمل على تشجيع المعلم وحثه ذاتيا لتطوير قدراته ومهاراته التعليمية مما ينعكس على أداء المعلم.

• هل هناك اختلافات بين الاحتياجات التطويرية لمعلمي ومعلمات العلوم في المرحلة المتوسطة لدمج التقنية في التعليم؟

أنا الذي اشعر به إن التقنية في مجال التعليم للبنين متقدمة جدا عن تعليم البنات وذلك يرجع إلى البدايات في تعليم البنين سبقت تعليم البنات أيضا الإمكانات كانت متوفرة لدى تعليم البنين أكثر. الآن بعد توحيد تعليم البنات ودمجها تحت مظلة وزارة التربية والتعليم بدأت برامج تقنية المعلومات والاتصالات في تعليم البنات تتحسن بدرجة كبيرة.

• هل هناك اقتراحات تساعد في تطوير مهارات استخدام تقنية المعلومات والاتصالات لدى معلمي العلوم؟

أنا أعيد وأركز على موضوع التوعية بأهمية توظيف التقنية وأن العملية ليست ترف أو ترفيه ، والتوضيح للمعلم بأن برامج تقنية المعلومات هي لمصلحتك أنت كمعلم لتسهيل عمل وتيسيره وجعل عملية التعلم والتعلم أكثر جاذبية وتشويق وفاعلية وأن هذه البرامج ليست ضدك وليست عبء عليك. فيجب العمل على تغيير القنوات السابقة والسلبية لدمج التقنية في العملية التعليمية وعموما هذه القناة على فكرة ليست موجودة في مجتمعنا فقط بل أيضا حتى في المجتمعات

المتقدمة . أعطيك مثال بسيط قضية إعداد الوسائل في السابق كان المعلم يتعب في إعداد الوسيلة او الحصول عليها، الآن السبورة الذكية كمثال كسوفت وير كامل يضع المعلم كامل المنهج بجميع الوسائل والبرامج بطريقة ميسرة ومشوقة وجاذبة فدمج تقنية المعلومات تعمل على تيسير العملية التعليمية للطالب والمعلم. أيضا ملاحظة مهمة لابد عند طرح برامج دمج التقنية في العملية التعليمية لابد ان تكون سهلة ومبسطة لتشجيع المعلم ويجب ان تكون في ابسط صورة لكي لا ينفرد منها المعلم. أيضا عملية التدريب على جميع البرامج والمشاريع.

• هل ممكن تسليط الضوء على مشروع سيمانور ومشروع إنتل؟

بالنسبة لمشروع سيمانور شركة سيمانور حولت جميع المناهج والمقررات لجميع المواد والصفوف من الصف الأول الابتدائي إلى صورة رقمية الى ما يسمى بالكتب الالكترونية ووضعها على متصفح إضافة لبعض الروابط يستطيع المعلم أو الطالب يطلع عليها ويتصفحها دون نقلها أو نسخها كنوع من الحماية . هذه التجربة لم تتبناها الوزارة تبني كامل لكن الشركة اقترحت أن توفر هذا المتصفح بطريقة مجانية على هيئة أقراص مدمجة بها عدد محدد من الساعات للتجربة وإذا اقتنع ولي أمر الطالب أو الطالب بأهمية هذه التجربة يقوم بشرائها من حسابه الخاص من الأسواق التجارية. هذا المشروع بناء على مذكرة تفاهم بين وزارة التربية والتعليم وبين شركة سيمانور ولكنه ليس بصورة إجبارية. أما بالنسبة لمشروع إنتل ليس لدي أي خلفيه عنه.

Appendix 3 Science Teachers' Questionnaire

- Appendix 3.1 : Science Teachers' Questionnaire - English Version
- Appendix 3.2 : Science Teachers' Questionnaire - Arabic Version

Appendix 3.1 Science Teachers' Questionnaire - English Version

Integration of ICT into science curriculum and the Professional development needs of science teachers in Saudi Arabia

Dear science teachers

This survey investigates the integration of information and communication technology (ICT) into science teaching in intermediate schools. The results of this survey should assist in determining the professional development needs of science teachers in relation to ICT and pedagogical skills. Personal information such as your name and address is not required.

Questionnaire instructions

For the purposes of this questionnaire, Information and Communications Technology (ICT) means: Computer-based and communication technologies, networked or stand alone, both hardware and software, that are used as a teaching, learning or information resource.

This survey is intended for all science teachers (male and female) who teach in intermediate schools. Your assistance in reaching these teachers with a copy of the survey would be appreciated.

Please answer each question by marking an (X) in the box that best describes your answer. For example

- What is your age group?

20-30	31-40	41-50	51-60
	X		

If you are not sure about which answer to choose, please mark the box with the answer you think is closest to your opinion.

For some questions you need to write a number in the box.

After filling in the survey please send it to the educational training department in the Jeddah educational district.

If you have any inquiry or questions about this survey please call the person below on mobile phone number 0505691671 or email your query to s3125940@student.rmit.edu.au

Thank you in advance for your time to complete this survey.

Integration of ICT into science teaching in Saudi Arabia, and the professional development in ICT for science teachers

1. What is your gender? Male Female

2. What is your age group?

20-30 years	31-40 years	41-50 years	51-60 years
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. What is the highest level of education you attained?

Education Degree	Diploma	Bachelor's degree	Master's degree	PhD
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. How many years have you been employed as a science teacher? (Include this year)

1-5 years	6-10	11-15	16-20	21-25	More than 26 years
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Currently, how many class periods do you teach per week?

4 classes	8 classes	12 classes	16 classes	20 classes	24 classes
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. Do you perform work besides science teaching at your school? Yes No

7. What is the location of your current school? City Rural

8. What kind of building is the school? Government owned Rented

9. What is the work period of your school? Morning Afternoon

10. What is the average number of students in the class?

Less than 20 21-30 31-40 more than 41

11. What ICT equipment is available in your school and how many items are there?

Q	Statement	Yes	No
A	Computer laboratories		
B	School-wide computer network		
C	Internet access		
D	Computers in your classroom		
E	Electronic microscope in the science laboratory		
F	Internet access in the science laboratory		
G	Data projector in your classroom		
H	Data projector in the science laboratory		
I	Computers in the science laboratory		

12. Have you undertaken any ICT training programs? Yes No
 If not, go to Q 17

13. If you have attended ICT training, please specify when?
 Pre-service In-service Both

14. At which type of training centre did you do the ICT training programs?
 Private training centre Gov't training centre Both

15. How many ICT training programs have you done during the last three years?
 None From 1-3 From 4-6 More than 6

16. In general, what are the effects of these training programs on your teaching methods?
 Helpful Unhelpful

17. If you have not undertaken ICT training programs for educational purposes, please explain the reason.

	Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
A	Attendance at training programs is not a priority for me at this time.					
B	Lack of Ministry of Education encouragement					
C	The timing of the ICT training programs did not suit me.					
D	A lack of school administrative support					
E	The educational training center is too far.					
F	A lack of computer hardware and software in my school					
G	I do not have to attend training programs					
H	No such programs were available to me					
I	I do not have the time to attend any training programs					
J	Content of training programs does not meet my training needs					

Whether or not you use ICT, I would like to know what you think about it. Please indicate if you agree with each of the statements below by ticking the most appropriate box.

18. Based on the following scale, please rate your skill level in each of the following applications.
- **Not familiar:** You don't use it at all
 - **Entry:** You are just beginning to learn the basic skills and are aware of the possibilities, but you do not regularly use ICT in your teaching practice.
 - **Adaptation:** You are familiar with a variety of uses of ICT, and often use it to support your existing classroom practices and teaching strategies.
 - **Transformation:** Use of ICT has significantly changed your classroom practice.

Please rate your skill level in each of the following applications		Not familiar	Entry	Adaptation	Transformation
a	Familiarity with computers, (assembling computers and accessories such as screens, printers, scanners, modems, digital cameras, etc)				
b	Managing operating systems (changing desk top settings, date, time region, the degree of screen clarity)				
c	Organise and save educational files in folders				
d	Prepare summaries, abstracts, and educational material using text-based programs (eg Microsoft Word, Harf)				
e	Using programs for photos and drawings (Photo Shop, Al-Rassam)				
f	Prepare audio-video presentations for class activities				
g	Use programs to analyse data and create diagrams, register exam results (eg Microsoft Excel)				
h	Setting up and deleting educational programs (scientific programs and CD information programs such as encyclopaedia)				
i	Use science programs for laboratory experiments				
j	Use search engines to collect science information for lesson preparation				
k	Design and publish internet pages on science subjects or for student assignments				
l	Use emails to communicate with teachers, students, and parents				
m	Organise emails groups for distributing information and instructions				
n	Use chat programs (Messenger, Pal Talk)				

19. What do you think about ICT?

Statement		Strongly agree	Agree	Neither agree nor disagree or NA	Disagree	Strongly disagree
a	I wish to learn more about using ICT in teaching process					
b	ICT training is useful for my personal development					
c	I have to develop my ICT skills to maintain my professional capacity					
d	Using ICT has a negative impact on student learning					
e	Using ICT has a positive impact on my teaching methods					
f	Using ICT is not necessary for science laboratory experiments					
g	Using ICT in class wastes lesson time					
h	I do not think there is more to learn about ICT					
i	I would use ICT if there was sufficient relevant equipment at the school					
j	I prefer to use traditional teaching methods					
k	I do not have adequate skills to use ICT					
l	Using ICT requires more time and effort					
m	Class management is difficult with ICT					
n	Training programs for using ICT are aligned to novice teachers.					
o	Excellent teaching is possible without using ICT.					
p	Using ICT decreases the interaction between me and the students.					

20. Do you use a computer?

Yes

No

If No please go to Q25

21. Where do you use a computer? At home

At school

Both

22. Do you use the computer for educational purposes? Yes No

23. Do you have access to the internet? Yes No

24. Do you use the internet for educational purposes? Yes No

25. Please indicate to what extent, if any, each of the following are barriers that prevent you using information technology

To what extent if any do each of the following limit your use of ICT		Does not limit or N/A 0	Slightly limits 1	Somewhat limits 2	Greatly limits 3
a	Unavailability of ICT equipment at school				
b	Insufficient technical support for ICT				
c	Insufficient space to use ICT in classes				
d	Large classes limit use of ICT				
e	Internet is not available at school				
f	Internet speed is unsuitable for classroom use				
g	Limited number of Arabic science web sites				
h	No Arabic programs or books for most science curricula				
i	Science curriculum is not designed for ICT				
j	Extensive annual science curriculum content				
k	There is no coherent plan to integrate ICT in the school				
l	Insufficient time to acquire ICT skills				
m	ICT equipment may fail during class				
n	Unsure of ICT competency in class				
o	Insufficient ICT training pre-service				

Other comments

Please add any comments that would encourage your use of ICT in the classroom; anything you feel discourages you from using ICT.

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Thank you for your participation. Together we will improve the quality of education provision in the KSA.

Researcher Abdullellah Alsulaimani

Appendix 3.2 Science Teachers' Questionnaire -Arabic Version

رسالة توضيحية لمشروع البحث

دمج تقنية المعلومات والاتصالات في تدريس مادة العلوم وتحديد الاحتياجات التطويرية
لمعلمي العلوم في مجال دمج تقنية المعلومات والاتصال في المملكة العربية السعودية

أخي معلم العلوم في المرحلة المتوسطة

أختي معلمة العلوم في المرحلة المتوسطة

السلام عليكم ورحمة الله وبركاته

أنا زميلكم / عبدالإله بن عبدالله السليمانى والمبتعث من الإدارة العامة للتربية والتعليم بجدة لتحضير درجة الدكتوراه في تقنية المعلومات والاتصالات في مجال التعليم بجامعة رMIT (RMIT) بمدينة ملبورن بولاية فكتوريا بأستراليا. عنوان بحثي هو تقويم دمج تقنية المعلومات والاتصالات في تدريس العلوم وتحديد الاحتياجات التدريبية لمعلمي ومعلمات العلوم في المملكة العربية السعودية. ويشرف على البحث كلا من الدكتورة ماري هان هانراهان والبروفسور هيدر فهرانج بكلية التربية بجامعة (RMIT). تهدف هذه الدراسة إلى تطوير وتنمية قدرات معلمي العلوم تربويا لدمج تقنية المعلومات والاتصالات في تدريس مادة العلوم في المرحلة المتوسطة في المملكة العربية السعودية. ولإكمال هذه الدراسة احتاج إلى البحث بشكل خاص في كل ماله علاقة بدمج تقنية المعلومات والاتصالات بتدريس مادة العلوم في المرحلة المتوسطة، وسوف أقوم بجمع المعلومات من خلال إجراء بعض المقابلات الشخصية بالإضافة لعمل استبيان مع معلمي ومعلمات العلوم في المرحلة المتوسطة.

يسرني دعوتك للمشاركة في هذه الدراسة من خلال مشاركتك بالإجابة على الاستبيان الخاص بالبحث. تهدف الاستبانة إلى استكشاف الأفكار والتوجهات والخبرات لمعلمي ومعلمات العلوم في المرحلة المتوسطة وخصوصا في مجال الدمج التربوي لتقنية المعلومات والاتصالات في تعليم مادة العلوم للوصول إلى تحديد الاحتياجات التدريبية والتطويرية في هذا المجال.

إن مساهمتكم في البحث من خلال الإجابة على الاستبيان مهم جدا لموضوع البحث حيث أن نتائجه سوف تساعد في فهم الطرق التي سوف تؤدي إلى الرقي بالعملية التعليمية في المملكة العربية السعودية ، كما أود أن أوضح لسيادتكم بأن تعبئة الاستبيان سوف يستغرق خمسة عشر دقيقة تقريبا، ونوعية الأسئلة لن تسبب أي إزعاج أو مخاطر محتملة لكم. والمعلومات المستخلصة من الاستبيان سوف تستخدم لأغراض البحث العلمي ولن يطلع عليها سوى الباحث والمشرفين على البحث و يتم تخزينها لمدة لا تقل عن خمس سنوات طبقا لنظام جامعة (RMIT)، وفي حالة نشر نتائج هذه الدراسة سوف يتم المحافظة على سرية المعلومات الشخصية بحيث تضمن عدم ذكر(الاسم،العنوان، اسم المدرسة) في نتائج الدراسة، وفي حالة وجود أي استفسار خلال هذه الفترة أرجو الاتصال على التلفون (0000000) وللاستفسار عن نتائج

الدراسة مراسلتي على البريد الإلكتروني S3125940@student.rmit.edu.au

يقصد الباحث بتقنية المعلومات هو استخدام وتوظيف (الحاسب الآلي وبقية الأجهزة الرقمية التي يمكن ان تتصل به مثل الطابعات و الكاميرات و الماسحات الضوئية و المجاهر الالكترونية و أجهزة وشاشات العرض، و برامج الحاسب الآلي المختلفة مثل برامج تشغيل النظام و البرامج التعليمية إضافة للوسائط المتعددة، و شبكات الحاسب الآلي و الانترنت) والتي يمكن استخدامها في عملية التعليم و التعلم .

- هذه الاستبانة موجهة لجميع معلمي و معلمات مادة العلوم في المدارس الحكومية في المرحلة المتوسطة و التابعين للإدارة العامة للتربية و التعليم بجدة (بنين – بنات) .
- الرجاء الإجابة على جميع الأسئلة و ذلك بوضع علامة (X) في المربع المناسب و الذي يمثل أفضل تعبير عن إجابتك، على سبيل المثال،
- إلى أي مجموعة عمرية تنتمي؟

30-20 سنة	40-31 سنة	50-41 سنة	60-51 سنة
	X		

- في حالة عدم تأكدك من الإجابة التي تختارها، فمن فضلك اختر الإجابة التي تعتقد بأنها الأقرب لرأيك .
- أمل من مدير/ة المدرسة استلام الاستبانة من معلمي/ معلمات العلوم بعد تعبئتها إعادتها بأحد الطرق التالية:
- إرسال الاستبانة لمركز الإشراف التربوي التابع له المدرسة،
- أو إرسال الاستبانة على فاكس رقم (000000)،
- أو إرسال الاستبانة على البريد الإلكتروني adoorvme@yahoo.com
- وفي حالة وجود أي استفسار خلال هذه الفترة أرجو الاتصال على التلفون (000000) وللاستفسار عن نتائج الدراسة مراسلتي على البريد الإلكتروني S3125940@student.rmit.edu.au
- اشكر لكم تعاونكم و إسهامكم في تحقيق أهداف البحث و تخصيص جزء من وقتكم الثمين للإجابة على هذه الاستبانة.

الباحث / عبدالإله عبدالله السليماني

S3125940@student.rmit.edu.au

استبانة

دمج تقنية المعلومات والاتصالات في تدريس مادة العلوم وتحديد الاحتياجات التطويرية
لمعلمي العلوم في مجال دمج تقنية المعلومات والاتصال في المملكة العربية السعودية

أولاً: معلومات عامة عن المعلم والمدرسة

1. هل أنت معلم معلمة

2. إلى أي مجموعة عمرية تنتمي؟

30-20 سنة	40-31 سنة	50-41 سنة	60-51 سنة

3. ماهي أعلى شهادة علمية حصلت عليها؟

المؤهل	دكتوراه	ماجستير	الشهادة الجامعية	كلية متوسطة	المؤهل التخصص

4. كم عدد سنوات خبرتك في المجال التعليمي؟ (تتضمن هذه السنة الدراسية)

من 1-5 سنوات	من 6-10 سنوات	من 11-15 سنة	من 16-20 سنة	من 21-25 سنة	أكثر من 26 سنة

5. كم عدد الحصص المكلف/ة بتدريسها؟

4 حصص	8 حصص	12 حصة	16 حصة	20 حصة	24 حصة

6. هل توجد أعمال إدارية مكلف بها من قبل إدارة المدرسة أو الإدارة التعليمية ليس لها علاقة بتدريس العلوم؟

نعم لا

7. أين تقع مدرستك؟ داخل المدينة في القرية

8. ما نوع المبنى المدرسي؟ مبنى حكومي مبنى مستأجر

9. ما هو وقت دوام المدرسة؟ صباحي مسائي

10. كم عدد متوسط الطلبة/ات داخل الفصل؟

20 طالب/ة أو أقل من 21 – 30 من 31 – 40 أكثر من 41 طالب/ة

11. ماهي التجهيزات التقنية (الحاسب الآلي وملحقاته) المتوفرة بالمدرسة ؟

لا	نعم	الأجهزة
<input type="checkbox"/>	<input type="checkbox"/>	أ معمل للحاسب الآلي في المدرسة
<input type="checkbox"/>	<input type="checkbox"/>	ب شبكة داخلية لأجهزة الحاسب الآلي في المدرسة
<input type="checkbox"/>	<input type="checkbox"/>	ج الاتصال بالإنترنت متوفر بالمدرسة
<input type="checkbox"/>	<input type="checkbox"/>	د أجهزة حاسب آلي داخل الفصول التي تقوم بتدريسها
<input type="checkbox"/>	<input type="checkbox"/>	هـ أجهزة عرض البيانات (داتا شو) داخل الفصول التي تقوم بتدريسها
<input type="checkbox"/>	<input type="checkbox"/>	و أجهزة حاسب آلي في معمل العلوم
<input type="checkbox"/>	<input type="checkbox"/>	ز جهاز عارض بيانات (داتا شو) في معمل العلوم
<input type="checkbox"/>	<input type="checkbox"/>	ح الاتصال بالإنترنت متوفر بمعمل العلوم
<input type="checkbox"/>	<input type="checkbox"/>	ي مجهر ضوئي (رقمي) متصل بالحاسب الآلي في معمل العلوم

ثانيا: التدريب والبرامج التدريبية في مجال تقنية والمعلومات والاتصال.

يقصد الباحث بتقنية المعلومات هو استخدام وتوظيف (الحاسب الآلي وبقية الأجهزة الرقمية التي يمكن ان تتصل به مثل الطابعات و الكاميرات و الماسحات الضوئية و المجاهر الالكترونية و أجهزة وشاشات العرض، و برامج الحاسب الآلي المختلفة مثل برامج تشغيل النظام و البرامج التعليمية إضافة للوسائط المتعددة، و شبكات الحاسب الآلي و الانترنت) والتي يمكن استخدامها في عملية التعليم والتعلم .

12. هل سبق لك أن تدربت على طرق استخدام تقنية المعلومات في التعليم؟ نعم لا

عند الإجابة بلا انتقل للسؤال رقم (17)

13. متى كان تدريبك على استخدام تقنية المعلومات في التعليم؟

قبل عملك كمعلم/ة أثناء عملك كمعلم/ة في كليهما

14. في أي مركز للتدريب حصلت على البرامج التدريبية الخاصة باستخدام تقنية المعلومات في التعليم؟

مراكز تدريب تابعة لإدارة التعليم	مراكز تدريب خاصة (تجارية)	في كليهما

15. كم عدد البرامج التدريبية التي حضرتها خلال الثلاث سنوات الأخيرة والخاصة باستخدام تقنية المعلومات في التعليم ؟

أكثر من ستة برامج تدريبية	من 4 – 6 برامج تدريبية	من 1- 3 برامج تدريبية	لا يوجد

16. بشكل عام، كيف كان أثر التدريب على طريقة تدريسك؟

ايجابي
 سلبي
 ايجابي وسلبي

17. إلى أي مدى ساهمت العوامل التالية في عدم مشاركتك في برامج التدريب الخاصة بدمج تقنية المعلومات والاتصال؟

العبارة	موافق بشدة	موافق	غير متأكد	غير موافق	غير موافق بشدة
أ حضور البرامج التدريبية لم يكن من أولوياتي .					
ب عدم وجود حوافز وظيفية لحضور البرامج التدريبية.					
ج أوقات البرامج التدريبية غير مناسبة.					
د عدم توفر الدعم من إدارة المدرسة أو الإدارة التعليمية.					
هـ موقع مركز التدريب بعيد عن مقر سكني.					
و عدم توفر أجهزة تقنية المعلومات والاتصال في المدرسة.					
ز أنا غير مطالب بحضور البرامج التدريبية.					
ح قلة عدد البرامج التدريبية.					
ط ليس لدي الوقت الكافي لحضور برامج التدريب التربوي بشكل عام.					
ي محتوى البرامج التدريبية لا يلبي احتياجاتي التدريبية في مجال تقنية المعلومات.					
أخرى (الرجاء حدد)					

ثالثاً: استخدام تقنية المعلومات والاتصال في التدريس.

18. بناء على التدرج التالي حدد مستوى مهارتك في التطبيقات التالية:

- لا أجيدها = لا أجد استخدامها إطلاقاً.
- مبتدئ = أعرف استخدام الحاسب الآلي بصورة بسيطة، ولكن لا أستطيع توظيفه في العملية التعليمية.
- ملم = أعرف عدة استخدامات وتطبيقات بصورة جيدة وأستطيع استخدامها في العملية التعليمية.
- متطور = أجد استخدامها بصورة متقدمة وبسهولة وأستطيع استخدامها لتسهيل العملية التعليمية.

متطور	ملم	مبتدئ	لا أجيدها	المهارة
				أ التعامل مع الحاسب الآلي، مثل (توصيل وتركيب جهاز الحاسب الآلي وملحقاته كالشاشة، الطابعة، الماسح الضوئي، المودم، الكاميرا الرقمية،).
				ب التعامل مع نظام التشغيل مثل (تغيير إعدادات سطح المكتب، التاريخ والمنطقة الزمنية، تغيير درجة وضوح العرض أو الشاشة).
				ج القدرة على تنظيم الملفات التعليمية وحفظها على الحاسب الآلي.
				د عمل الملخصات والنشرات التعليمية باستخدام برامج محرر النصوص مثل برنامج (مايكروسوفت وورد، حرف).
				هـ برامج معالج الصور والرسومات مثل (الرسام ، الفوتوشوب).
				و عمل عروض تقديمية بالصوت والصورة واستخدامها أثناء الدرس.
				ز القدرة على استخدام جداول البيانات لتحليل البيانات والرسوم التوضيحية ، أو تسجيل نتائج الاختبارات ورصد الدرجات مثل برنامج (مايكروسوفت اكسل).
				ح تنصيب وحذف البرامج التعليمية مثل (برامج علمية، موسوعات علمية).
				ط برامج خاصة بمادة العلوم مثل برنامج (محاكاة المختبر) لإجراء التجارب المعملية داخل معمل العلوم.
				ي استخدام محركات البحث على شبكة الإنترنت لجمع معلومات لتحضير الدروس.
				ك القدرة على تصميم وبناء صفحة تعليمية على الإنترنت لنشر أو إرسال معلومات عن المادة أو المحتوى العلمي لها، أو لنشر الأعمال الطلابية على الإنترنت.
				ل إستخدام البريد الإلكتروني للتواصل مع المعلمين، الطلبة ، أولياء الأمور في غير أوقات ساعات المدرسة.
				م إنشاء بريد إلكتروني جديد وتكوين مجموعات بريد إلكتروني.
				ن التعامل مع برامج المحادثة الصوتية مثل (الماسنجر، البال توك).

19. ضع إشارة أمام الاختيار الذي تعتقد أنه مناسب.

غير موافق بشدة	غير موافق	غير متأكد	أوافق	أوافق بشدة	العبارة
					أ أرغب في تعلم المزيد عن استخدام تقنية المعلومات والاتصال في التعليم.

غير موافق بشدة	غير موافق	غير متأكد	أوافق	أوافق بشدة	العبارة
					ب التدريب على استخدام تقنية المعلومات والاتصال مفيدة لتطوير قدراتي المهنية.
					ج يجب أن اطور مهاراتي في مجال تقنية المعلومات لأواكب تطورات العصر.
					د استخدام تقنية المعلومات في تدريس العلوم له أثر سلبي على تعلم الطلبة.
					هـ استخدام تقنية المعلومات في تدريس العلوم له أثر ايجابي على طريقة تدريسي.
					و استخدام تقنية المعلومات غير مفيد في التجارب المعملية في العلوم.
					ز استخدام تقنية المعلومات داخل الفصل يساهم في إضاعة وقت الدرس.
					ح لا أرى أي ضرورة لتعلم المزيد حول تقنية المعلومات والاتصال.
					ط أرغب في استخدام تقنية المعلومات ولكن لا تتوفر بالمدرسة الامكانيات.
					ي أفضل استخدام الطرق التقليدية في التدريس لأنني تعودت عليها خلال دراستي.
					ك لا أملك المهارات الكافية لإستخدام تقنية المعلومات في تدريس العلوم.
					ل استخدام تقنية المعلومات يتطلب مني بذل المزيد من الجهد والوقت.
					م صعوبة إدارة الفصل أثناء استخدامي تقنية المعلومات.
					ن برامج التدريب على استخدام تقنية المعلومات مفيدة فقط للمعلمين المبتدئين.
					س مدرس العلوم المتميز قادر على التعليم بامتياز دون استخدام تقنية المعلومات.
					ع استخدام تقنية المعلومات يقلل التفاعل الاجتماعي بيني وبين الطلبة.

20. هل تستخدم جهاز الحاسب الآلي؟ نعم لا
إذا كانت إجابتك بلا انتقل للسؤال رقم (25)

21. أين تستخدم جهاز الحاسب الآلي؟ في المنزل في المدرسة في كليهما

22. هل تستخدم جهاز الحاسب الآلي لأغراض تعليمية؟ نعم لا

23. هل لديك اشتراك بالإنترنت؟ نعم لا

24. هل تستخدم الإنترنت لأغراض تعليمية؟ نعم لا

رابعاً: عوائق استخدام تقنية المعلومات والاتصال في التدريس.

25. إلى أي مدى تعيقك هذه العوامل عن استخدام تقنية المعلومات في مجال التعليم؟

تعبق بشدة	تعبق نوعا ما	غير متأكد	لا تعيق إطلاقا	العبارة
				أ نقص أجهزة تقنية المعلومات في المدرسة
				ب عدم كفاية الدعم والتوجيه الفني لإستخدام تقنية المعلومات
				ج عدم وجود المساحة الكافية داخل الفصل لاستخدام تقنية المعلومات
				د وجود عدد كبير من الطلبة داخل الفصل يحد من استخدام تقنية المعلومات
				هـ عدم وجود اتصال بالإنترنت داخل المدرسة
				و سرعة اتصال الانترنت بطيئة وغير مناسبة لاستخدامها اثناء التعليم
				ز قلة المواقع العربية المتخصصة بتدريس العلوم على الانترنت
				ح عدم وجود كتب وبرامج الكترونية باللغة العربية لغالبية مناهج ومقررات العلوم
				ط تصميم مقرر العلوم لا يتوافق مع استخدام تقنية المعلومات
				ي المحتوى العلمي لمقرر العلوم طويل ويجب الإنتهاء منه خلال السنة الدراسية
				ك عدم وجود رؤية او خطة لإدخال تقنية المعلومات في المدرسة
				ل عدم وجود وقت كاف في الجدول المدرسي لإكتساب مهارات تقنية المعلومات.
				م أخشى من اعطال اجهزة تقنية المعلومات او تلفها عند استخدامها
				ن أخشى من الفشل في استخدام تقنية المعلومات أمام الطلبة
				س عدم وجود تدريب كافي على استخدام تقنية المعلومات قبل بدء عملي كمدرس
				ع أخرى (اذكرها من فضلك)

شكرا لمشاركتك

الباحث: عبدالإله عبدالله السليمانى 1429هـ