THE UNIVERSITY OF HULL

Introduction of Multimedia Project-Based Learning in a Technology-Rich Environment: a Study of Teacher Attitudes and Influencing Factors in Basic Education Schools in Oman.

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By

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Author's declaration

CERTIFICATE OF ORGINALITY

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified in acknowledgment or footnotes, and that neither the thesis nor the original work contained therein has been previously submitted to any institution for a higher degree.

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Abstract

In 1998 the government of Oman embarked on a major reform of the education system, to be implemented in stages. Key features of the new-style schools, called Basic Education schools, were to be a constructivist approach to teaching, and the integration of technologies across the curriculum. However, no clear model for integration was proposed.

The aim of this study is to explore factors influencing adoption of a constructivist, technology-rich approach in education, in order to propose a model for technology integration.

The research sample was composed of 200 Learning Resource Centre teachers in Basic schools in the regions in Oman.

Teachers' attitude towards elements of the new, before and after the provision of training and practice, were explored via a questionnaire using 3 and 5-point Likert scales. Attitude change was measured, and the effects of teaching experience, urban or rural residence and previous ICT training on attitude were explored. Additional qualitative information was gathered by structured observation of video-recorded lessons, and by interviews with 40 teachers.

Teachers were generally favourable towards the new approach, but lacked confidence in how to implement. After the training, there was a marked increase in positive attitude for all elements except IT goals. Attitudes and practice towards constructivist were found to be influenced by teachers' years of experience, with more experienced teachers being less amenable to change. Other factors such as technology problems and student misbehaviour were also perceived as significant constraint. Recommendations are made for overcoming these problems.

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CHAPTER ONE

SETTING THE SCENE

1.1 Background

The history of education in Oman can be traced back to the time when the Omanis embraced Islam. The need was to teach the Quran and the transmission of Islamic religion and culture (AlManthri, 2001). Such teaching was provided by what is known in Arabic as "*kuttab*", which is basically a group of boys and girls taught by a single teacher (either male or female) to recite the Holy Quran, and sometimes basic writing skills (AlHammami, 1999).

Before 1970 there was no national education system or educational infrastructure in Oman. Educational opportunities were very limited and there were few Omanis who had the chance of education in other countries. There were only three schools for formal education in the country. Two of these schools were in the capital area: the Sayyidiya School in Muscat (opened in 1940) and the Sayyidiya school in Mutrah (opened in 1959). The third Sayyidiya School (opened in 1955) was in Salalah, in the south of the country. There were a total of 909 pupils and thirty teachers in these schools.

When His Majesty, Sultan Qaboos bin Said, began his reign in July, 1970, Education, especially of young people, was one of the major concerns of His Majesty. In a speech in the early 1970s, he stressed the importance of education for the whole Omani population- even if it had to take place under the trees. He said (Ministry of Information, 1995, p.23)

> Education was my great concern, and I saw that it was necessary to direct efforts to spread education. We have given the Ministry of Education the opportunity and supplied it with our capabilities to break the chains of ignorance. Schools have been opened regardless; the important thing is that there should be education, even under the shadow of trees.

The progress of education in Oman since the 1970s has been remarkable (Ministry of Education, 1987). Clements (1980) reported that the number of schools increased in from 3 schools before 1970 to 352 in 1979. Steady increase at all school stages continued until, in the school year 2001-2002, the total number of schools in the Sultanate was 1013.

In addition to quantitative development, there has been a concern for qualitative improvement, to meet the needs of socio-economic development. Although Oman has achieved remarkable progress, both socially and economically, with the implementation of successive Five-Year Development Plans, there are new challenges confronting the Government, due mainly to uncertain oil revenues. Recognising the finite nature of oil reserves, and the vagaries of an oil market outside its control, the Government is placing greater emphasis on the diversification of the country's economic base, led by the private sector (Ministry of Information, 1999). Because of this change of focus from total dependence on oil to diversity of income source to promote economic growth, there was a need to equip Omanis with the skills and knowledge needed to meet the industrial and service needs of modern society.

In the last decade, there was concern that the existing education system did not adequately prepare Omani students for the challenges and opportunities that will be presented both domestically and globally. The perceived failure was attributed to many factors: The method of teaching was a major problem as it relied almost entirely on rote learning; it was teacher-centred rather than pupil-centred (AlManthri, 2001); and there were few or no educational teaching aids or resources.

AlHammami (1999) summarised the weaknesses of the current system as follows:

- Poor education facilities such as libraries, laboratories, and teaching aids;
- Ineffective teachers because of low qualification;
- An outdated curriculum;
- Education outcomes that did not satisfy the needs of the labour market;
- Overcrowding of classrooms because of the increase in population;
- Inspectors' comments that focused more on criticism than helping teachers;
- Overloading of teachers with non-teaching duties.

In recent years, as a result of concerns that the general education system did not meet the requirement of the country's development aspirations, reforms have been introduced in a limited, but growing number of schools, termed Basic Education schools, which are intended to provide ten years' unified education for all children in the Sultanate.

The reforms were based on a study of the Omani education system carried out in the early 1990s, by a team of educational experts from the Canadian Educational Consultancy Services (Ministry of Education, 1995). AlManthri (2001, p.3) claims "The Reform promotes the acquisition of knowledge and skills that rely upon students using problem solving, higher order thinking skills, and technological applications."

The change in the Omani educational system requires a move to child-centred/child-based learning, where children are encouraged to work on their own with guidance from the teacher. The characteristics of this type of learning can be summarized as follows:

- children can work at their own speed, rather than at the speed of the whole class;

- children are encouraged to use a wider range of materials than the set text or work books;
- children develop cognitive learning habits (Ministry of Education, 1995).

Current education policy in Oman favours a constructivist approach, in which the focus should be on helping children to learn independently, with content being presented as problems to be solved (Chapter Two provides more detail on the constructivist approach). Teachers should lead children to find the right answers and the children should be encouraged to cooperate and work together in groups (Ministry of Education, 1998).

A major change in the new reform is pupils' assessment. The reform works to eradicate the traditional form of assessment and promote alternative/authentic assessment. Wiggins (1990, p.1), who first introduced the concept of "authentic assessment", maintains that assessment is authentic when it directly examines student performance on worthwhile intellectual tasks. Alternative/authentic assessment will be considered in more detail in Chapter Two.

It was recognized that, in order to support the new concept of child-centred learning, children from an early age should have available learning resources to help them develop. For this reason, Learning Resource Centres (LRCs) form an essential part of primary school planning so that children can benefit from their very first experience of formal education. Materials in a wide range of formats - printed (books, periodicals); audio visual (for example, videos, audio cassettes); and electronic (for example, CD-ROMs, multimedia packages) are provided in the Learning Resource Centre (LRC). It is equipped with equipment such as listening/recording booths; television and slide projector.

Another strong strand in the educational reform programme is the provision of computers in the schools, with the goal of making the children computer-literate at an early age. Each LRC is provided with 15 computers, networked to the server which is controlled by the LRC teacher. The plan is eventually to provide computer laboratories for pupils in all grades. Information Technology is being introduced as a curriculum subject with timetabled teaching periods allocated to it. Therefore, the goals of introducing technology in basic education involve the integration of three types of use: learning about technology, learning from technology and learning with technology.

As stated earlier, the new education system was introduced in Basic Education schools. The vision of every school having a learning resource centre is obviously a very expensive one, which cannot be implemented overnight. The new system is therefore being phased in gradually. Commencing in the academic year 1998-1999, as phase one of the reform, the Ministry of Education introduced the Basic Education System in grades 1 – 4 (age 6-10 years), Phase two will extend the system to grades 5-10 (ages 11-16 years). The reform started with 17 schools across the whole country and every year the number of schools is being increased.

1.2 Statement of the Problem

The Canadian Study on the Omani education system in the 1990s asserted the benefits of an influx of technology on students' learning and recommended a technology-rich learning environment for Oman (Ministry of Education, 1995). Significant resources have therefore been expended to place computers and other technologies in the Basic Education schools, in Oman. The approximate budget to establish one Learning Resource Centre is from 25,000 to 30,000 Omani Rials, equivalent to 40,000 (Ministry of Education, 1997b).

As a member of the team following up the needs of Basic Education schools (TFBES) in 1998 and 1999, the researcher had an opportunity to observe some IT lessons in 23 Learning Resource Centres. The TFBES team reported to the Ministry of Education in September, 1999 and noted the following features of IT teaching in Learning Resource Centres:

- Many technologies and media available in LRCs were not being used by either teachers or students (see Appendix One) ;
- IT activities were taught solely as skills with drill and practice exercises for some subject areas;
- Teachers were the dispensers of information; they mainly lectured and explained to the whole class IT skills, then set students to work on exercises;
- Students practised these skills individually and sometimes in pairs;
- Due to the small number of computers (15 in each LRC), classes were divided into two. Half of the students were assigned to work on on-computer activities and the other half worked on off-computer activities. In the next lesson they swapped turns. It is interesting to note that there was no relationship between what students did in their on-computer activities and their off-computer activities.

Thus, so far the full potential of integrating technology appears not to have been met. Many types of equipment have started to gather dust because of lack of knowledge of how to use them in LRCs and, even where resources are used, they are being used as an "add-on" within a traditional approach to teaching, rather than integrated into subject-teaching within a constructivist approach as intended by Omani policy-makers and as recommended by the Canadian Study.

This manner of use does not appear consistent with the goals of technology integration set out in the Government reform document accompanying the introduction of the Basic Education system.

The reform document expresses the view that technology use is intended to help students learn and develop in a number of important areas. These include:

- helping students become proficient at accessing, evaluating and communicating information;
- fostering an increase in the quantity and quality of students' thinking and writing;
- helping students learn to solve complex problems;
- making students globally aware and able to use resources that exist outside the school;
- creating opportunities for students to do meaningful work;
- nurturing artistic expression (Ministry of Education, 1995, p. A9-2)

The reform document indicates that students should use technology to promote their learning, rather than to gain discrete skills and knowledge:

> Learning how to use computers is important; learning with computers is equally important. Computers must be considered by educators to be tools which can both help students to learn how to learn and which can strengthen learning in subjects as diverse as biology, history and languages. Almost as a by-product, students learn how to use technology, a task which most adults find intimidating. (ibid: A9- 1)

The document proposes that technology should be used as a learning tool:

> With the tools of technology, students can dramatically raise knowledge levels, learn problem-solving techniques, develop the skills required to manage massive amounts of information, analyse concepts from several different perspectives and develop the hard to-quantify higher-order analytic and critical thinking skills that are required in the marketplace. (Ministry of Education, 1995, p. A9- 2)

Students will not learn how to use technology, or how to access and communicate information, if the technology available in schools is not used in lessons. Nor can the skills of evaluation, problem-solving and critical thinking be developed by the use of technology, if the use is solely the drill and practice type. As the literature on technology in education makes abundantly clear, technology alone cannot bring about changes in teaching (Mergendoller, 2000). There are many traditional ways for teachers to use technology that do not require rethinking how one teaches; however, these ways do not exploit the full potential of technology to benefit students' learning (Jonassen, 2000). Technology holds tremendous promise as a catalyst for cooperative and group learning, but it has to be accompanied by effective pedagogy (Mergendoller, 2000). The education literature suggests that the most effective technology integration is associated with a constructivist approach to teaching (see for example, Ehrich, McCreary, Ramsey, Reaux, & Rowland, 1998a; Strommen and Lincoln, 1992). The U.S. Office of Technology Assessment (1988, p.42) concurred:

> By and large, the research to date supports the continued use of instructional technologies in the schools....there is evidence that computer-assisted instruction can raise achievement test scores for some students; but there is also wide agreement that computer technologies can already do more than provide electronic equivalents of drill and practice workbooks, and that much of their future promise lies in experimentation and development of non-traditional learning methods.

Matthew (1996) envisages how changes towards constructivist learning and technology might take place. Learning will take place as students construct their own knowledge using a variety of resources including teachers, textbooks, and reference materials, rather than textbooks combined with teacher lectures. Teachers will be models and mentors who encourage students to think critically to solve their own problems, rather than providing students with rote drill and practice activities. Curriculum changes will engage students in inquiry involving real problems across subject areas and will involve in-depth research, instead of the mastery of skills and concepts. In classrooms, students will work cooperatively, rather than competitively. Changes in assessment will focus on students evaluating themselves and demonstrating their ability to apply and defend what they have learned, instead of the rote recall of information. In restructured schools, students will make use of new technologies for creating knowledge, rather than paper, pencil and textbooks for developing basic skills.

In view of the disparity between the status of technology integration in schools as observed by the TFBES inspection team, with that envisaged by the Reform Document and by the education literature, the researcher, during the team's visits, took the opportunity to meet some LRC teachers to enquire about their attitudes and practices at that time regarding use of technologies and media. Many teachers were concerned that they were not exploiting the full potential offered by the technology and media in the LRCs and also frustrated because they did not know how to make the best possible use of these facilities. Overall, teachers were not happy with the narrow range of ways they were currently using the technology (for example for drill and practice) but they did not possess the knowledge, skills and understanding to move beyond this.

This experience highlights the need for research to determine what kind of teaching would lead to effective use of technology in the Learning Resource Centres, in a manner that would support learning goals across the curriculum. The present research is intended as a contribution towards that goal.

Based on the problems observed in Omani schools, and theoretical underpinnings from the literature, it was decided to focus the research on two main dimensions: the implementation of a constructivist, projected-based approach in the use of technology in the classroom; and the attitudes of teachers towards the approach. The rational for these dimensions was as follows: firstly, the project-based approach. It was not feasible within a single study to investigate a number of different approaches, given the time and resources that would be needed to train teachers in a range of approaches and the large number of schools that would have to be involved to provide a meaningful sample of each approach for comparison. In selecting project-based learning as the focus for investigation, account was taken of the literature.

Multimedia project-based learning, as a model of instruction, has been suggested by a number of writers as an effective way to integrate technology into students' learning. Studies such as Cohen (1997); Dexter and McGhee (2001); Liu and Rutledge (1997); Penuel and Yarnall (2000); Sandholtz, Ringstaff and Dwyer (1997); Simkins (1999) and Turner and Handler (1997) showed the benefits of Project-based learning in students' learning and use of various technologies for developing students' projects (see Chapter Three for more details about project-based learning). Furthermore, project-based learning would be consistent with the child-centred approach (based on constructivist theory) promoted by the education reform in Oman. However, according to the information obtained by the TFBES team, the approach was not introduced in Learning Resource Centres (LRCs) in Basic Education prior to this study.

According to Kennewell, Parkinson and Tanner (2000, p.109) a constructivist technology rich environment has the following characteristics:

(a) project- and resource-based learning, with theoretical principles discussed as necessary to solve problems and explain relationships, as they are met;

(b) work in groups, on and off the computer, involving discussion and reporting;

(c) direct experience of the need for information and for practical ICT solutions in the world of work;

(d) assessed project work to be carried out when pupils have sufficient higher order skills, and knowledge of processes and techniques, to be able to work largely independently.

Integrating technology into the curriculum is not, however, an easy task. Arranging educational technology so that it supports and expands student learning is an important hurdle to overcome (Mergendoller, 2000). Byrom (1998) notes technology integration can be difficult, time-consuming and intensive for most teachers. This brings us to the second focus of this research: teacher attitudes.

Literature shows that teachers are important elements of change in educational practice (AlManthri, 2001); they play important roles in students' learning, whether in a traditional learning environment or in a constructivist learning environment. The constructivist learning environment promotes effective learning in which students are actively engaged in their learning; hence teachers have to promote students' empowerment (Moseley and Higgins, 1999).

To create such an environment is not easy and success or failure in adopting constructivism to some extent depends on the teachers (Marcinkiewicz, 1993). They are viewed as important agents of change in the learning environment, for example, from a traditional learning environment to a constructivist learning environment.

Scott and Hannafin (2000, p.3) maintain, "Within schools, teachers are in the best position to be change agents. Therefore, it is important to determine which teachers are more likely to embrace change and hold views that are consistent with school reform efforts." In a constructivist learning environment, changes might involve (as discussed in Chapter Two) students' and teachers' roles, goals of instruction, alternative means of student assessment and the learning setting, e.g. cooperative and collaborative learning.

Although in such an environment the burden of delivering instruction, for example, through lectures, tutorials and seminars, is shifted from the teachers' shoulders, teachers still have major roles to perform. Oates (1985, cited in Hannafin and Savenye, 1993, p.28) argues that teachers need to create an intellectual environment in which knowledge is acquired. Collins (1991) maintains that "the solution of these problems [such as getting students' attention and having control over students] is to change our view of the teacher's role to that of a facilitator of students' self-directed learning rather than a dispenser of information" and "such a change in belief will not come easily and will only come about slowly with the introduction of a great many computers into schools." Prawat (1992, p.357) agrees with Collins' point of view on the demands put on teachers' shoulders:

> The adoption of such an approach to teaching and learning, as I will argue in this article, would result in major changes in the teacher's role. Thus, in all constructivist teaching-learning scenarios, the traditional telling-listening relationship between teacher and student is replaced by one that is more complex and interactive. It is not surprising that constructivist teaching places greater demands on teachers [and students].

For this reason, teachers' currently held beliefs/attitudes and practice need to be considered when evaluating the potential for change, for example, the feasibility of an innovative 'technology-rich' constructivist environment. Ertmer, Addison, Lane, Ross, and Woods (1999) maintain that it is important to examine whether teachers' current classroom practices and beliefs support or inhibit technology use in order to get educational innovation to become practice.

Therefore, this study attempts to investigate the feasibility of implementing a new approach to using technology underpinned by constructivist theory: a project-based approach, and examines teachers' attitudes towards adopting the new approach.

1.3 Research Questions

The aim of this research is to explore the attitudes of teachers towards a constructivist approach to teaching and learning, and to investigate whether and how their attitudes change as a result of training and practice (introducing the new approach). Thus the main research question is:

- **What are teachers' attitudes towards project-based learning (constructivist learning approach), before and after the training?**

Within this framework, a number of subsidiary questions are investigated, as follows:

Effect of teacher teaching experience

A number of researchers have suggested the existence of associations between teaching experience and willingness to embrace change, including a constructivist approach and the integration of technology, which are key features of the project-based approach investigated in this study. However, findings have been inconsistent. As regards the tendency to adopt a constructivist approach to teaching and learning, Hannafin and Freeman (1995) and Scott and Hannafin (2000) found that this is less likely among more experienced teachers, who tend to take a more traditional standpoint. Regarding the integration of technology, and especially computers, into teaching, Howie and Wen (1997) and Smerdon, et al. (2000) found that more experienced teachers had more difficulty in adjusting to technology integration and more negative attitude towards it than less experienced teachers. In contrast, McCoy and Haggard (1989) and Grandgenett and Harris (1994) found that teachers with more teaching experience made more use of computer technology in their teaching. Henry (1993), on the other hand, found no relationship between teaching experience and use of technology in the classroom. These inconsistencies and contradictions may be related to differences in cultural setting, or to a combined effect of years of teaching experience with other factors such as age or training. It was therefore decided to investigate whether more light could be shed on the possible impact of this factor in the present study, leading to the following research question:

1- **Do teachers' years of teaching experience have an influence on their attitudes towards project-based learning (constructivist learning approach), before and after the training?**

Rural and urban effect on attitude

Historically, rural education reform has been difficult due to rural-urban antagonism, the concentration of wealth and political power in urban areas, conflicting values, and social inequality, and too often, policymakers have portrayed rural communities in a negative light—as backward, uneducated, and opposed to progress. (*The ERIC Review*, 2001). Rural areas tend to lag behind cities and suburbs in obtaining access to the Internet and other technologies, and different teachers adopt new technologies at different times (ibid). However, according to Collins and Dewees (2001) professional development can help rural teachers adapt technology to their classrooms. The authors state that:

> The problem of using technology in the classroom [in rural areas] can be ameliorated with professional development for teachers and administrators along with adequate funding to implement and sustain rapidly changing hardware and software needs (p.4).

In the context of this study, teachers' residence areas is an interesting issue to investigate, since this is brought up in the government reports. It has been argued that Omani society is dominated by two major features: religion and family (AlNabhani, 1996). For example, Islam and the traditions of the country provide guidance for everyday life, including education and discipline. AlNabhani (1996) suggests that the influences of these factors can be seen more in rural areas than urban areas. If this is still the case, rural teachers might have more negative attitudes towards, for example, gender mixing and unrestricted movement during cooperative activities. Rural and urban area differences exist in the illiteracy rate and educational attainment of men and women, as well as in people's attitude, beliefs, values and practice related to women's education and social development (Ministry of Education, 1999). However, according to the E.F.A Assessment Report 2000, such differences in attitude are disappearing as increasing efforts are put into the spread of education (Ministry of Education, 1999). Morales (1999) who conducted a study on the integration of technology in some Mexican schools, found that there was no significant difference between urban and rural teachers' attitude towards technology. Therefore, it would be interesting to see whether there is an effect of residence areas on teachers' attitudes in Oman, or whether rural-urban differences have in fact been overcome. It is important to investigate this, as any difference between rural and urban areas, in attitudes towards project-based learning, technology integration and related issues would have policy implications for the introduction of such an approach, leading to following research question:

2- **Do teachers' areas of residence (urban and rural) have an influence on their attitudes towards project-based learning (constructivist learning approach), before and after the training?**

Effect of training

It may be expected that teachers who had attended more ICT courses and advanced training courses would have more positive attitudes towards some aspects of the new approach because during their training they may have been exposed to some concepts related to aspects of the recent reforms, such as child-centred education, cooperative and collaborative learning (Ministry of Education, 1997a).

Conversely, those teachers who had attended fewer ICT courses may be expected to show more negative attitudes towards the approach. In his study, Christensen (1998) found that teachers who reported that they had received training on the integration of ICT into their teaching had significantly higher (more positive) attitudes on all the teacher attitude subscales measured. LRC Teachers in Oman have varying opportunities to attend ICT courses and so attendance at such courses may be a factor influencing their attitude to project-based learning. This will be investigated, leading to the following research question:

3- Does teachers' previous training have an influence on their attitudes towards project-based learning (constructivist learning approach), before and after the training?

Other factors affecting use of technology

Previous research has suggested that teachers' integration of technology into their teaching may be influenced by a number of factors in addition to those already mentioned, for example lack of time (Topp, Mortensen and Grandgenett, 1995; U.S. Office of Technology Assessment, 1995), lack of equipment (Butzin, 1992; Smerdon et al., 2000), lack of technical support (Topp et al., 1995; Dawes, 2001) and current assessment practices (U.S. Office of Technology Assessment, 1995).

It would therefore be interesting to see whether these or any other factors were identified by teachers in Oman as constraints on their implementation of the approach as, again, this would have implications for policy-makers.

4- What are other factors influencing or hindering teachers' practice during implementation of the project-based learning approach?

1.4 Significance of the Study

No other studies have been conducted to address this problem in Oman and even in the Gulf states, according to the author's recent knowledge. The researcher is aware of a few similar studies conducted in Great Britain and the United States of America, in classroom settings rather than in Learning Resource Centres (e.g., Goodwyn, Clarke and Adams, 1997; Sandholtz et al., 1997). As no previous attempt has been made to implement technology integration in Omani schools in general and in Basic Education schools in particular and no attempt has been made to evaluate teachers' attitudes towards such integration in Oman, this study will be the first of its kind. This study, although conducted with a group of teachers in Basic Education schools, will have implications for all reformed schools in the Sultanate. An understanding of the factors influencing teachers' effective use of technology in schools will certainly provide empirical evidence which will help educators and decision makers in the Ministry of Education to foster the required preconditions (such as constructivist training for teachers and availability of equipment) to achieve a sustainable integration of technology in schools in Oman. The study is intended to raise issues that might enhance further use of technology in reformed schools at any stage and provide guidelines on how technology integration can be successfully achieved.

1.5 Organization of the Thesis

In Chapter Two, constructivist learning theory is discussed in order to identify its main principles and the implications for practice in relation, for example, to the roles of teachers and students, collaborative learning, the role of prior knowledge in the construction of new learning, and alternative, "authentic" modes of assessment. Particular attention is paid to the role and effective use of technologies in a constructivist learning environment. The discussion leads to a proposal that project-based learning is an appropriate approach for integrating technology across subject areas which offers an effective way to put constructivist principles into practice and use technology to support teaching and learning.

Following on from the proposal in Chapter Two, Chapter Three discusses project-based learning in depth. The history of the approach is outlined, the resources needed to implement it are considered, and the implementation procedures are presented in some detail.

The implementation of an innovation in education, such as project-based learning, may be facilitated or impeded by a range of attitudinal, instructional and logistical factors. The identification and addressing of such factors are essential to the success of reform efforts. In Chapter Four, therefore, research evidence on such factors is reviewed, in order to identify issues that need to be considered in the context of Oman's educational reforms.

The outcome of chapters Three and Four is an understanding of the key dimensions of the constructivist approach, of the importance of attitude in educational innovation, and of the possibility that attitude may vary with teachers' teaching experience and training. The remainder of the thesis reports on the empirical exploration, in Omani Basic Education schools, of teachers' attitudes towards the dimension of constructivism before and after training, and of the impact of teachers' characteristics and practice factors on their attitudes. Chapter Five explains the location and sample of the research and the development of the research instruments: an attitude questionnaire, interview questions and an observation schedule. An account is given of the training intervention and the procedures adopted in collecting and analysing data, before and after training.

Chapter Six presents the data from the questionnaire survey. First, data are presented on teachers' attitude towards dimensions of the constructivist approach before training, both for the sample as whole, and in relation to teaching experience, residence and previous ICT training. Then, attitudes after the training intervention are reported and compared with the pre-training attitudes to show the extent and areas of attitude change, for the whole sample and for teaching experience, residence and training sub-groups.

The quantitative data in Chapter Six are complemented in Chapter Seven by qualitative data from observation and interviews, which provide additional insights into teachers' opinions, experiences and difficulties related to implementing constructivist, project-based learning.

The last chapter presents the conclusions and recommendations for effective technology use in Learning Resource Centres.

CHAPTER TWO

LEARNING THEORIES, ENVIRONMENTS AND TECHNOLOGIES

2.1 Introduction

Many educational reformers believe a revolution in schools is taking place in the way students learn and the way instruction is done. Educational reforms always focus on those two issues, namely, adopting new methods of learning and new methods of teaching (Sheingold 1990, as cited in Means and Olson, 1993, p.3). More traditionally-oriented teachers, certainly in Oman, believe that the method of lecturing while students listen and absorb is really the only practical way to teach and learn. The literature, so far, reveals that there is no single or best method of instruction (Walker, 1983); each method has its own advantages, which tempt educationists to adopt it, and each has its disadvantages which result in avoidance.

During the last decade, when new technologies such as computers, the internet, multimedia, and communication tools appeared, many professionals thought that this technological revolution would, like a magic wand revolutionize education (Means and Olson, 1993). That is to say, learning and teaching based on new technologies would become the saviour of education and the solution to students' academic failure.

Opinions have differed on the effectiveness of using technology for basic skills, drill and practice, because some studies showed that the use of technology in instruction resulted in significant learning achievement (Kulik, 1994); whereas others showed that there were no significant differences between the experimental and control groups (see for example Spencer, 1991). While Clark's (1983) analysis of instructional technology research maintains that there is little or no significant gain in learning as a result of using any specific medium, he does contend that the critical factor in determining student achievement is the instructional method, and not the medium such as the computer or instructor. Similarly the U.S. Office of Technology Assessment (1995, p.57) noted, "It is becoming increasingly clear that technology in and of itself does not directly change teaching or learning. Rather, the critical element is how technology is incorporated into instruction". For several authors, the educational potential of the new technology is best realised in the context of a constructivist approach. Strommen and Lincoln (1992) state, "The key to success lies in finding the appropriate points for integrating technology into a new pedagogical practice (constructivism) so that it supports the deeper, more reflective self-directed activity children must use if they are to be competent adults in the future." Ehrich, et al. (1998a) contend that technology integration can effectively support constructivism. Studies such as Baker, Gearhart and Herman (1994) and Sivin-Kachala (1998) showed the effectiveness of technology in promoting problem solving and high-order and critical thinking when used in constructivist context.

In this chapter, the theoretical underpinnings and characteristics of constructivist learning are discussed in contrast to the traditional learning and the role of technologies in such environments is considered.

2.2 Constructivist Learning Theories

Constructivism as a theory of learning has existed for many years in most fields (*SEDLetter*, 1996) but it was not applied systematically in education until very recently. The theory has captured much attention, especially from educationists. The theory has roots in both philosophy and psychology.

Assimilation allows the growth of schemata but does not account for a change of schemata. That is to say it does not add new schemata or modify existing ones. Accommodation is the process which accounts for the change of schemata by creating a new schema or restructuring an existing schema to assimilate new ideas and events. If children cannot assimilate a new idea into existing schemata because there are no schemata into which it readily fits, they can create a new schema or can modify an existing schema so a stimulus will fit into it (Wadsworth, 1989).

Radical constructivism, proposed by von Glasersfeld, represents the opposite end of the continuum, which claims that knowledge acquisition is an adaptive process that results from active cognizing by the individual learner, rendering an experientially based mind, not a mind that reflects some external reality. Radical constructivism represents a break from conventional ways of looking at acquiring knowledge. It refers to ordering and organizing of a world constituted by our experience (von Glasersfeld, 1995). Von Glasersfeld (1995) maintains that reality is unknowable since our experience with external forms is mediated by our senses, and our senses are not adept at rendering an accurate representation of these external forms (e.g., objects, social interactions). Therefore, according to von Glasersfeld (1995), while knowledge is constructed from experience, that which is constructed is not, in any discernible way, an accurate representation of the external world or reality.

Social constructivism stands somewhere between cognitive constructivism and radical constructivism; it embraces the view that knowledge is the result of social interaction and language usage, and thus is a shared, rather than an individual, experience. Therefore, learning is viewed as a result of social interaction. This can be

Von Glasersfeld (1984) proposed three essential epistemological tenets of constructivism:

1. Knowledge is not passively accumulated, but rather, is the result of active cognizing by the individual;
2. Cognition is an adaptive process that functions to make an individual's behaviour more viable given a particular environment;
3. Cognition organizes and makes sense of one's experience, and is not a process to render an accurate representation of reality.

Constructivism, in general, maintains that knowledge is constructed by the individual from within rather than being transmitted to the learner from another outside source (Cobern, 1993).

Because of the different psychological and philosophical views that come under the umbrella of constructivism, constructivism can be seen as a continuum. The assumptions that underlie this continuum vary along several dimensions and have resulted in the definition of and support for multiple types of constructivism. In general, this continuum can be divided into three broad categories: cognitive constructivism, social constructivism, and radical constructivism.

Cognitive constructivism represents one end of the continuum, in which the emphasis is on knowledge acquisition as an adaptive process that results from active cognizing by the individual learner. The theory was developed by Jean Piaget (1977), who held the view that children construct knowledge of the world through two processes: assimilation and accommodation. Assimilation is the process of changing new ideas, events and information to fit into existing schemata[1] (structures).

[1] A schema (plural is Schemata) can be thought of as an index of files, concepts or categories that adapt or change with mental development.

explained by the notion of the Zone of Proximal Development[2] (ZPD) which is promoted by scaffolding. Vygotsky (1987, cited in Schoonmaker, 1997, p.6) maintains that "what the child is able to do in collaboration today he will be able to do independently tomorrow". The Zone of Proximal Development is a means that potentially maximizes the potential for enriching intellectual performance.

> According to this view, an individual gains understanding by constructing new knowledge or transforming old knowledge into new, and this process is facilitated through peer interaction during which differing individual perceptions arise and are reconciled (King, 1990).

For the process of active knowledge construction, as discussed above, to take place, it requires a learning setting or environment that supports it. Adey and Shayer (1994) outline some principles that can be applied in designing instruction to help learners gain and develop knowledge: the learning environment should support learners' activities, social interaction which permits learners' interaction with their peers and with teachers and if possible with others, and encouragement of cognitive conflict through, for example, critical exploration.

For effective constructivist instruction, there must be an appropriate learning setting that promotes constructivism-inspired activities and learning tasks. Constructivism is child-centred. It "proposes that learning environments should support multiple perspectives or interpretations of reality, knowledge construction, context-rich, experience-based activities" (Jonassen, 1991, p.28). Bruner (1990), for example, suggested the importance of developing a learning environment where students authentically engage in knowledge construction.

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[2] Vygotsky (1978, p. 86) defines the zone of proximal development as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers."

According to Wilson (1995), at minimum, a learning environment contains: the learner, and a setting or "space" wherein the learner acts, using tools and devices, collecting and interpreting information, perhaps interacting with others (ibid: p.26). Therefore, the learning environment is not to be confined within one place such as the classroom; it should go beyond that, to include all places where learners are given opportunities to acquire knowledge from various resources in their world. According to Hill and Hannafin (2001) resources are media, people, places or ideas that have the potential to support learning.

The remainder of this chapter is divided into three main sections. Section 2.3 is concerned with the features of a constructivist learning environment, and seeks to identify the major differences between traditional learning settings and constructivist learning environments. Section 2.4 discusses the components of a constructivist learning environment. Section 2.5 contains a discussion of technology use in constructivist learning environments and how technology and constructivism can serve each other.

2.3 Features of Constructivist Learning Environment

Shuell (1986) suggests that learning, in a constructivist environment, is viewed as an active, constructive, cumulative and goal-oriented process. The focus in the type of environment shifts from teaching to learning, giving an indication of the greater emphasis given to the learners, who are presumed to be active knowledge seekers.

Resnick (1987) suggests that schools should prepare students to be adaptive learners and to focus attention on independent thinking and learning as important educational goals. In addition, learning should be situated so that students can acquire an understanding of important ideas for application to life outside school. In this sense, Resnick's view of learning in this environment emphasizes the importance of child- or learner-centred learning, as opposed to a teacher-centred environment.

In the traditional setting, learning is considered as a product of knowledge, whereas in the constructivist environment, learning is viewed as a developmental process. Whereas, the focus in the former approach is on the amount of information learners acquire to pass exams, in a constructive setting, learners are involved in different and difficult tasks that promote higher order thinking abilities. These include comprehension, analysis, application and evaluation. There is also full potential for human and material interaction in which learners get involved.

Jonassen and Rohrer-Murphy (1999) differentiate constructivist learning environments (CLEs) from other learning environments as follows:

- CLEs provide multiple representations of reality.
- CLEs emphasize knowledge construction instead of knowledge reproduction.
- CLEs emphasize authentic tasks in a meaningful context rather than abstract instruction out of context.
- CLEs provide learning environments such as real-world settings.
- CLEs encourage thoughtful reflection on experience.
- CLEs "enable context- and content-dependent knowledge construction."
- CLEs support "collaborative construction of knowledge through social negotiation, not competition among learners for recognition."

What this means in practice will be explored in the next section.

The constructive setting, further, promotes active meaning construction. According to Brooks and Brooks (1993, p.10-11) who discuss the characteristics of the educational setting in the constructive classroom, such settings encourage active construction of meaning as follows:

- They free students from the dreariness of fact-driven curriculum and allow them to focus on large ideas.
- They place in students' hands the exhilarating power to follow trails of interest, to make connections, to reformulate ideas, and to reach unique conclusions.
- They share with students the important message that the world is a complex place in which multiple perspectives exist and truth is often a matter of interpretation.
- They acknowledge that learning, and the process of assessing learning, are, at best, elusive and messy endeavours that are not easily managed

An interesting and well-put description of such a learning environment is that of Wells (1999). He maintains that (a) learning and development are social collaborative activities, (b) the zone of proximal development can serve as a guide for curricular and lesson planning, (c) learning should occur in meaningful contexts, and (d) learning should be related to a child's own experiences.

This type of environment allows learners to think with what they know about something; they are actively engaged in manipulating the target knowledge. Such interaction with knowledge (prior knowledge and new knowledge) and working with it, makes the learner's knowledge not only rich but also understood and well digested. It is also a setting where learners receive help, assistance, clues and feedback from others such as teachers and peers. This is called scaffolding. Piaget refers to this as "teachable moments" when adults stretch a child's capacity, but stay within what they are capable of understanding (Tinzmann et al., 1990)

The discussion below sheds light on some components of technology-rich constructivist learning environments, highlighting when applicable, some differences between the two learning environments, the constructivist and the traditional. The discussion focuses on the following aspects: (1) the goals of learning, (2) the learners' role, (3) the teacher's role, (4) collaboration, (5) prior knowledge and (6) assessment.

2.4 The Components of a Constructivist Environment

Many theorists and practitioners (such as Brooks and Brooks, 1993; Driscoll, 1994) have tried to explain the link between three different types of constructivist theory and practice, and have come up with constructivist pedagogies with an array of results. While these pedagogies share a set of core design principles, the peripheral principles tend to vary greatly. The general theoretical and practical constructivist consensus, however, across all three types of constructivism, indicates that the following six elements are essential in constructivist pedagogy (Brooks and Brooks, 1993).

2.4.1 Goal of learning

The learning goal is an important factor that has a great impact on the learning setting. In the traditional approach, knowledge is considered as something that exists independently, and can be transmitted to learners. It is a teachers' responsibility to transfer information to learners. Hence, the goal of learning is for learners to acquire as much knowledge as possible within the frame of prepared goals for each lesson (Panitz, 1997). Learners are limited to what is delivered to them by the teacher in a lecture, a seminar or classroom setting. In other words, the teacher predetermines information; learners also treat knowledge as facts to memorize for taking examinations.

In the constructivist environment, by contrast, the goal of learning is to engage learners in active manipulative, constructive, intentional, complex, authentic, cooperative and reflective learning (Driscoll, 1994). The active involvement goal reflects what takes place in the learning setting. To achieve learning goals, from a constructivist perspective, learners should be given the opportunity to build on their knowledge, based on their prior knowledge: to construct and reconstruct. Constructivists view the child's experience as a primary means of constructing knowledge. For the social and radical constructivists, authentic experiences are important so that the individual may construct mental structures that are viable in meaningful situations. Von Glasersfeld (1995, p.59) elaborates more:

> The constructive activity during the first two years of life lays the foundation of what will become the child's experiential world: it forms the essential scaffolding for all further constructing. As the child's living experience expands, layer upon layer of conceptual constructs is built upon the foundation.

For the cognitive constructivist, authentic experiences are essential so that the individual can construct an accurate representation of the "real" world, not a contrived world (Bakken, Thompson, Clark, Johnson and Dwyer, 2001).

Honebein (1996) identifies seven pedagogical goals for constructivist learning environments that distinguish them from other learning environments. They:

- Provide experience with the knowledge of construction process.
- Provide experience in an appreciation for multiple perspectives.
- Encourage learning in realistic and relevant contexts.
- Encourage ownership and voice in the learning process.
- Encourage the use of multiple modes of representation.
- Encourage self-awareness of the knowledge construction process (Honebein, p.11-12).

It is apparent that these goals provide a framework for developing students' learning experiences. They promote increased social interaction and discussion among students and between students and teachers; and they promote higher-order thinking and student autonomy in the classroom (Olsen, 1999).

2.4.2 Learners' roles

Constructivism is strongly influenced by the work of Jean Piaget (1977), who held the view that children construct knowledge of the world through assimilation and accommodation; it is not transmitted by the educator (Boudourides, 1998). Thus, in this view of constructivists, knowledge is not the result of transmission[3], but of the learner's own construction of meaning. Knowledge is shaped within a constantly changing social context. It comes into existence by the learner's own actions, by research and active experience, not by passive consumption. As a result, several representations of reality are possible (von Glasersfeld, 1990).

Philips (1995) identifies three roles for learners in constructivist education: the active learner, the social learner, and the creative learner. In these three roles, the learner is seen as an active participant who is in charge of constructing his/her learning.

In a constructivist learning environment, students are engaged in active research and become managers of their own learning (Scott and Hannafin, 2000). Jonassen (1998) maintains that the learner has to be given the opportunity to process information, to ask questions, to solve problems and to make decisions. Knowledge is not to be imparted to the learner, but acquired by the learner through an open inquiry process.

As Airasian and Walsh (1997) point out, this implies a change in role, compared with a traditional learning environment. As they argue

> They [students] will have to think for themselves, not wait for the teacher to tell them what to think; to proceed with less focus and direction from the teacher, not to wait for explicit teacher directions; to express their own ideas clearly in their own words, not to answer restricted response questions; to revisit and revise constructions, not to move immediately on to the next concept or idea. (p.448)

[3] Traditionally, learning is viewed as the teacher's responsibility. The teacher is the dispenser (the transmitter) of knowledge and the burden of acquiring knowledge and expertise is put on the shoulder of the learner (Sharan, 1980).

King (1990) reported that students in a constructivist learning environment were engaged in both cognitive and metacognitive[4] skills, as well as social skills. That is to say they had been actively engaged in their learning. The students were given the opportunity to process information, to ask questions, to solve problems and to make decisions. In constructivist learning environments, learning is more collaborative and less didactic.

However, knowledge construction is not restricted to the constructivist environment. Students can also construct knowledge in a didactic environment (Weinert and Helmke, 1995, cited in Salomon and Perkins, 1996, p.115).

Moreover, a constructivist learning environment may not attract all students; only those who are highly motivated will succeed in such an environment. Therefore according to Edelson, Gordon and Pea (1999), if students are not sufficiently motivated or they are not motivated by legitimate interest, they either fail to participate in project activities, or they participate in them in a disengaged manner that does not support learning. Schunk (1987) maintains that children of low and average ability might not motivate-model themselves on fast learners, as they are supposed to do in such learning environment.

Moreover, Wilson (1995) argues that compared with a traditional classroom, a constructivist learning environment places more responsibility on students for their own learning. This type of responsibility can cause some children to feel frustrated and uncomfortable, particularly if they are accustomed to having a teacher who "transmits" information to them.

[4] Metacognition refers to one's knowledge concerning one's own cognitive processes or, stated simply, thinking about thinking. The Metacognition process requires that learners take ownership of their learning and performance (Kanuka and Anderson, 1999).

2.4.3 Teachers' roles

Unlike traditional "top-down" teaching, Vygotsky (1978) would advocate a bottom-up teaching approach where the teacher facilitates, as opposed to directs, what and how students learn concepts both in and out of the classroom. In the learning setting, teachers should contribute a major role in establishing the learning environment for their students.

To enable students to acquire different skills and knowledge, teachers should give adequate guidance to students during their learning. Questions that facilitate such guidance should be promoted; students are encouraged to construct their own knowledge and obtain new understanding through the use of discourse, discussion and questioning guided by constructive teachers (Jaramillo, 1996).

This point of view is also held by Phye (1997), who maintains that implementing a constructivist classroom requires that the classroom teacher must be in a position to:

> (1) influence or create motivating conditions for students (2) take responsibility for creating problem situations..., (3) foster acquisition and retrieval of prior knowledge..., and (4) create a social environment that emphasizes the attitude of learning to learn; the learning process not the product of learning is the primary focus of constructivism... (p.596)

Another role of the teacher in this sort of setting is to provide feedback during lessons, in addition to feedback from the learner's peers which is also considered to be critical.

From the discussion above, teachers' roles are as facilitator, coacher and co-learner. Their responsibility is to help and guide learners throughout their knowledge acquisition. Such a role of providing guidance for learners is, according to Vygotsky, to motivate them to excel beyond their current skills level (i.e. activating learners' zone of proximal development.).

Although it might seem that teachers in a constructivist setting might have less direct involvement in students' learning, nevertheless it appears that they still have a large burden on their shoulders. They are responsible for establishing the "right" learning environment, providing necessary resources, and having good class control. Consequently, only teachers with a strong belief in constructivism will take the risks of and the initiative in adopting such a model (Prawat, 1992), or they might revert to objectivism (Allen, 1992). According to Brooks and Brooks (1993) teachers encounter difficulties in shifting their pedagogical practices in ways consistent with current reform for several reasons: most teachers were not educated in settings that emphasize student involvement in developing concepts and understandings, and most teachers were not trained to in non-authoritative ways (see Chapter Four).

2.4.4 Collaboration

Traditional learning techniques are being scrutinized for their ineffectiveness in promoting high-order thinking (Jonassen, 1996). In the last twenty years, the popularity of new learning techniques emphasizing critical thinking and collaboration has increased. Most of these new techniques fall under the rubric of cooperative learning methodologies (Dillenbourg, 1999).

According to Panitz (1997) the underlying premise for collaborative and cooperative learning is founded in the constructivist approach. Although cooperative and collaborative learning are mostly used as near synonyms, some researchers (e.g. Oja and Smulyan, 1989) tend to distinguish between them. Cooperation may be seen to emphasise some agreement reached by the participants, although they can proceed individually towards goals they have defined themselves; in collaboration, mutual goals are argued and purposed by all participants working together on all stages of a project (ibid).

Collaboration is an important tenet of constructivist teaching (Driscoll, 1994), and the value and the importance of collaboration in students' learning have been appraised in many studies. The past two decades have witnessed hundreds of studies investigating the effectiveness of collaborative learning compared with traditional teaching methods. Most of these studies reveal the positive impact of collaborative learning on students' achievement, motivation, social behaviour and attitudes toward school, toward learning and toward their group-mates (Johnson and Johnson, 1989; Qin, Johnson and Johnson, 1995; Slavin, 1991).

As an individual gains experience in a social situation, this experience may prove an individual's knowledge structures or it may challenge those structures. If there is contradiction or confusion, then the individual must accommodate this contradiction in order to maintain either an accurate model of reality or a coherent personal or social model of reality (Wadsworth, 1989, p.157). Moreover, learners are supposed to acquire a newer and better insight by confrontations of insights via a cognitive conflict. Accordingly, the acquisition of knowledge is regarded as a confrontation of opinions, as well as a process of cooperation and co-construction of knowledge.

Cooperative learning may be seen as a unique setting that allows and encourages learners to construct "correct" knowledge and understanding. When learners construct their knowledge individually, they might have incorrect interpretations or understanding of this knowledge. According to Whipple (1987), learning occurs as individuals exercise, verify, solidify, and improve their models through discussion and sharing of information. This emphasises the value of group work since, in a small group, they can share their own constructed knowledge and as they do this, they correct and guide their knowledge construction (Chapter Three, section 3.4.2 discusses more about working in small groups).

Gokhale (1995) draws attention to Bruner's view that cooperative learning methods improve problem-solving strategies because learners are confronted with different interpretations of the given situation. The idea of shared meanings can be elicited from Bruner's (1990, p.13) statement that "Our culturally adapted way of life is dependent upon shared meanings and shared modes of discourse for negotiating differences in meaning and interpretation." Thus, learning in a constructivist context is collaborative and necessarily depends on sharing of knowledge and understanding among learners.

During group tasks, some of the work might be done individually, but there must be interaction among individuals. This interaction involves sharing resources, providing each other with efficient and sufficient help and assistance, challenging each other's conclusions, motivating each other to strive for mutual benefit (Johnson and Johnson, 1989). This type of interaction promotes cognitive thinking that includes explanation, negotiation, discussion and understanding.

Knowledge is created as it is shared and the more it is shared, the more is learned (Tinzmann et al., 1990). The feedback learners receive during group or peer interaction is very important for knowledge construction. This reflects Vygotsky's (1978) theory of social interaction, as he writes, "the mind extends beyond the skin and is inseparably joined with other minds." Learners better construct new ideas and develop intellectually when interacting with one another. Receiving scaffolding from peers, teachers and others would advance the zone of proximal development of the learner. Therefore, group activity is vital to linking the learner with higher forms of mental activity through interaction with more knowledgeable peers and adults (Jaramillo, 1996). In the same vein, Jonassen (1994) stresses the need for collaboration among learners, which allows interaction and promotes knowledge construction.

Further, learners learn as they observe each other. Peers can provide positive reinforcement for and models of thinking. Bandura (1977) observed that much of human learning is a result of modelling rather than shaped by reinforcement. A behaviour can be modified or learnt by exposing individuals to modelling stimuli (Spencer, 1988, p.181). According to this theory, the process of modelling others involves four thinking steps: (1) attention, (2) retention, (3) reproduction and (4) motivation (Good and Brophy, 1990).

It can be argued that the essence of the success of involving students actively in the learning process has been closely related with the ability of the students to engage in a continuing acquisition of knowledge and understanding (Jones, Valdez, Nowakowski and Rasmussen, 1994; *SEDLetter*, 1996). The continuing acquisition of knowledge requires students to be active participants in a community of learners.

Cooperative learning provides the opportunity for students to maximize their own and each others' learning. Carefully structured cooperative learning ensures that students are actively involved in constructing their own knowledge while at the same time encouraging each other to achieve their learning goals. Simply put, cooperative/collaborative learning reflects constructivist learning theories which emphasise the importance of human interaction in individual learning.

Although it might seem that cooperative learning has many advantages, it is not without problems, and putting learners in groups does not always meet with success. The success of group work depends basically on the success of the group process. The interaction among a group's members, positive attitude towards one's group and positive contribution to the group's activities are fundamental elements for achieving common goals. Any problem in this commitment and relationship might lead to unsuccessful group work and cooperation.

Such problems are identified in the literature. For example, Bennett and Dunne (1994) noticed four types of problems as a consequence of group members' behaviours: (1) "free riders": students who do not make any real contribution to the group work because they rely on high attaining students who do the work for them; (2) the "sucker", hard-working and motivated students who feel that others are taking advantage of them, so they get less involved; (3) ganging up on the tasks: when a group of students find ways round doing the task when they do not like the work; and (4) rejected contribution: when students try to make a real contribution but are rejected by other members; they are unlikely to continue their contribution.

Furthermore, some consistent observations in Nath and Ross's (1996) study during implementation of cooperative learning were bickering within group and poor contribution to the group's activities. Hence these were the major obstacles in cooperative learning settings.

Johnson and Johnson (1997) distinguish some of these problems. For example, some students may control their group, others will become overly verbose, some will shy away from committing themselves and some students will be passive members.

Such problems related to the effective implementation of cooperative learning are related to the teacher's role in facilitating productive interactions. If teachers lack the interest, motivation or, skills of managing cooperative learning, it might have a negative impact on successful use of the cooperative learning model (Nath and Ross, 1996). Giving students freedom to study in depth and breath may lead to loss of control over students; some teachers are not able to function in a non-directive role or outside their area of subject expertise (Jaques, 1991, p.101)

Because cooperative learning implies a change of role for the teacher, the adoption of such a model is likely to depend on teachers' beliefs and motivation towards it, which may not always be forthcoming (Chapter Four will shed light on the influence of these problems on teachers' attitude and practice).

The researcher would argue that cooperative learning may not suit all learning styles. For example, less self confident, low self-esteem students tend to prefer self directed learning and working alone, because they do not want to expose their ignorance to other students.

Jaques (1991) provides a good summary of some of the disadvantages of cooperative learning activities; he says they are time-consuming, and can demand a lot of preparation, some students don't or won't participate; materials often are expensive, learning is unpredictable and difficult to evaluate; and there are dangers of hurtful stress in some, especially where the activities are not carefully handled by the tutor.

2.4.5 Prior Knowledge

Cognitive, social, and radical constructivism all assert that the acquisition of knowledge and understanding is an ongoing process that is heavily influenced by a student's prior knowledge. Therefore, learners' prior knowledge is an important element in the constructivist learning environment; it is the ground on which new understanding and knowledge is built. Piaget posited that the human mind creates schemata (structures) by which individuals intellectually adapt to and organize the environment. From this perspective, learners' prior knowledge is considered as schemata which evolve through the processes of adaptation and organization (assimilation and accommodation).

In this sense, the building of new understanding is rooted in previous experience and understanding. New experiences are compared with prior experience and understanding in an effort to achieve consistency. As learners encounter objects or circumstances that do not fit their previous understandings and experiences (they are in state of disequilibrium[5]), they seek balance, or equilibrium[6]. Vygotsky (1978) argued for the role of social interaction in transformation of prior knowledge. Von Glasersfeld (1995) emphasises the importance of prior knowledge; he maintains that learning is an active, continuous process whereby the learner takes information from the environment and constructs personal interpretations and meaning based on prior knowledge and experience (von Glasersfeld, 1995).

DeJong and Mensink (2000) emphasize the importance of prior knowledge; they maintain that prior knowledge can enable the learner to relate concepts, to think of examples, to structure the learning material, etc. In this way, adequate activation of prior knowledge (factual and strategic knowledge) can support knowledge (re)construction processes aimed at deeper understanding. By using prior knowledge learners can search for and construct meaning and structure in order to act in complex problem situations.

This process of knowledge acquisition is an ongoing process influenced heavily by the learners' prior knowledge, in the sense that learners do not simply repeat what is said in the classroom setting, but they reconstruct and relate their prior knowledge (what they have heard, read, experienced or learnt) in the light of new learning setting (Jonassen,

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[5] Disequilibrium is the Piagetian term used to describe a state of imbalance between assimilation and accommodation.

[6] Equilibrium is the Piagetian term used to describe a state of balance between assimilation and accommodation.

1998). In a constructivist setting, according to Wittrock (1986) information is retained and understood through elaboration and construction of connections between prior knowledge and new knowledge.

It is important for teachers to understand the prior knowledge of each learner because, as maintained by Brooks and Brooks (1993), by understanding learners' prior knowledge, the teacher can create and structure learning activities or tasks that result in maximal and effective learning. Christen and Murphy (1991) maintain that students generally fall into three categories: much, some, or little prior knowledge.

However, the question here is how a teacher can determine each learner's prior knowledge, since knowledge and understanding are invisible? Moreover, learners' different previous knowledge results in their having multiple perceptions of reality (von Glasersfeld, 1990).

The answer is that learners' knowledge can be inferred from their action. Brooks and Brooks (1993) comment that "teachers' ability to uncover students' conceptions is, to a large degree, a function of questions and problems posed to students" (p.65). They go further and maintain, "... We don't know what ideas are within students' reach unless we do something specific to find out" (p.72). Some of the techniques suggested by Brooks and Brooks (1993) to elicit learners' prior knowledge involve questions, use of dialogue and listening to and observing learners in the learning setting (Boethel and Dimock, 2000).

Christen and Murphy (1991) suggested the following techniques to identify and call up learners' prior knowledge: Teacher can brainstorm the topic, ask specific and/or general questions about the topic or post a problem or scenario (section 3.4.4, in Chapter Three, explains more about these techniques). Based on such steps, teachers may identify a mismatch between the learner's prior knowledge and the learning task and can take action accordingly. Jonassen (1998) recapitulates actions teachers might take to resolve prior knowledge as follows:

> Learners experiencing difficulties in performing a task possess insufficient prior knowledge or readiness to perform. This suggests three separate approaches to scaffolding of learning: adjust the difficulty of the task to accommodate the learner, restructure the task to supplant a lack of prior knowledge, or provide alternative assessments.

Put simply, in a constructivist learning environment, teachers can activate learners' prior knowledge about target topics by asking them what they know already about these topics; then learners (within small groups) set goals specifying what they want to learn more about; and, after reading, learners discuss what they have learned. Involving learners in such activities promotes and encourages the application of higher-order thinking strategies which help learners to construct meaning from what they read and to monitor progress toward their learning goals.

2.4.6 Alternative assessment

From the above discussion, because of the constructivist view of knowledge acquisition, it can be said that there is a need for different types of assessments from those of traditional measurement[7], to determine the extent and quality of knowledge acquisition by learners. Such assessment methods should reflect how learners' learn; allow learners' involvement in assessing their learning and their knowledge; allow instantaneous feedback through interaction with peers, group or teacher; allow the assessment of skills, knowledge, attitudes and behaviour (Terenzini, 1989); downplay

[7] Traditional assessment can include: (1) multiple-choice items which consist of a stem that contains one or two sentences followed by at least two alternatives. These alternatives are suggested answers among which the students should choose correct or best option; (2) extended response items in which students with more than a word, symbol, phrase or a formula, and (3) short-answer in which students respond to each item with a word, phrase, or symbol (AlSarimi, 2000).

memorization and rote learning; reflect the process of learning and higher –level thinking, and, finally, promote the use of multiple sources of data (Brandt, 1989; Shepard, 1989).

Further, the proposed methods should focus on the coherence of knowledge, the interrelatedness of information, the ability to solve problems, the ability to recognize underlying principles and patterns, and a true accumulation of knowledge that can be applied in the appropriate situation as reliable products of the construction of knowledge (LaBonty and Everts-Danielson, 1992, p.186).

Authentic assessments (sometimes referred to as performance assessments or alternative assessments) reflect means to measure constructivist principles of knowledge acquisition. They differ from traditional short-answer paper-and-pencil assessments in a number of ways and they use the actual work of the students or teachers as objective assessments.

Wiggins (1990, p.1) argues the advantages of using authentic assessment as follows: (1) Authentic assessments require students to be effective performers with acquired knowledge, (2) Authentic assessments present the student with the full array of tasks that mirror the priorities and challenges found in the best instructional activities, (3) Authentic assessments attend to whether the student can craft polished, thorough and justifiable answers, performances or products, and (4) Authentic tasks involve "ill-structured" challenges and roles that help students rehearse for the complex ambiguities of the "game" of adult and professional life. (Wiggins, 1989, 1990). Herman, Aschbacher and Winters (1992, p.15) maintain that authentic assessment provides a means to understand whether students can organize, structure, and use information in context to solve complex problems.

Alternative or authentic assessment methods include, for example, portfolios, journals, interviews, and attitude inventories (Dwyer, 1994). Another possibility is performance-based tasks, which are designs in which learners work collaboratively in small groups or individually to produce a piece of work that depicts their understanding of knowledge and skills.

However, authentic assessment is not without its difficulties. According to Hyerle (1996, cited in Sandra, 1997, p.15) constructivist approaches such as cooperative learning and portfolio assessment are already being used in schools, but most of these "create the environment for constructivism but do not centre explicitly on how an individual learner constructs knowledge".

Studies such as Firestone, Mayrowetz and Fairman (1998); Hannafin and Freeman (1995) and Tyack and Tobin (1994) reveal there is a resistance to alternative evaluation on teachers' part. Furthermore, students also may be uncomfortable with it; one of the disadvantages of authentic assessment is that students are uncertain whether they have done well or poorly in their work, i.e., they are not provided with feedback about individual performance (Kannapel, Aagaard, Coe and Reeves, 2000).

Evaluation of students' performance on the basis of the product of all group members might result in lack of care and conscientiousness among group members; higher achievers may do the job for the rest of group. In addition, how can one be sure that the result of such assessment measures students' learning? In other words, does this type of assessment measure students' actual learning? "Individual accountability is low and it is difficult for the teacher to know what each child has contributed" (Bennett and Dunne, 1994). Jaques (1991) concurs that it is difficult to assess individual learning outcomes because assessment is based on group work rather than individual contribution.

Dana and Davis (1993, cited in Holloway, 1999, p.86), for example, wonder how teachers should assess students' constructed knowledge; they maintain that teachers' assessment must allow learners to express their unique experience of learning and understanding. Therefore, Dana and Davis promote the use of alternative strategies to measure what students know. Bennett and Dunne (1994) recommend strategies through which teachers can gain more information about students' learning in a cooperative setting, such as post-task interviews, whole-class discussion and post-task written tests.

Even if it is assumed for the sake of argument that this type of assessment does measure actual learning, the problem still arises of how a student's performance can be compared against that of others inside and outside a particular school.

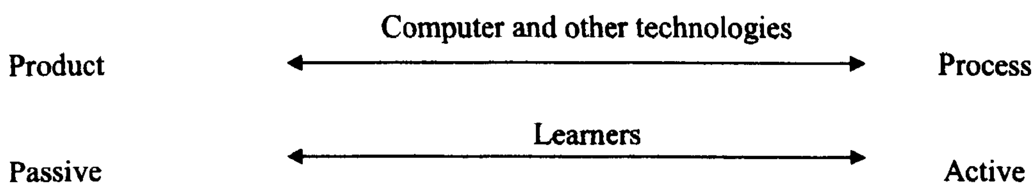
2.5 Technology Use in a Constructivist Learning Environment

The literature tends to classify the use of computers according to the objectives of learning as viewed by the underpinning learning/teaching theory. For example if the objective of learning is to acquire discrete knowledge (as in the behavioural theory), the goal of computer use might be to reinforce learning or acquire new knowledge and skills. McDaniel, McInerney and Armstrong (1993, p.77) argue:

> If computers are seen mainly as a way of helping students acquire knowledge and skills within traditional classrooms, then computers will simply be a tool for achieving old goals. On the other hand, if the computer can be linked to emerging educational goals stressing cognitive processes, the potentialities for student growth seem unlimited.

Lai (1992) suggests that computer application in the classroom can be conceptualized as a continuum, with varying degrees of learner control. At one end of this continuum, computers are perceived as a powerful teaching aid used mainly to enhance human capacities. Drill and practice, or tutorial applications are good examples of such practices, where computers are used as tutors for individualized instruction. As it is clearly seen, these applications are deliberately oriented towards individuals. They may therefore decrease learners' social interaction and result in individual isolation (Bloomfield, 1987). Technology at this stage is seen as yet another teaching aid, with the focus on what the computers could do for the learners (product-oriented), rather than what the learners could do with the computers (process-oriented). At this product-oriented end of the continuum, the computer is seen as an object of central importance (Ryba, 1987). Students in this kind of learning environment are passive learners and computers are expected to assume the role of knowledge presenters.

Figure 2.1: Lai's Continuum of Technology Use.



At the other end of the continuum, however, the emphasis is not so much on what learners could learn from the computer, but what they could do with the computer (process-oriented). In such an environmental setting, the learners are active and computers are seen as helping them with problem solving. Learning with computers and computer applications are taking place within wider physical, social and educational contexts (Moore, 1987). In these environments, learners are creative, engaged in solving significant problems, and are active in decision-making. That is to say that learners develop a personal commitment to their academic goals and construct their own personal meaning from the knowledge they have acquired in the process. A good example of such an environment is Logo[8]; according to Scott, Cole and Engel (1992) Logo promotes problem solving, and constructive authentic conversation. Other examples are Sherlock I and Bio-world, cited by Lajoie (1993). Lajoie maintains that such computer-based environments can (a) support cognitive processes, such as memory and metacognitive processes; (b) share the cognitive load by providing support for lower level cognitive skills so that resources are left over for higher order thinking skills; (c) allow the learners to engage in cognitive activities that would be out of their reach otherwise, and (d) allow learners to generate and test hypotheses in the context of problem solving.

On way of classifying uses of computer technology is Crompton's (1996) distinction between tutorial use and application use. Tutorial use refers to software or systems used for explaining, demonstrating and transmitting information. Some of this software provides learners with drill and practice material. Good examples of tutorial technologies are computer-assisted instruction (CAI), and instructional television. Application use refers to the use of productivity tools such as word processor, spreadsheet, desktop publishing systems and graphic software to help students to achieve their academic tasks. Users can analyse data, write their tasks and use these tools for other uses. These tools can support learning by enhancing the quality of the learning process and improving students' academic productivity.

Another way of expressing the different uses of technology in education is made in the distinction by Salomon, Perkins and Globerson (1991) between learning from technology and learning with technology. In the former category, technology is used to convey information and skills. In this sense, technology is used to make learning easy, as well as to reinforce the practice and the use of information and skills that are designed for

[8] Logo is microworld program designed by Papert based on Piaget's theory. Papert suggested that students explore and learn in the Logo microworld much like they explore and learn in earlier social-cognitive developmental stages.

students to learn in a particular setting or lesson. Common examples of this kind of technology use are computer assisted instruction and integrated learning systems, ILS (Hativa and Lesgold, 1996; Zucchermaglia, 1991). Hativa and Lesgold (1996), however, maintain that "Computerized drill and practice programs, in spite of being among the most common educational programs in school, are not universally held in high regard today as a good use of computers. Many educators and researchers believe that mundane drill generally does not develop high cognitive abilities (ibid: p.151). This does not signify, however, that the demands for acquiring IT skills are diminished; they are acquired while practising meaningful tasks. Therefore, it can be said that learning from technology reflects and promotes the traditional theory of learning, whereby information accumulation and memorization are considered important.

On the other hand, learning with technology implies the use of technology as a tool. Technology of this category serves as a means to search and process information. Furthermore, technology is also used to reflect learners' understanding and perceptions of their learning experience. Learning with technology reflects and supports constructivist learning theory, whereby information processing and construction are seen as crucial in students' learning (Jonassen, 2000).

Figure 2.2: Theories and Computer Use

Theory	**Behaviourist**	**Constructivist**	**Social-cultural**
	↓	↓	↓
Activities	Drill and practice tutorials	LOGO programming micro worlds	Collaborative learning situated learning
	↓	↓	↓
Learning Processes	Individual instructions and feedback; drill and practice	Individual, discovery based, generalisable skills	Social, scaffolded, interactive, reflective

Source: Mcloughlin and Oliver (1998, p.128)

Furthermore, within this classification there are two uses: (1) technology to support problem solving, rooted back to Piaget's theory of cognitive development and (2) technology as a tool to support knowledge construction and cooperative learning (Boyle, 1997). The latter is based on Vygotsky's social interaction theory (McLoughlin and Oliver, 1998). Referring to Vygotsky's notion of social interaction, Wertsch (1991, cited in Warschauer, 1997, p.90) maintains that all human activity is mediated by tools or signs such as language and computer, which cannot only facilitate action but alter the entire flow and structure of mental functions.

The types of technology (which support Learning with technology) are "open-ended or tool packages" (Jonassen, 1996; Scrimshaw, 1997). Scrimshaw maintains that these types of software assume that the learner is predominately an active creator of knowledge; they allow learners to collect and enter their own data. According to Jonassen (1996) and Roehrig and Glenn (1996) the use of such technology means that learners can be engaged in critical and higher order thinking. That is because learners can access, manipulate and evaluate information; later they can present it to others. Therefore these types of technology are the most appropriate to support constructivist learning environments. The subsequent discussion shows the influence of technology on a constructivist learning environment.

Further, technology use in a constructivist learning environment can take two forms: as a resource of information through which students use technology to find and research for information and as a learning tool through which students think about their learning and engage in higher order thinking (Chapter Three specifies the type of computer application used in this study).

2.5.1 Technologies as a resource of information

In the age of information technology and in the world of instant information, there are many sources of information that learners can access, so their learning should not be confined by what teacher can teach, but they should be empowered with thinking skills that promote unlimited learning using these resources. According to Chance (1986, p.1):

> "... we must offer our students more than rote drill, more than minimal competencies, more than facts. We must begin to teach our children how to evaluate information, how to apply information, how to produce information. We must teach them, in other words, how to think."

Technology meets this need by providing access to a lot of available information. Using electronic databases, for example, students can retrieve and manipulate data and turn these data into meaningful information (Jonassen, Peck and Wilson, 1999, p.111), as well as test relationships between variables in ways that would be difficult without technology (Harrington-Lueker, 1997).

Technology can have an important role to play in supporting the constructive approach or child-centred inquiry process. Hence, this inquiry process imposes the need for such tools to acquire information and, later, knowledge. Technology provides learners with instant access to information. It allows exchange of information between classrooms, teachers and individual students. Using online and offline databases, accessing multimedia technical resources such as multimedia CD ROMs, and exploring interactive audio and video clips are examples of types of activities which learners do with technology. Crompton (1996) calls such use exploratory use (also called information retrieval systems): in these applications students, are free to explore the information. They can trace and explore their own interests. CD ROMs, which contain, for example encyclopaedias and atlases, on-line databases and multimedia CDs are examples of these applications.

As argued earlier, learners' interaction with knowledge is essential in constructing and developing new knowledge, or maintaining active learning and, to achieve this, the learning environment should be rich in information and resources.

> A major goal in constructivist pedagogy is to ensure that the learning environment is as rich as possible. Emphasis is placed on identifying the unique interests, styles, motivations, and capabilities of individual learners so that learning environments can be tailored to them. (Reeves, 1996)

Salomon and Perkins (1996, p.24) see a great potential in the computer, if rightly used (i.e., as searching, processing and manipulating tools). They provide some examples of how technology can serve learners' learning as follows:

> For instance, computers and attendant resources such as CD-ROMS or network-accessible databases can provide quickly accessible and efficiently searchable information resources. Through E-mail, computers can support a social network beyond the confines of the classroom. Collaborative activities among students with computer activities as the focus are a well-known pattern. Software for preparing and manipulating outlines and for constructing diagrams that show the relations among things and concepts allow for the direct overt expression of semantic networks that students are building—and the effort to express them of course refines and extends them. Multimedia composition systems, and even conventional word processors, allow students to construct concrete expressions of ideas that have a real audience in other students as well as the teacher and provide occasion and motivation for feedback and refinement.

The same view is shared by Jonassen (2000), who argues that the computer can support the constructivist environment by providing learners with what is needed in constructing their knowledge. Wilson (1996b, p.5) indicates that a constructivist learning environment is "a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities." Technology used in this way can provide learners with information that teachers are unable to provide. Selinger (2001, p.90-91) makes the following comment:

> Computers can present information in ways in which teachers are unable; they can present information in multimedia formats allowing users to select and experience new knowledge in text, graphics, sounds or video; and make use of hyperlinks to link concepts together. It allows the learner to make choices about the medium through which they learn and presents them with a wide range of hitherto unimaginable resources.

2.5.2 Technology as a tool

Jonassen and Reeves (1996, p.697) state that technologies as tools are essential components of a learning environment in which learners are required to think harder about the subject matter domain being studied and to activate their thoughts about it than would be impossible without these tools. For example, in traditional computer based learning, knowledge is encoded and presented to learners by program designers, whereas cognitive tools engage learners to create their own knowledge that reflects their understanding and comprehension of information and ideas. Jonassen (1996) elsewhere calls such tools "mindtools", explaining that:

> Mindtools, therefore, are computer applications that require students to think in meaningful ways in order to use the application to represent what they know ... that the most appropriate use of the computer is as a cognitive tool for accessing information and interpreting and organizing personal knowledge. (Jonassen, 1996, p.3)

He couples the importance of adopting both technologies as tools and the constructivist learning environment in the learning process. Jonassen presents examples of such a marriage as he maintains:

> Cognitive tools and learning environments that have been adapted or developed...include (but are not necessarily limited to) databases, spreadsheets, semantic networks, expert systems, multimedia/hypermedia construction, computer conferencing, collaborative knowledge construction environments, and to a lesser degree computer programming and microworld learning environments (p.2).

Such a marriage, he argues, promotes active cognitive learning strategies and critical thinking. Learners are actively engaged in their learning; they think deeply about what they are learning, search, analyse, and evaluate the content that they are learning and they use technologies to help them with their learning.

Jonassen and Reeves (1996) summarize the relationship between technology and constructivist learning, and the role of cognitive tools in learning as follows:

- Cognitive tools are most effective when they are applied within the constructivist learning environment.
- Cognitive tools empower learners to design their own representations of knowledge rather than absorbing the representations preconceived by others.
- Cognitive tools can promote the deep reflective thinking that is necessary for meaningful learning.
- Cognitive tools enable mindful, challenging learning rather than the effortless learning promised but rarely realized by other instructional technologies.
- Cognitive tools should be applied to tasks or problems defined by learners with the support of their teachers.
- Cognitive tool use for education should be situated in realistic contexts with results that are personally meaningful for learners.
- Cognitive tools can enable intellectual partnerships in the form of distributed cognitive processing.

A useful description of the process of learning in this type of environment is that suggested by Salomon and Perkins (1996). They call it a "Knowledge Networking" environment, characterised by

> ... the active and thoughtful role of the learner, the semantic network that the learner needs to build, the social interactions involved and the distribution of knowledge across a social and physical network, the way that knowledge can be finely woven into the particularities of a situation, and the way that links in a network can connect very different settings, in keeping with the ideas of abstraction and transfer (p.123).

This description provides a clear vision of what might take place in such an environment. Implicitly, there are indicators of active learning not only in gaining knowledge and understanding but also in developing skills and understanding in administering and managing one's own learning. In the long run, these skills make learners into life-long learners.

2.5.3 How technology supports components of a constructivist learning environment

Means (1994) argued that learning in a constructive-technology rich environment, can be characterized by a high level of student exploration, highly interactive instruction, and student collaboration for extended periods of time on authentic and multidisciplinary projects, the teacher acting as facilitator and coach, and predominantly performance-based assessment strategies.

As indicated in an earlier section, increased use of learning technology will produce a number of changes in the way that teachers work. These changes will place greater emphasis on student activity rather than teacher activity. If these challenges are met, they will enhance the ability of teachers to contribute to increasingly effective and student-centred learning. Technology (predominantly cognitive tools applications) in schools has been linked to a shift from traditional, didactic educational practices to more student-centred, interactive learning activities (Collins, 1991; Means, 1994; Sandholtz et al., 1997).

Collins (1991) discusses how the computer and its applications have played an important role in shifting from didactic teaching to the constructivist approach of learning. He cites some studies that show that in technology-rich classrooms there are many observable changes:

- There is a shift from whole class to small group instruction.

- There is a shift from lecture and recitation to coaching.
- Teachers work with weaker students more often, rather than focusing attention on brighter students, as in traditional settings.
- Students are more actively engaged.
- There is a shift from assessment based on test performance to assessment based on projects, progress and effort.
- Students become more cooperative and less competitive.
- Students learn different things instead of all students learning the same thing.
- There is an integration of both visual and verbal thinking instead of the primacy of verbal thinking (Collins, 1991, p.29-30).

As mentioned earlier, the constructivist learning approach promotes an active learner's role through conducting in depth exploration and discovery. Technology can further support such a role by providing learners with means to conduct such active exploration. Means and Olson (1997, p.125) illustrate:

> When students are using technology as a tool or a support for communicating with others, they are in an active role rather than the passive role of recipient of information transmitted by a teacher, textbook, or broadcast. The student is actively making choices about how to generate, obtain, manipulate, or display information.

Similarly, Cohen (1997, p.1) argues that in the constructivist approach, students are encouraged to construct their own knowledge and obtain new understanding through the use of discourse, discussion and questioning via different types of technology guided by constructivist teachers.

Technology as tools can help learners to organize, restructure, and represent what they know and this can not take place in a traditional setting but only in a constructivist setting (Jonassen and Reeves, 1996). Studies such as Dwyer (1994), Dwyer, Ringstaff and Sandholtz (1991), and Penuel and Means (1999), found that students in a technology-rich constructivist learning environment were engaged in both cognitive and metacognitive skills, as well as social skills. Moreover, in such settings, according to Dwyer, et al. (1991), students frequently serve as technology experts for classmates, teachers, and family members.

An example of such learner control is given by Aldrich, Rogers and Scaife (1998), who show that when using ICT, students may not only make choices about the pace and order of a presentation, but may choose topics; take notes; answer questions; explore virtual landscapes; enter, draw or chart data; run simulated experiments; create and manipulate images; make their own multimedia presentations, communicate with others, and more.

In a constructivist technology-rich environment, a major task of teachers is to establish an appropriate learning environment for their students. Salomon and Perkins (1996, p.115) describe this situation as one "where the teacher sets the stage, provides the opportunity, and offers no more than the raw material and guidance for the constructivist process.

Setting up a computer-supported learning environment requires considerable planning. Teachers have to understand clearly not only why computers should be used in their classes but how computer software can be integrated into the existing school curriculum to facilitate active learning (Lai, 2000; Scrimshaw, 1997). Teachers also have to be knowledgeable regarding where and how to locate the resources they need, and help students to select resources and material such as CR ROM (Moursund, 1999; Scrimshaw, 1997).

Scheduling to use the computer and other technologies requires management skills that teachers need to be equipped with; according to Davis (1993) lack of these skills can result in management problems when there is a large class and when teachers have to make sure that students get appropriate access to computing resources (Lai, 2000). Boyle (1997, p.22) maintains that

> Teachers need to assess the number of computers and other resources that will be necessary for the projects. This will help teachers schedule computer time, arrange groups, and provide students with necessary materials to complete their projects.

A computer-supported environment will facilitate the acquisition of active learning skills, provided the teacher has given adequate guidance to students. Teachers need to ask a series of metacognitive-sensitive questions (Kennewell et al., 2000), such as "Are you on the right track?", "What do you need to do next?". The inquiry process, according to Lai (2000), facilitated by the use of computers can sometimes lead to frustration because no 'correct' answers are given by the teacher. Teachers therefore have to be sensitive to the progress of the students and be willing to provide encouragement and help whenever it is needed.

Indeed, for some this is precisely the practical meaning of the "constructivist perspective". Strommen and Lincoln (1992, p.3) draw attention to the new role of the teacher:

> The teacher [in a technology-rich environment] engages the children by helping to organize and assist them as they take the initiative in their own self-directed explorations, instead of directing their learning autocratically. Flexibility is the most important feature of the new role the teacher will have to play in such an environment.

Van Dusen and Worthen (1995) argue that teachers in a constructivist environment have free time to focus on small groups and individuals who need more specialized attention. Consequently, they can spend more time coaching their students on how to acquire skills and knowledge, help them to make choices and validate their learning. For example, while some students work on the computers, the teacher may assign seat-work to others, allowing him/her to spend time with small groups of students with similar needs. Integrated Learning Systems (ILS) also allows the teacher to conduct one-on-one tutorials with students. This change, however, requires a fundamentally different role for the teacher. This is because the new setting requires teachers to assign roles for their students working in groups and students share responsibility for their learning. As result, the burden on teachers is reduced.

Hannafin and Savenye (1993, p.28) summarize the roles of teachers in the new learning environment by drawing attention to terms like "coach," "guide," "organizer," "initiator," "diagnostician," and the like, which appear frequently in literature describing the technology-oriented teacher's new role.

Another role of the teacher, which technology can assist, is to encourage collaboration and cooperation for example, in a constructivist learning setting with technology, the teacher takes part in assigning groups based on diversity rather than pre-established friendships. In reporting examples, several writers note that both boys and girls were represented in nearly every group (Boyle, 1997; Järvinen, 1998). Scrimshaw (1997, p.112) elaborates on this:

> Another major contribution from the teacher is to assist learners to find out how to collaborate with and learn from others. This requires the explicit teaching and learning of ways of organising cooperative activities involving computers, whether in face-to-face groups round a single machine or through co-operation at a distance via a conferencing or e-mail system.

Collaborative and cooperative learning is an important feature of a constructivist approach. Jonassen (1994) suggests that a constructivist approach would incorporate "collaborative construction of knowledge through social negotiation". This would favour a classroom climate with an "emphasis on discussion, collaboration, negotiation, and shared meanings." He stresses the need for collaboration among learners, which allows interaction, which promotes knowledge construction (ibid).

While a shift to collaborative teaching practices can take place without the present of technology (as literature reveals a successful implementation of cooperative learning without technology; see for example Slavin, 1991), technology, mainly computers, can support cooperative and collaborative teaching in many ways; for example computers can be forums through which students can exchange, negotiate, present and access new information. Studies such as David (1992) and Dwyer, et al. (1991) showed that collaborative and cooperative learning activities are more common in technology-rich environments than in other settings and students collaborate and cooperate more when working on computer activities than when working on non-computer ones.

Software such as multimedia and hypermedia are good settings for practising constructive teaching because they promote group work and cooperative learning. Jonassen (2000) explains that a multimedia environment allows for opportunities to think, feel, create, discuss, and physically act on and control learning. Students' empowerment is evidenced through the multiple discussions that they must make for learning to take place. In such settings, learners together can coach and teach each other; hold discussion and argue about ideas and understanding. Complex tasks based on such software can be a challenging experience for learners.

As stated earlier, constructivist learning theory promotes learning based on prior knowledge; therefore teachers must understand what learners bring to the learning situation in order to help students to build new knowledge. Basically, technology as tools can offer help with this process. For example, students can use word-processing software or e-mail to share their understandings with student peers as well as teachers. These uses of technology have been demonstrated to improve writing skills, produce more and better ideas for decision making, and increase motivation (Honey and

Henríquez, 1996). Moreover, by adding elements, using Hypermedia software, that allow the user to move through text, images, and sound, a hypermedia environment is created. Hypermedia are structured so that the user accesses information in ways that are meaningful to him or her (Jonassen, 1996) rather than through a linear presentation. As students create hypermedia stacks, their existing knowledge is represented (Boethel and Dimock, 2000). Technology can help teachers to check students' prior knowledge; according to Means and Olson (1997, p.126)

> Technology [as a tool] can help to make students' thinking processes more visible to the teacher, something that does not happen when students simply turn in a completed assignment for checking and grading. As teachers observe their students working with computer applications, they can see the choices each student is making, stop and ask about the student's goals, and make suggestions for revisions or different strategies.

Rubin (1996, p.34) maintains that technology can be a powerful tool to support inquiry-based learning in schools: learning that is constructivist in orientation, that values conceptual understanding over procedural efficiency, that is responsive to students' prior knowledge and experience, that builds connections to the world outside schools, that supports the development of metacognitive skills, that prepares for lifelong learning, and that promotes educational equity.

Another aspect of change produced by the use of technology in a constructivist learning environment is in types of assessments. In such environment, alternative assessments are promoted. Such methods are needed because, as Dwyer (1994) maintains, traditional assessment tools usually do not measure the positive learner outcomes associated with effective technology use, such as creative problem-solving strategies or heightened abilities to collaborate in performing tasks (Dwyer, 1994). Designating appropriate assessment strategies helps teachers look for evidence of deeper understanding, statements of relationships, synthesis, and generalization of ideas to new domains.

For example, during their IT lessons, learners can produce instructional designs to be used by other learners, documentaries for local media, and other exhibits for the community (Grabinger, 1996). Learners, teachers and perhaps parents, if they are involved, can evaluate such projects (Chapter Three elaborates more on project-based learning). According to Irvine, Laughlin, Barlow and Ford (1997) when performance-based assessment is employed, students can use and present the work they have done in a variety of formats, including technological ones. They can use spreadsheets, graphing tools, word processing and sound tools and have access to the world through the World Wide Web.

Thus, to summarise this section, research looking into the influence of technology on learning and teaching suggests that technology can support and facilitate constructivist teaching (Collins, 1991; Fisher, 1989). For example, in classrooms with technology, researchers have documented a shift away from directed teaching (Dwyer et al., 1991; Means and Olson, 1995a); a move toward a more cooperative social structure (Dwyer et al., 1991); and greater emphasis on assessing student products, progress, and effort (Schofield and Verban, 1988, cited in Ringstaff and Yocam, 1995, p.1).

2.6 Conclusion

In this chapter, a description of a constructivist learning environment was established. An attempt has been made to describe what such a learning environment entails, and to link constructivist learning, cooperative learning and technology.

The table below, adopted from Moursund (1999) summarizes the differences between traditional and constructivist approaches to learning.

Table 2.1: Summary of the Differences between Traditional and Constructivist Learning Environment

The concepts of the setting	Traditional setting	Constructivist environment
Knowledge	-knowledge is inert -knowledge is not practised	-knowledge is active -knowledge is constructed by learners based on prior knowledge
Learning	-programmic and repetition -facts -memorization -curriculum centred	-meaningful learning related to learners' need and world -involve scaffolding and coaching -inquiry and invention -learner-centred
Teacher as	-authoritative -directive -knowledge teller -knowledge dispenser	-a coach -a mediator -co-learner -a model -a guide
Learner as	-passive -listener -information recipient -learners primarily work alone.	-active participant -expert -collaborator -thinker -learners primarily work in groups
Instruction	-lecture -seminar -drill and practice	-project-based -case/question -problem based
Assessment	-multiple choice -norm-referenced	-portfolio -multimedia presentation
Classroom activity	Teacher centred. Teacher driven. Teacher is responsible for "covering" a set curriculum	Learner centred (student centred). Cooperative. Interactive. Student has increased responsibility for learning. Collaborative tasks. Teams.
Technology use	Computer-assisted learning (drill and practice, tutorial, simulations). Tools used for amplification.	Communication, collaboration, information access, information processing, multimedia documents and presentations.
IT as content	Taught in specific time blocks or courses that focus on IT.	Integrated into all content areas, as well as being a content area in its own right.
Information sources	Teacher, textbooks, traditional reference books and CD-ROMs, use of a limited library, controlled access to other information.	All previously available information sources. Access to people and information through the Internet and World Wide Web.

Source: Moursund (1999).

Technology can be more effective and better used in these environments if the purpose is to promote cognitive skills such as searching for, analysing, evaluating and presenting information.

Educational technologies such as computers, printers, laserdisc players, VCRs, scanners, and cognitive tools (word processors, multimedia and spreadsheets) offer an excellent platform where learners can search for information in multiple formats and then organize, play, visualize, link, and discover relationships among facts and events. Further, learners can use these technologies to communicate their ideas to others. They can argue and critique their ideas, persuade and teach others, and add greater levels of understanding to their own growing knowledge. Simply put, an array of tools for acquiring information and for thinking and expression allows more ways to enter the learning enterprise successfully (Dwyer, 1994; Means and Olson, 1995a). All these actions and activities carried out by learners support a constructivist learning environment.

Chapter Three illustrates how such technology and constructivist learning theory can be implemented in an education setting through project-based learning using multimedia/IT.

CHAPTER THREE

MULTIMEDIA PROJECT-BASED LEARNING

3.1 Introduction

With advances in learning technology and communication, information is growing rapidly. In the past, books and teachers were the most frequent sources of information; nowadays there are many resources through which information can be represented such as CD Rom, the Internet and Databases. Such sources are widely available, and are easy to access. Therefore any educational system should consider this fact and equip students with skills to enable them to handle information from these sources. The idea of the teacher as the knowledge dispenser has no place in the new age of information, because of the diversity of information resources. Jager and Lokman (1999, p.3) maintain,

> It has to do with the fact that information is increasingly available in the present (knowledge) society. Moreover, information is dating so rapidly that education cannot keep on focusing on the transfer of knowledge any longer. Instead, it becomes more important that students learn how to search select, process and use information.

As it has been argued in Chapter One, technology alone cannot improve teaching and learning. According to Mergendoller (2000) technology use must be grounded firmly in curriculum goals, incorporated in a sound instructional process and deeply integrated with subject-matter content. Therefore, there is a need for a technique within which learners can meet their needs: their need to learn how to think, their need to develop their ideas and apply what they learn to solve problems. Usually, traditional use of technology supports traditional teaching (McDaniel et al., 1993, p.77) which offers learners memorized chunks of information that are rarely used or are not used productively, especially outside the school boundary (Narayanan, 1995). That is to say the acquired knowledge and skills are not transferred to real-world problems. This is because the goal of such an approach is to provide learners with as much information as possible, "knowing what", rather than to provide learners with the skills to acquire and use information in their real world, "knowing how".

As stated in Chapter One, for effective teaching and effective use of technology, the author proposes a project-based learning approach using IT as model for integrating technology into the curriculum in Learning Resource Centres in Basic Education schools in Oman. The approach reflects technology integration, which is supported by the constructivist approach (Ehrich et al., 1998a; Strommen and Lincoln, 1992).

Reviewing a decade of research on project-based learning, Thomas (2000, p.6-8) concluded that project-based learning is consistent with constructivism theory. In this respect, he argues that: (1) project-based learning can maximize students' learning and mastery because it emphasizes students' autonomy, collaborative learning and authentic performance assessment; (2) it offers the sort of help and assistance (scaffolding) needed to help students become proficient in conducting inquiry research; (3) learning is maximized if the context of learning promotes the use and the application of what is to be learned; (4) the incorporation of technology has added more flavour to the success of project-based learning, because technology has the value of making the knowledge construction process explicit and students become aware of this process.

Bailey (1996, p.3) discusses six principles of the constructivist framework of learning which any adopted model of instruction should reflect:

- Set the stage but have STUDENTS GENERATE THE KNOWLEDGE for themselves as much as possible.
- Anchor the knowledge in AUTHENTIC SITUATIONS and activities;

- Use the COGNITIVE APPRENTICESHIP methods of modelling, scaffolding, fading, and coaching to convey how to construct knowledge in authentic situations and activities;
- Situate knowledge in MULTIPLE CONTEXTS to prepare for appropriate transfer to new contexts;
- Create COGNITIVE FLEXIBILITY by ensuring that all knowledge is seen from multiple perspectives;
- Have the STUDENTS COLLABORATE in knowledge.

With these principles in mind, a project-based model of learning would have the above-mentioned features of constructivist theory. In project-based learning, students would have the chance to construct their knowledge by using different resources; would work collaboratively and cooperatively; and would produce facets which can be used by others. This approach would promote a technology-rich environment where both technology and the constructivist approach can be implemented side by side, as discussed in Chapter One.

The following discussion sheds light on the features, advantages, and some components of project-based learning using Multimedia/IT. Section 3.2 looks at the features and advantages of project-based learning in general, and when it is accompanied with IT in specific, and information resources for project-based learning, with particular reference to multimedia. Section 3.3 considers models for the implementation of Multimedia project-based learning in the Learning Resource Centre within Oman. In section 3.4 the model proposed by the researcher and adopted in the empirical part of this study, is described in detail. Problems anticipated with the introduction of such a model are considered in section 3.5.

3.2 Project-based Learning

Project-based learning is an instructional approach that contextualizes learning by presenting learners with problems to solve or products to develop (National Clearinghouse for ESL Literacy Education, 1998). Project-based learning, as a means of instruction, is not new; it is rooted in Dewey's theory of learning by doing (Blumenfeld et al., 1991; Mergendoller and Thomas, 2001). The approach started in the 1960s as an attempt for school reform based on "hands-on" learning; project-based learning had an impact on enhancing students' learning and motivation. However, the adoption of such an approach was not widespread because of inadequate support for both teachers and students (Blumenfeld et al., 1991).

Katz and Chard (1991) offer a comprehensive and constructive definition of project-based learning as:

> a way of teaching and learning that emphasizes the teacher's role in encouraging children to interact with people, objects, and the environment in ways that have personal meaning to them. It emphasizes children's active participation in their own studies of the world that is familiar to them (p.3).

According to Blumenfeld, et al. (1991) project-based learning is a comprehensive perspective focused on teaching by engaging students in investigations. There are two essential elements of project design: (a) a question or a problem that serves to organize and drive activities; (b) products (Blumenfeld et al. call them artefacts) that present the final work of the activities. The students or the teacher can initiate questions and problems related to the activities. The idea behind having questions or problems is to activate students' thinking and to motivate their learning.

3.2.1 The advantages of project-based learning

Guzdial (1998) maintains that project-based learning which requires students to work collaboratively and cooperatively (see section 3.2.2.4), has shown some advantages in terms of student learning because the very act of completing a project requires the students to engage themselves in a complex process of inquiry and design. The result of students' work can be thought of as an artefact, a product that can be shared and criticized.

Blumenfeld, et al. (1991) describe group project-based learning and the benefits of using long-term projects as part of classroom instruction. Specifically, they believe that projects have the potential to foster students' learning and classroom engagement by combining student interest with a variety of challenging, authentic, problem-solving tasks. They further stress that giving the students the freedom to generate artefacts is critical to their construction of knowledge. Blumenfeld, et al. (1991) argue that "as students investigate and seek solutions to problems, they acquire understanding of key principles and concepts. Project-based learning also places students in realistic, contextualized, problem-solving environments". Such active construction of knowledge situated in an environment context is consistent with the theory of learning expressed, in sections 2.2 and 2.3 (in Chapter Two).

Project-based learning can develop skills in children to enable them to be self-motivated learners. It provides children with opportunities to apply skills (Katz 1994; Elliott, 1998); addresses children's proficiencies; stresses intrinsic motivation; and encourages children to determine what to work on and accepts them as experts on their needs (ibid).

Project-based learning improves language skills by providing opportunities to practise language skills. Students can strengthen these skills by correcting each other's mistakes (Yoder, Retish, and Wade, 1996).

The project-based learning increases self-growth (such as confidence, self-esteem), attendance rates and empathy for others (Carr and Jitendra, 2000). This is clear when students work together collaboratively and cooperatively, presenting their final artefacts to audiences who will praise their work.

The project-based approach can serve as a good technique for a true integration of interrelationships of the disciplines; children can exercise all the development or curricular domains as they complete projects in small groups (Katz and Chard, 1991; Davis and Shade, 1994; Blumenfeld, Fishman, Krajcik and Marx, 2000).

Project-based learning functions as a bridge between using skills inside the classroom and in real life situations outside the classroom (Yamzon, 1999). It does this by promoting the use of skills and knowledge acquired inside school, outside the classroom. In this sense, what students learn or acquire is related to students' real life. This in turn would increase learners' motivation and interest, and lead to a more positive attitude towards their learning and school (Blumenfeld et al., 1991; Blumenfeld et al., 2000). Wrigley (1998) puts it nicely by stating that the project-based approach can serve as a powerful tool to prepare students for the world of work.

The project-based approach is a child-centred approach; it attempts to make learners more responsible for their learning. Instead of being passive receptors of information, they are involved in activities that promote cognitive thinking such as asking questions, finding and evaluating relevant information, and finding solutions for their inquiry (Wrigley, 1998). Thus, project-based learning empowers the learners to take charge of the learning process and trust in the power of the team (Elliott, 1998).

Further, project-based learning is meaningful learning because it encourages learners to investigate information, organize it and then integrate it into their previous experience (see 3.3.2). According to Mayer (1989), meaningful learning occurs when 'the learner selects relevant information, organises the information into a coherent whole, and integrates that information with appropriate existing knowledge' (see section 3.3.5).

Moreover, project-based learning has been seen as a vehicle for active and engaging learning; teachers who experience teaching through this approach recognize this trait of project-based learning (Yamzon, 1999). Active and engaged learning is characterized by the following features:

- children are engaged in authentic and multidisciplinary tasks
- assessments are based on students' performance of real tasks
- students participate in interactive modes of instruction
- students work collaboratively
- students are grouped heterogeneously
- the teacher is a facilitator in learning
- students learn through exploration (Jones et al., 1994).

Through project-based learning, students are learning and further developing: (1) knowledge and skills, (2) critical thinking and problem solving, (3) self-worth and personal empowerment, (4) personal and social responsibility, and (5) cooperation and collaboration (Tretten and Zachariou, 1997 as cited in Yamzon, 1999, p.12).

Wolk (1994) reported, from his observation of children involved in project-based learning, the following features of learning: (1) a rich learning environment, (2) a true learning community, (3) adoption of many learning strategies, (4) success for everyone.

Further, consistent with the principles of constructivist use of technology, discussed in Chapter Two (section 2.5), there is a mutually beneficial relationship between project-based learning and educational technology in general. Studies (such as Blumenfeld et al., 1991; Coley, Cradler and Engel, 1996; Means and Olson, 1995b) show that technology is better and more used during project-based learning (Turner and Handler, 1997) and project-based learning is especially effective when supported by educational technologies.

Mendrinos (1997) maintains that hypermedia and multimedia are technological applications that can provide an engaging environment for learners to construct knowledge through the association of relevant and meaningful information prompted by project-based learning.

Barron and Goldman (1994) maintain that the use of technology such as multimedia and hypermedia, by students as a tool in school projects contributes to the authenticity of the students' projects, because technology pervades society today. In the use of multimedia in IT-assisted project-based learning (PBL) the content and assessment tend to be authentic, and students learn both the subject area being studied and also how to create multimedia documents.

One way of fostering constructive skills (in this sense constructivism can be a valid paradigm) would be to allow students to construct "objective" and socially shared knowledge by giving them the opportunity to develop multimedia computer programs (Lehrer, 1991). Students using multimedia in project-based learning, learn competencies from both the IT and the disciplines being focused on in the PBL lesson.

The following list of goals is extracted from Moursund (1999). The original list is much longer and is based on a survey of the literature in this field. A good IT-assisted PBL lesson is apt to include the goals listed below:

- Expertise: Students gain increased knowledge and skill within a discipline;
- Research: Students employ research skills;
- Higher order thinking skills: Students improve their higher-order thinking skills through challenges.
- Information technology: Students acquire new knowledge and skills in information technology.
- Engagement: Students are intrinsically motivated.
- Community of scholars: The entire class-student, teacher, teaching assistants, and volunteers-becomes a community of scholars, working together and learning from each other. Often this community of scholars expands to include parents, students from outside the class, and others.

Wise and Groom (1996) reported a successful implementation of a media project in K-12 schools. In those studies, students showed high interest in their project and more enthusiasm. Their creativity was stimulated. Also the studies show that the role of teacher was that of a facilitator and students were active learners.

Cohen (1997) carried out a study to investigate the relationship between student learning style and ability to use the computer as a cognitive tool. The participants of study were comprised of 12 male students and 3 females. The students were required to designed many different types of projects to work on as teams including designing databases of historical figures using ClarisWorks. Students used various technology and resources such as the Internet, scanners, images and databases. The author reported a frequent social interaction between students and students, between students and teachers.

Students were observed seeking teachers' help and seeking help from each other. Furthermore, teachers and students interacted in a much more casual way. Teachers in the study used students as project manager "experts" to help other students.

One important conclusion drawn by the researcher is that the way the teacher managed the discipline and rules pervading the classroom changed as well. Learning was seen as a much more natural process, which was not disrupted by conversation and discourse. The boundaries and rules of the traditional classroom (e.g., never interrupt the teacher) were replaced by a much more fluid interpretation of how a classroom should function.

Sandholtz, et al. (1997) provides strong evidence of the success of IT-assisted project-based learning (PBL) in the Apple Classroom of Tomorrow schools in which students had ready access to IT both at school and at home. In that study students used a wide variety of technology and media in their learning. Teachers acted as facilitators and students were active learners.

Turner and Handler (1997) cited a five year study in which students were engaged in multimedia project-based learning. The students were engaged in active learning, as they were searching for, organizing, evaluating and presenting information. In their multimedia presentation, the students incorporated text, scanned graphics, video-disk images, recorded sound, and QuickTime movies. The study concludes that such a multimedia learning environment facilitated engaged learning and peer collaboration, and that it promoted and validated students' self-esteem.

Simkins (1999, p.1) maintains that with project-based learning and multimedia (PBL+MM), students acquire new knowledge and skills in the course of designing, planning and producing a multimedia product, such as a hypermedia stack, computer presentation, Web site or video.

Penuel and Yarnall (2000) cite and discuss the results of a five year evaluation study of using a project-based and multimedia project-based approach. The study shows solid, empirical evidence of the superiority of the multimedia project-based approach to the traditional project-based approach. The study compares two groups of students, those who underwent the experience of learning by traditional projects without using multimedia and those who learnt through multimedia projects on the following dimensions:

- how well they accurately represented the key content of the documents provided;
- how well they addressed the likely concerns of their audience; and
- how well their design integrated text and graphics into an eye-catching and convincing presentation.

The study shows that multimedia project students outperformed the comparison students on all the above mentioned dimensions. Those students gained more communication and presentation skills, content mastery, sensitivity to their audience, and coherent design integrating multiple graphical and textual elements.

In addition to this encouraging result, the study also touches upon some factors that contributed to this result, such as new roles of teachers and new roles of students. Teachers took the role of facilitator or coach, spent less time teaching, encouraged students to solve problems and helped students to develop new knowledge and integrate it into their multimedia presentation (compare section 3.3.3). Students engaged in small group collaborative activities, participated in meaningful discussion led by their groups, were involved in higher-order thinking e.g. solving problems and designing multimedia presentations that could be viewed by other audiences reflecting their understanding of the subjects and skills they gained during their projects.

In their study of multimedia projects for a children's museum, Liu and Rutledge (1997) found that students' interest and involvement increased throughout the project. The authors also noticed an increase in students' time spent on the project and an increase in their motivation. The study shows that students' self-efficacy was enhanced and students obtained a more positive image about themselves. What was most encouraging was that this experience of designing multimedia presentations for real audiences provided many students, who were considered at-risk and could not otherwise succeed in schools, with a way to pursue their own goals. It also appeared that such an environment offered a promising opportunity for students to exercise and develop their higher order thinking skills.

From their study, Dexter and McGhee (2001) concluded that project-based learning benefited all the students who participated. The students showed enthusiasm, developed ICT skills and had a deep understanding of the topics they studied for their project. Students learnt to use a wide variety of ICT such as the Internet, integrated software packages and multimedia software. The study shows that there was an improvement in students' test scores.

Another important aspect of multimedia project-based learning is the notion of preparing students to be lifelong-learners. Liu (2001) argues that designing Multimedia projects helps students to gain developing skills such as management, research, organization and representation, presentation, and reflection skills. He concludes that engaging students as multimedia designers can have positive impact on their use of cognitive strategies and their motivation.

In summary, there is strong research evidence that in the hands of an appropriately prepared teacher, IT-assisted project-based learning (PBL) works (U.S. President's Committee of Advisors on Science and Technology, 1997).

3.2.2 Information resources

Project-based learning involves students using humans as resources of information such as experts in a certain field, experienced people in the community, subject teachers and even friends (Liu and Chien, 1998). Hill and Hannafin (2001, p.42) provide some reasons for using humans as sources of information:

> The human resource may be an expert in a particular subject area or simply another learner. As the expert or peer continues to develop and enhance her or his understanding, her or his knowledge also evolves. This continual growth of understanding and knowledge frequently alters the nature of the information available when the expert or peer is consulted—making humans a resource that can be tapped on a regular basis for new information.

In addition to the use of resources (discussed in Chapter Two, section 2.5.1), Project-based learning also involves students in producing and reproducing different media, such as capturing video or audio clips from audio cassettes and video tapes, scanning images from books, newspapers or magazines and using existing digital audio and video files (U.S. Office of Technology Assessment, 1995). "Resource-based learning involves the re-use of available assets to support varied learning needs." (Beswick, 1990, cited in Hill and Hannafin, 2001, p.38). Moreover, students become audience as well as authors. Turner and Handler (1997, p.28) emphasise that "student authors learn how to create original visuals with graphics software, digital cameras, scanners, and video cameras as well as how to search for visual information on the Web and in print resources".

3.2.2.1 The effect of learning from media resources

Najjar (1996b) examined a wide variety of empirical studies that looked at the effectiveness of multimedia in learning. The findings of those studies touched upon (1) the relationship between media and learning, (2) the relationship among different multimedia and media, and (3) the relationship between multimedia and prior knowledge. He concludes:

> So, empirical studies support the idea that multimedia may help people learn. Multimedia that encourages the information to be processed referentially, building dual coded verbal and pictorial cognitive representations, seems to improve learning. For example, relevant, supportive illustrations improved the learning of textual stories. Multimedia also seems to be more effective for helping learners with low prior knowledge or aptitude in the domain being learned (p.6).

This reflects two modes of Bruner's theory [9] of knowledge construction: iconic representation and symbolic presentation. According to Boling, et al. (1998) iconic presentation is pictorial (pictures) and symbolic presentation is verbal (words or text). Therefore the use of multimedia caters for students' individual learning style (Khoo, 1994). The findings of the Apple Classrooms of Tomorrow (ACOT) project from 1985 to 1994 show that

> By incorporating pictures, sound, and animation, multimedia significantly enhances students' ability to recall basic facts, as well as improving their understanding of complex systems. One reason for this improvement may be that digital media tools can be used to address each student's individual learning style, thereby empowering all students to achieve their potential. (Baker et al., 1994)

Further, Multimedia also enhances students' understanding, improves retention and helps problem-solving transfer (Mayer, 1997; Mayer and Anderson, 1992; Mayer and Gallini, 1990). Learning with multimedia can decrease the study time spent on the

[9] Bruner argues that children construct knowledge through three basic modes of representation: the enaction mode (doing), the iconic mode (imagery) and symbolic mode (language e.g., words). In their early age, children rely heavily upon enaction to learn and understand their world. In this stage children cannot express their experience through language or imagery representation; they tend to use physical action

subject-matter by up to 60% compared with the traditional classroom method (Khoo, 1994; Najjar, 1996b; Steward, 1994). Reinhardt (1995) argues that 80% of understanding comes from visualization (for example, from the use of animation, video, laserdiscs, CD-ROM books, and hypermedia) and much less from hearing, although retention rate is higher for the latter. A multimedia presentation may contain animation and video excerpts as well as audio materials. This enhances learning because, according to the British Audio Visual Society (cited in Bruntlett, 1999, p.74) people remember 10 percent of what they read, 20 percent of what they hear, 30 percent of what they see, 50 percent of what they see and hear, 80 percent of what they say and 90 percent of what they say and do at the same time.

Steward (1994, p.3) emphasizes the importance of multimedia instruction and makes a comparison between multimedia instruction and traditional instruction; he argues that the strength of multimedia:

> "...lies in its ability to simulate life situations while engaging the senses. Multimedia interactive tutorials allow students to put themselves in real-life, decision-making situations while providing immediate graphic feedback that allows learners to see, feel, hear, and experience the ramifications of their decisions in an unprecedented way. Learning via multimedia interactive tutorials is specific, whereas traditional classroom lecture-type learning is more abstract and cannot involve students in the consequences of their decisions ...."

Further, he maintains that multimedia can bring a new sense of reality into the classroom; it provides instruction to suit a variety of students of varying skill levels.

Multimedia presentations are engaging because they are multimodal, which means multimedia can stimulate more than one sense at a time, and in doing so may be more attention getting and attention holding (Jonassen and Reeves, 1996; Jonassen, 1996).

In addition to those characteristics, multimedia has the ability of capturing the attention of students who have grown up in an age where technology is playing an increasing role in their lives and education (Hirschbuhl, 1992).

Boyle (1997) argues that multimedia can be used to support a variety of learning settings. A review of research (Daiute and Morse, 1994, cited in Ayersman, 1996, p.512) shows that the inclusion of images and sounds can improve comprehension and production of text while more fully bringing culture into the classroom. Students are better able to recall information when multiple modes of information are combined.

However, in contrast to these authors, other writers have questioned whether media use is necessarily or always beneficial to students' learning. For example, Spencer (1991) discussing the effectiveness of some media used in education, based on comparison of students' learning with and without the use of media, concludes that there is no significant difference in students' learning. For example, the effect size[10] of visual-based instruction is 0.15. Jonassen (1996) and Moore, Burton and Myers (1996) contend that little or no research exists which supports the effectiveness of multimedia in learning.

Furthermore, it has been claimed that combining different modalities (audio, picture, text, motion) simultaneously, overwhelms the information capacities of the brain and once the processing channels are overloaded, no learning take place (Jonassen, 1996; Moore et al., 1996).

Najjar (1996a) maintains that redundant multimedia does not always improve learning compared to "monomedia." He suggests that there are three situations in which multimedia information may help people to learn: (a) when the media encourage dual

[10] The basic index for the effect size calculation is the mean of the experimental group minus the mean of the control group divided by the pooled standard deviation (PSD)(Yiping et al., 2001)

coding of information, (b) when the media support one another, and (c) when the media are presented to learners with low prior knowledge or aptitude in the domain being learned.

Heller (1990) identified four potential disadvantages to the incorporation of hypermedia in education: "... disorientation, cognitive overload, flagging commitment and unmotivated rambling". Hypermedia can be very confusing for learners especially novices, because of the difficulties of navigating through the system and finding what they want. Hypermedia is so rich in information that learners may face cognitive overload. Jonassen (1996, p.210) elaborates on this problem:

> Hypermedia documents can contain thousands of nodes, each with multiple links to other nodes, so it is easy for users to get lost in hyperspace, becoming disoriented, losing track of the route they took, unable to find their way out of the hypermedia document or to the topic they were exploring earlier. Although most hypermedia documents provide an array of options to the user, they typically do not provide suggestions for where the user should begin or proceed after beginning. This lack of direction can result in disorientation of the user.

Jonassen (1996) recommends that the way to solve these problems with multimedia and hypermedia is, rather than considering them as an information resource, to consider them as tools to construct and learn with, as to be discussed in the following section.

3.2.3 Multimedia programs as tools

In section 2.5 (Chapter Two), a general discussion was provided about the use of computers as tools for learning. Learning with technology incorporating a constructivist learning approach holds potential for better learning (see for example, McDaniel et al., 1993; Means and Olson, 1995a; Jonassen, 1996). This section looks more specifically to multimedia programs as tools to support students' learning.

Using multimedia programs as tools engaging learners in a tool-like environment, has demonstrated an improvement in learning, collaboration, communication and problem solving (Carver, Lehrer, Connell and Erickson, 1992; Jacobson and Spiro, 1995).

Jonassen (1996) argues that multimedia-based applications (HyperStudio and PowerPoint) can be quite valuable in furthering knowledge construction, that is, the process of organizing and designing multimedia presentations that engages students in complex thinking. Through this process, learners are forced to reflect on what they know and how best to represent it when they have to communicate in these media (ibid).

Toomey and Ketterer (1995) maintain that the computer and its multimedia applications have potential as cognitive tools. Using multimedia as a tool feeds learners' curiosity and encourages them to shape their own pattern of learning as they interact with cooperatively constructed and reconstructed multimedia presentations. Toomey and Ketterer distinguish two types of multimedia use in education, as an interactive tool and as a development tool. The latter promotes storing, sharing and reconstructing and representing knowledge in interactive textual, graphic, pictorial, visual and aural forms.

Learning through hypermedia or multimedia programs and using authentic tasks requires learners to see the "relevance of the knowledge and skill to their lives, and the leverage it provides in problems they see as important" (Cunningham, 1991, p.13).

Another argument for the advantage of multimedia as a cognitive tool is proposed by Reeves (1998), as he maintains that using multimedia construction programs as cognitive tools engages many skills in learners such as project management skills, research skills, organization and representation skills, presentation skills, and reflection skills. He argues that

> In the cognitive tools approach, media and technology are given directly to learners to use for representing and expressing what they know. Learners themselves function as designers using media and technology as tools for analyzing the world, accessing and interpreting information, organizing their personal knowledge, and representing what they know to others.

Producing multimedia presentations (by multimedia programs) can be a meaningful way of learning by which students construct and coordinate these presentations (Mayer, 1997, p.1).

Lamb (1999, p.2) sees the role of a multimedia environment in students' learning as he maintains, "(a) multimedia learning environment, focusing on particular concepts, topics or themes can focus student learning without distracting from exploration." For the purpose of promoting learning, in such an environment, he argues, students can use tools that they need to create what he calls their own "tree houses" of their learning (ibid). They can use a variety of tools for planning, producing and presenting information.

Multimedia programs have proved a powerful catalyst for cooperative learning; they promote small group collaboration (Johnson and Johnson, 1986; Webb, 1983). This learning environment requires students to work together and support each other as they use a variety of tools and information resources.

Jonassen, et al. (1999) maintain that multimedia and technologies afford students the tools to explore, experiment, construct, converse, and reflect on what they are learning, so they can learn from their experience. For example, for students to construct their own knowledge, they can access and explore different information resources which can be provided by technologies such as text documents, graphics, sound resources, video, animations, the Internet, or any other medium of information that is appropriate for helping learners understand the content well enough to be able to use it to solve problems (ibid). Ivers and Barron's (1998) statement about the importance of multimedia can provide a good summary of the effectiveness of multimedia use in education. They maintain:

> Multimedia provides students with a powerful medium of communication and offers students new insights into organizing, synthesizing, and evaluating information. Multimedia has the potential to change the roles of teacher and learner and the interaction between them by allowing students to create their own interpretations of information (p.2)

Multimedia not only provides different sources of information, but it can also be seen as a tool which promotes interaction, conversation and sharing information among learners. Section 3.4.1.1 discusses in detail the multimedia presentation programs that are used in multimedia project-based learning in Learning Resource Centres in Oman.

3.2.4 Why multimedia project-based learning?

It is important to look at the motives behind adopting such an approach in Learning Resource Centres. This approach should (see Chapter Two) engage students in active learning by using the technologies and resources available in those centres and, not only that but impart skills and knowledge they can use outside the classroom.

Towards the end of their projects, students are expected to design final artefacts that reflect their learning and their use of media and technologies in LRCs. By this it is meant that they work on projects, learn new information, use different types of technologies and then are involved in developing a final product that can be viewed, evaluated and used by other audiences. This reflects Bruner's discovery learning and what Jonassen, et al. (1999, p.194) call learning by doing, which means engaging students in a meaningful project that requires students to explore, experiment, construct, converse, and reflect on what they are learning. Students' work can be viewed by parents, the school heads or teachers. These works can be used by other students as learning material.

Information becomes something to learn and use for a reason, rather than for a test (Druin and Solomon, 1996).

Learning with aims and for purposes is an effective learning technique. It is motivational and rewarding. Many educators urge for the promotion of such learning. John Dewey, the pioneer of learner-centred education, promoted the direct experience of students; learners should have hands on experience in their learning; he maintained ". . . there is an intimate and necessary relation between the processes of actual experience and education (Dewey, 1938, p.20). Papert (1980) argues that the best learning takes place when the learner takes charge. Bonnett (1996) maintains that students know that they have learned something when they can explain their work and ideas to others or when they can successfully teach others difficult concepts or content.

Lafer (1997) states that more learning will take place when students are asked to write for a purpose and for an actual audience:

> The hope is that students, through (participation) in these activities, will come to understand the deeper structures of the disciplines that they are studying, not just the surface-level information that makes no useful sense unless given context by the deeper structure.

Further, giving students opportunities to use multimedia programs to design multimedia presentation, and to explain something to their peers, creates a powerful learning environment (Lundeberg, Coballes, Standiford, Larson and Dibble, 1997). Jameson (2000) argues that allowing students to develop their own local, self-generated meaning using new technologies, as well as critically evaluating the works of other, is crucial since the power resides in the fluent use of the 'new literacies'.

Scott, et al. (1992) maintain that knowledge construction is based on two important aspects of constructivism theory: explanation and information design. This can be achieved in project-based learning where students interact with each other, sharing information and skills through the process of explaining and designing.

Bailey (1996, p.3) attempts to establish a relationship between constructivist teaching (through project-based instruction) and multimedia as he maintains that

> the easy correspondence between Constructivist design and the process involved when students produce multimedia projects, as well as other factors including evocation of intrinsic motivation, and the utilization of visualization and other nonverbal cognitive strategies ... suggest this as a highly effective mode of learning.

Turner and Handler's (1997) study provides compelling evidence that the most powerful learning (where the learner learns more about topics) occurs when learners are involved in authoring and designing artefacts that can be used or viewed by other audiences.

Another motivating reason for implementing multimedia project-based learning, under the umbrella of Oman recent educational reforms, is the failure of the traditional curriculum to accommodate students' interest and motivation and to engage students in cognitively difficult work (Marx, Blumenfeld, Krajcik and Soloway, 1997). Ritchie (1995) identifies three critical features of learning situations that are significant for development technological capability: 1) learning through practical experience; 2) an active learning process that allows children to construct their understanding of the world, and 3) learning within a social context.

Thus Multimedia project-based learning is a vehicle not only for learning technology skills and subject contents, but also for collaborative and cooperative learning.

3.3 The Implementation of Project-based Learning

Implementing multimedia projects is a demanding job for teachers. Though some studies have shown the effectiveness of this approach as an instructional technique that combines both project-based learning and the effective use of technology as a cognitive tool (as discussed in section 3.2), it requires of teachers a lot of preparation before implementation and follow up during implementation. Teachers should be enlightened with some guides as they create and implement projects (Sandholtz et al., 1997). These guides serve as outlines or procedures teachers should follow during projects.

The literature provides many models of project implementation based on techniques adopted in many studies which have implemented project-based learning. Although these models created by the researchers in these studies were implemented in different settings and for different school stages, they appear to share some common features. Some authors (see for example, Chard, 1997 and Sloane, 1999) argue that projects have the same basic structure, such as the phases of generating questions and goals, engaging in learning experience, displaying pupils' work and evaluation. On the other hand, these projects seem to differ in how they begin, the type of goals, their length and how much work they involve (Chard, 1997).

The purpose of this section is to look at some project-based models of instruction; it is also to propose a model for implementing multimedia project-based learning in Learning Resource Centres, based on Gagne's model of instruction.

3.3.1 Models of project-based learning

Sharan and Sharan (1992) maintain that project-based learning (Project work) is not new in the field of elementary education; the idea of plunging children into group projects has been growing for several years. The approach is becoming a good method of teaching and learning to increase students' interest and motivation. Blumenfeld, et al. (1991) argue:

> The idea of project-based learning is not new; however, considerable advances in our knowledge about motivation, learning, teachers, and classrooms increase the possibility of success now... Projects can be designed to include elements that are likely to enhance most students' interest, including variety, challenge, choice, cooperation, and closure in the service of answering real questions.

The following discussion sheds light on three selected models, as examples of those project-based learning models which share common features.

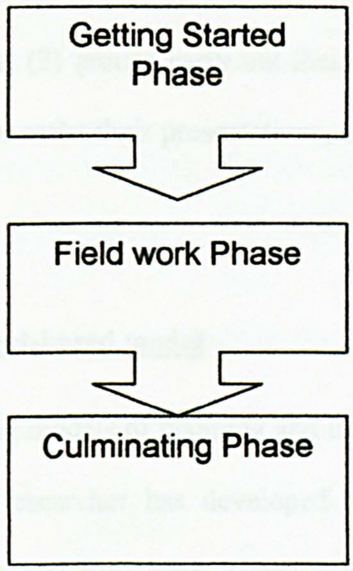
Katz and Chard (1991) propose three phases of project implementation in elementary schools. These phases describe the event of instruction that teacher and student are involved in and provide a guide for teachers to follow when designing projects for students.

The first phase is getting started. In this phase, teacher and students devote several discussion periods to selecting and refining the topic to be investigated. The selection of the topics can be either by the teacher or by the students. The second step in this phase is brainstorming in which students make a web or conceptual map of the topic with the help of the teacher.

The second phase is called field work. Students start investigation by searching for relevant information for their topics. The investigation often includes field trips, objects, events and visiting web sites.

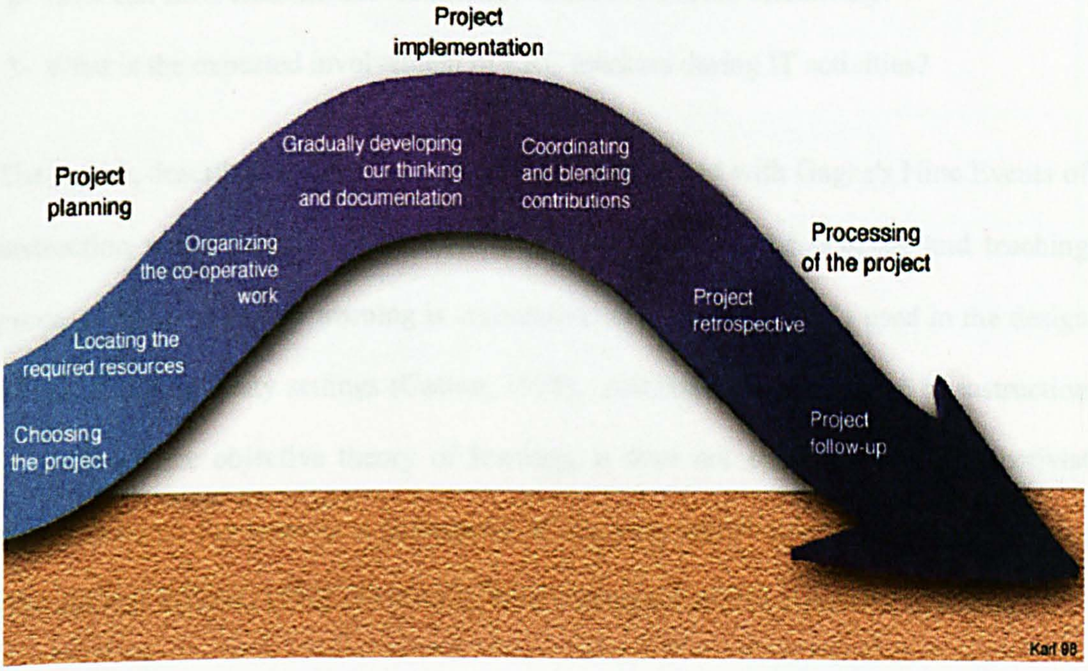
The final phase is culminating, debriefing events. Students at this stage wrap up their work, which includes preparing and presenting reports. The result can be presented in the form of artefacts, talks, or dramatic presentations. The following figure depicts these stages.

Figure 3.1: Katz and Chard's Stages of Project Implementation



Canada's Schoolnet (1998) proposes a three-phase model of project implementation for pupils aged 10 to 12: project planning, project implementation and results processing. The drawing below depicts these phases

Figure 3.2: Canada Schoolnet Phases of Project Implementation.



Source: Canada's SchoolNet (1998)

Putnam (1997, p.150) suggests several phases of carrying out project investigation: (1) the class determines subtopics and organizes itself into research groups, (2) groups plan their investigations, (3) groups carry out their investigations, (4) groups plan their presentations, (5) groups make their presentations, and (6) teachers and students evaluate their projects.

3.3.2 Multimedia project-based model

Based on existing models of planning and implementing project-based learning in different settings, the researcher has developed a teaching model for implementing project-based learning in LRCs in Oman. The proposed model, called multimedia project-based, is different from others; it provides more detail about how to implement project-based learning. According to Guskey (1986, p.9) for successful innovation of practices, it is important to illustrate how they can be implemented. This teaching model will also address the following issues:

1- How should IT learning activities be designed and arranged?

2- How can LRC teachers use technology-related resources effectively?

3- What is the expected involvement of LRC teachers during IT activities?

The model, described in detail in section 3.4, is associated with Gagne's Nine Events of instruction which describe what should take place during the learning and teaching process. Gagne believes learning is cumulative; his model is widely used in the design of instruction in many settings (Casino, 1998). Although Gagne's model of instruction is based on the objective theory of learning, it does not conflict with constructivist theory because the latter is a philosophy of learning, rather than a model of teaching (Brooks and Brooks, 1993). Driscoll (1994) comments on this argument as follows:

> As a theory, it (constructivism) may indeed be incommensurable with an instructional theory such as Gagne's, because the two would have been built from opposing assumptions. But as a philosophy, constructivism may be viewed as not competing with other instructional theories, but providing them with an alternative set of values.... .

The following table depicts how both Multimedia project-based learning and Gagne's (1985) Nine Events of Instruction (in Flynn, 1992) are related:

Table 3.1: Gagne's Instruction and Multimedia Project-based Learning

Events of Instruction	Learning Processes	Multimedia project-based Learning*
1. gaining attention	Attention	Phase Three
2. informing learner of the objective	Expectancy	
3. stimulating recall of prerequisites	Previous Knowledge	Phase Four
4. presenting the stimulus material	Students using technologies and resources to collect information	Phase Five and Phase Six
5. providing learning guidance	-Teacher provides scaffolding (help and assistance). -Feedback from peers, teachers and other groups	
6. eliciting the performance		
7. providing feedback		
8. assessing the performance	Students present their work to the class and other audience.	Phase Seven
9. enhancing retention and transfer	Qualified to carry out another investigation	Another Project

* The phases are explained in detail in section 3.4

3.3.2.1 Features of the model

The proposed model is based on the objective of using technology in Basic Education schools Oman which is to enhance students' understanding and thinking through using technology as tool for learning and as a source of information (discussed in Chapter One in more detail). In line with Omani education policy, it is assumed that it should reflect a constructivist approach to learning and should have the following characteristics: the model should

- promote informative learning to match themes, values, and events in subjects;
- be related to prior experience with meaningful student involvement;
- promote high-order thinking skills;
- emphasize the role of the teacher as a facilitator;
- contain student-centred activities;
- be based on cooperation, collaboration, and contribution;
- promote connection with telecommunications tools (this will be clear when schools are connected to the Internet);
- promote wise and wide use of resources.

It is important to note that teachers, who are to be involved in implementing multimedia project-based learning which promotes authentic and engaged learning, must realize that it will not be easy nor will it be quick. There will be a shift in their roles, as has been argued in Chapter Two, section 2.4.3. Beaman (1996) proposes five means to achieve successful multimedia project-based learning:

- Set the stage - explain why the students are using the technologies and processes;
- Provide coaching - help others gain skills by hosting mini-clinics or by tutoring;
- Get continual feedback – this helps the teacher to keep track of what's going on in the classroom and allows necessary adjustments;
- Be patient - learning always starts off slowly at first;
- Don't expect too much - not all students will adjust to this method.

The teacher is seen here as an important element of the environment not as a knowledge dispenser but as a facilitator and guide, who provides help to students through scaffolding.

The student is as an active participant and knowledge seeker. For higher-achievers, their role can be extended to that of teacher as they provide help and assistance to their group members.

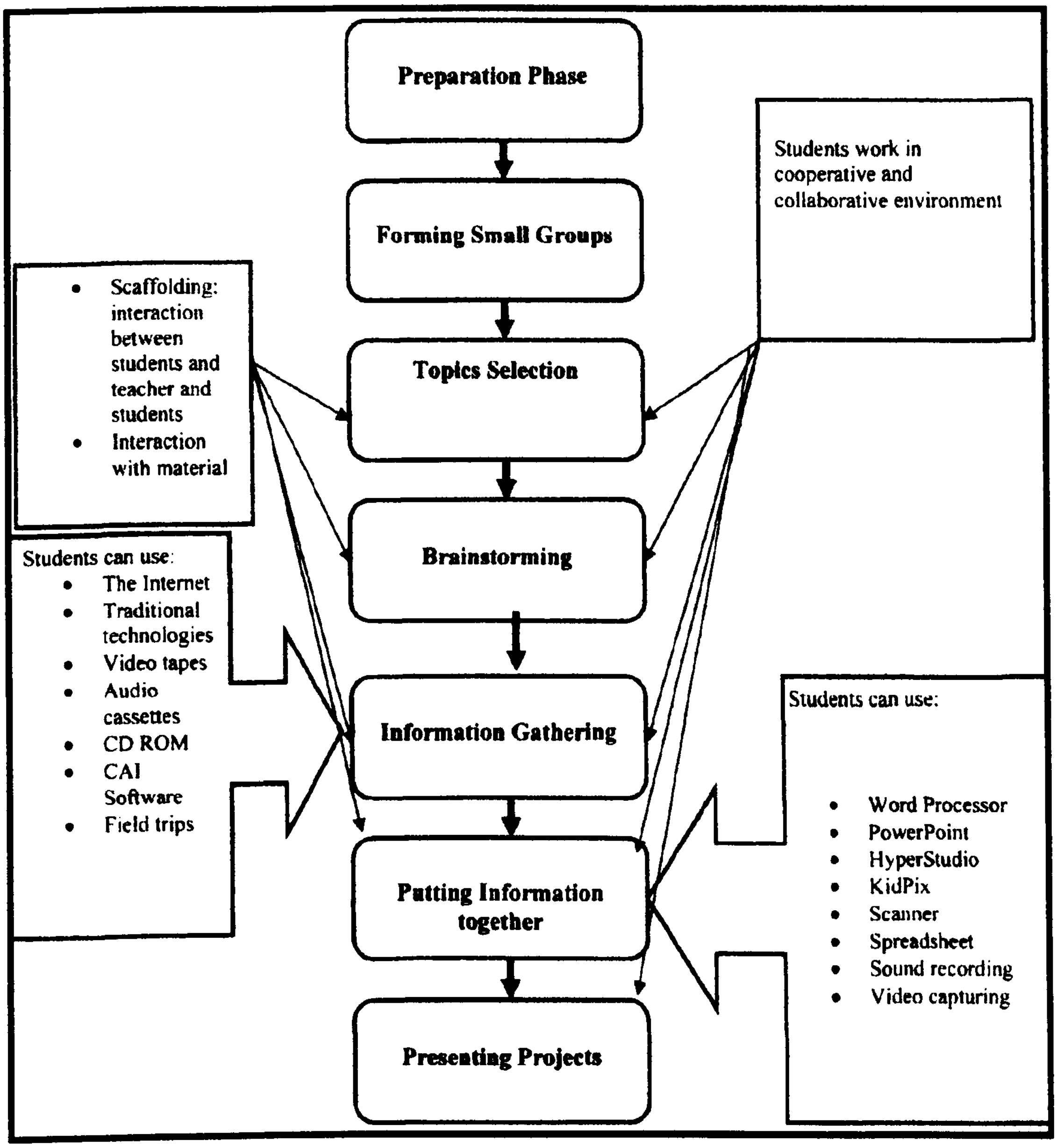
There is also a wide use of technologies during some of these phases. As has been discussed in Chapter Two, section 2.5, technology use here is twofold: (1) technologies are used as an information resource, such as the use of database, CD Rom and the Internet; (2) they are used as cognitive tools with which students can create their own presentations of their projects such as the use of the presentation programs, PowerPoint, KidPix and HyperStudio.

There is the potential for two types of interactions: (1) human interaction between students and teacher and among students; (2) students' interaction with the materials such as books, computers and other technologies.

3.4 Phases in the Multimedia Project-based Model

The proposed model has seven phases that should occur in order. As can be seen from Figure 3.3 below, in some phases there are many teachers and students' activities that take place. In the following the phases of the model are described in more detail with more focus on the important steps that should be followed in the implementation.

Figure 3.3: Multimedia Project-based Model



3.4.1 Phase one: Establishing the learning environment

Before students start their projects, it is very necessary that materials and resources are available. It is obvious that students are expected to use a wide variety of materials from inside the Learning Resource Centre and from outside it. Therefore it is the teacher's responsibility in the first place to provide and make sure that the needed materials, resources and technologies are available (Chard, 1997).

Dewey 1938 (cited in Harris and Fuqua, 1996, p.34) stated that teachers are responsible for creating learning environments and choosing experiences that maximize the likelihood that learners will raise questions, seek solutions, and construct understanding. Katz (1994) emphasizes the importance of the teacher's role in preparing such an environment for students; he maintains

> if the topic of a project is exotic and outside of the children's direct experience they are dependent upon the teacher for most of the questions, ideas, information, thinking, and planning. Young children are dependent on adults for many aspects of their lives and their learning experiences; however, project work is that part of the curriculum in which their own interests, ideas, preferences, and choices can be given relatively free rein. (Katz, 1994, p.23)

Ivers and Barron (1998, p.22) maintain that teachers need to assess the number of computers and other resources that will be necessary for the projects.

Another consideration before starting projects is training students to work cooperatively and collaboratively. In some circumstances, students working in small groups is a new setting of learning; they might not be used to this setting. Therefore, to maximize the potential from small groups, students should be trained in how to work together. Matthews, Cooper, Davidson and Hawkes (1995) maintain that students should receive formal training in the social skills necessary for group work before they start working in their groups. Further, cooperative and collaborative learning is assumed to promote high order thinking activities; according to Doyle (1986, cited in Mergendoller and Thomas, 2001, p.2), those activities are the most problematic for maintenance of classroom order, because they require students to work inside and outside the classroom, and culminate in procedurally complex tasks. Hence, it is important that students are familiar with the setting to establish class control. Holt (1997) emphasises that for cooperative groups to be effective, members should engage in teambuilding activities and other tasks that deal explicitly with the development of social skills needed for effective teamwork. Blumenfeld, et al. (1999) maintain that students must possess the skills needed when working with others as well as the knowledge necessary to explore questions that arise. Kutnick and Marshall (1993) argue that social skills training will positively affect microcomputer group work.

Students' gaining basic skills of technologies is another consideration in multimedia project-based learning. Teachers should make sure that students are familiar with basic technology skills (Ivers and Barron, 1998). The idea of giving students some basic skills is to reflect effective ways of learning IT skills (Carroll's 1990 approach, 'Minimalism'). Carroll (1990, cited in Boyle, 1997, p.13) argues that learners should try to make sense of the situation rather than following a rigid series of steps. The central idea is to minimize the amount of explicit instructional material and instead to support 'natural' patterns of learning (Boyle, 1997). Stables (1997) also emphasizes the importance of students being taught what they "need to know", for example technology skills; teaching them something other than what they need at the time can only result in frustration and discouragement. Through this approach, learners explore how to use technologies and learn more in a meaningful way. These skills might include the use of commands such as save, open file, knowing how to scan images, capture video clips and use the basic skills of presentation programs such as KidPix, PowerPoint and HyperStudio.

Getting students to acquire and practise basic skills beforehand is essential for successful multimedia projects; Liu (2001) emphasises this as she maintains "..... to learn the tools and be able to use state-of-the art multimedia" is important before starting the main projects. A good example of how this can be done is provided by Strommen and Lincoln (1992), who cited two examples of teaching programming in HyperCard to clarify this idea, the conventional method and the constructivist method.

In a traditional classroom, the teacher lectures to the students each day about a particular procedure, while the children sit at desks and listen or take notes. In the computer lab, children take turns working individually at the computers on weekly or bi-weekly programming assignments. Competence in programming is assessed via written tests, and through evaluation of the weekly programs written by the children to prove their competence with the assigned programming procedure.

In the second example, rather than leading the children through a teacher-directed, step-by- step introduction to Hypercard procedures, the class is organized around student-originated projects that utilize the Hypercard system as an expressive medium. The focus here is on using the HyperCard to design projects on different topics. Students conceive and execute the program so that by the end it presents them with a rich, open-ended, self-directed task in which they can explore the various procedures and how they interact, rather than simply learn them in isolation from one another, in a rote fashion. Students produce a final product, which reflects a meaningful learning

Further, to save time and assure appropriate skills acquisition, teachers can use the "jigsaw" technique to disseminate these skills among small groups. That is, groups of students are to be trained to be experts in using technologies and then each of those "experts" later should be put in a small group so he/she can teach his/her group members during project work (Bennett and Dunne, 1994; Mergendoller and Thomas, 2001).

A final point to address in relation to creating the learning environment is the provision of appropriate presentation technologies with which students can prepare their final products.

3.4.1.1 Features of Multimedia programs used in Learning Resource Centres

Today there are numerous multimedia presentation products available for children (Druin and Solomon, 1996; Jonassen et al., 1999), for example: Authorware, HyperCard, HyperStudio, KidPix and PowerPoint. These programs vary in price and power: some of them are easy to use, user-friendly; other require user's acquaintance with programming languages, e.g., Authorware. HyperStudio, KidPix and PowerPoint are most common and popular programs for presenting students' works or projects. They also support multimedia files formats which students can gather during their searching stages. The programs make it possible for students of all ages to become the authors of multimedia content (Jonassen et al., 1999; Simkins, 1999). Druin and Solomon (1996, p.120) maintain that Multimedia programs give children the opportunity to create their own multimedia presentations and interactive experience. With those programs children can design multimedia projects that incorporate video, sound, pictures, text and animation as well.

In this study three of these programs are selected for presenting students' final projects, KidPix, PowerPoint and HyperStudio. These programs are very simple to master, available in LRCs and outside the classroom. Maddux, et al. (1997) emphasize the popularity of the HyperStudio and PowerPoint as they maintain:

> Presentation software such as PowerPoint and authoring systems such as HyperStudio are increasingly used by teachers and students to create presentations, reports, and instructional material.

The following section sheds a light on some features of the programs,

3.4.1.2 KidPix

Parson and Johnson (1996) argue that KidPix is user-friendly and readily engages children, making creating writing projects enjoyable. The final product is a slide show complete with motion, sound effects, narration, and eye-catching screen transitions that captivate the audience. Print copies of the slideshow allow children to share their published work with their parents and classmates. KidPix can be used to by students to develop literature-related projects (Lamb, 1999; Matthew, 1996). Gouzouasis (1994, cited in Jonassen et al., 1999, p.102) found that using KidPix to construct hypermedia presentation on science-fiction stories, promoted students' intentional learning. The students became skilled producers and were very comfortable in demonstrating their products to a group of adults. Gouzouasis concluded that students had more fun producing multimedia than from learning about the computer activities.

However, the program does not word wrap, nor can text be edited once it has been entered. Each screen is a separate slide; thus, text does not automatically flow to the next page as in a word processor. Limited font styles and sizes restrict text styles. Also, composing and illustrating at the computer takes time which can be conserved if students do their writing before getting to the computer. The researcher's experience with this software is that it only supports 256 colours, so the resolution of the display is very low.

3.4.1.3: PowerPoint

Hlynka and Mason (1998, p.1) define PowerPoint as "part of the Microsoft Office software package. Its standard use is for preparing a sequence of "slides" to use in support of a presentation. Each slide typically contains a quotation, a list of terms, or phrase central of the presenter's themes". Hlynka and Mason (1998, p.48) identify a list of benefits of using PowerPoint in education:

- PowerPoint helps structure content.
- PowerPoint helps structure the process of a lesson or lecture, preventing it from rambling.
- PowerPoint adds technical face validity to a presentation.

- PowerPoint adds backgrounds, clip art, dissolves, wipes, and builds both between slides and within slides.

3.4.1.4 HyperStudio

Horn (1994) maintains that HyperStudio is a good place to start designing multimedia presentations because it is easy to use and easy to make stacks. "Show children how easy it is to create programs in HyperStudio and they will be hooked on computers" (p.2). HyperStudio can be seen as a good tool to facilitate human interaction and feedback in the classroom and a good tool for assessing students' work and projects. Matthew (1996) expresses as this quality as follows:

> Students working together create their own multimedia fables using HyperStudio or HyperCard. During the development of these products, students receive peer and teacher feedback. Both process and product checklists created by the students and teacher are useful for assessing students' creations.

Students can use the HyperStudio program as an individualized and interactive system of instruction to enhance instructional delivery and as a tool to create applications that can be assessed as final works (Irvine et al., 1997).

3.4.2 Phase two: Forming small groups

Before any project starts it is crucial that students are arranged into small groups. Each student in his/her group is given particular responsibilities. Therefore it is recommended that consideration be given to ways of grouping students that can facilitate effective engagement of students in their groups. Brush (1997) outlines four fundamental elements for effective group cooperative work:

- Positive Interdependence: Each student has a key role and a task requires the actions of each member to be achieved.

- Individual Accountability: Each individual within a group must be accountable for mastery of the instruction.
- Group Rewards: The accomplishments of the group should be rewarded to provide positive incentives for the group to interact constructively.
- Group Training: Children must be taught the social skills needed for collaboration and must be motivated to use them.

These elements are essential to be considered when establishing groups to get students to work together.

However, there are some interesting questions to be asked before taking such an initiative such as, why should we put students in small groups?, what is the ideal number of students in each group?, what is best way of grouping in a technology-rich constructivist environment? The following argument attempts to answers those questions.

3.4.2.1 The benefits of working in small groups

Working in pairs or in small groups is a catalyst for spontaneous social interaction among students (Hoyles and Sutherland, 1989, cited in Yelland, 1994, p.21) and cognitive development (Bennett and Dunne, 1994).

Another argument for working in small groups is posed by Davis (1993) who explains that, regardless of the subject matter, students working in small groups tend to learn more of what is taught and retain it longer than when the same content is presented in other instructional formats. Yiping, Philip, and Sylvia (2001, p.482) carried out a meta-analysis study which evaluates small group and individual learning with technology. The study shows the superiority of small group learning over individual learning. Yiping, et al. conclude:

> These results suggest that group task performance using CT [Computer technology] is not the same as individual achievement using CT given the differences in moderating influences. When students work together on group projects, it is important to differentiate group products and individual learning outcomes. There are situations when collaborative task completion is defensible scholastically, demonstrating what a collection is capable of, enhancing motivation and group cohesiveness via pride in a collective accomplishment, and so on. However, if the focus is on individual achievement, effective cooperative learning strategies such as positive interdependence and individual accountability (e.g., requiring students to take turns and agree on answers, to summarize and explain their group's work), emphasizing that all members learn, should be employed to ensure the successful learning of all students.

3.4.2.2 Group number

Some authors argue that the ideal group number of each group is from two to four students (Johnson and Johnson, 1986; Kagan, 1988). Others (such as Bennett and Dunne, 1994; Holt, 1997) who recommend two to six students in groups have also experienced successful group work. However, as the group's size increases, the lines of communication increase, there is less time for individual participation, more difficulty in managing lessons, and learning of skills and contents is minimized. Evidence on optimal group size from the pilot study in the present work (see Chapter Five) is in accordance with Johnson and Johnson's recommendation. It was found that large group size hindered teachers from implementing project-based learning. Yiping, et al. (2001, p.477) found that one reason for the effectiveness of small group learning was that group size was small (i.e., two members).

3.4.2.3 Grouping students heterogeneously

There are several ways in which students can be grouped to work cooperatively and collaboratively: heterogeneously, homogeneously, randomly, or according to their interests (Jonassen, 1996, p.37). Heterogeneous grouping is considered to be one of the factors influencing the effectiveness of educational technology (Means and Olson, 1995a; Jones et al., 1994). Kagan S. (1992, as cited in Jonassen, 1996, p.45) maintains that heterogeneous groups are often preferred because they produce the best opportunity for peer tutoring and support, better integrate the classes being mixed, and improve classroom management. Lehrer (1991) found that heterogeneous groups are likely to work the best in a multimedia learning environment because students with different abilities can work together to achieve their goals. Means and Olson (1993) maintain that heterogeneous student groups with skills in different areas (e.g., videography, script writing, editing) complement each other and teach and learn from one another. Another advantage of heterogeneous grouping is put forward by Bennett and Dunne (1994, p.118) who see it as alternative to ineffectual homogeneous grouping; they state that "An alternative strategy to the use of homogenous groups is obviously that of heterogeneous groups, with less able group members learning from the more able, where skills are shared and where co-operative interpretation of the task allows all to understand what is expected".

Learners' grouping needs to be heterogeneous and equitable (Hooper and Hannafin, 1988; Means and Olson, 1995a). Heterogeneous teams can include varied learning abilities ethnic and linguistic diversity, and a mixture of the sexes. Means and Olson (1995a) emphasize the importance and the advantages of such grouping:

> In many classrooms, teachers purposefully composed groups of mixed abilities, ethnicities, and genders. In classrooms of mixed grades, the ages of students within groups also varied. Such heterogeneous groupings allow for multiple perspectives and diverse skills, enhancing the quality of project work and creating new avenues for individual specialization and peer tutoring.

Another advantage of grouping students heterogeneously, according to Mergendoller and Thomas (2001), is to place unpopular or behaviourally challenged children in appropriate groups. Research has shown that when students of high ability are grouped with students of lower ability both benefit (Swing and Peterson 1982; Hooper and Hannafin 1988).

A disadvantage of grouping students heterogeneously is that it might generate hostility and reluctance to participate fully as they are required to work with members they do not like (Bennett and Dunne, 1994, p.116). However, in practice the evidence shows that students of mixed abilities appear to benefit from working in small heterogeneous groups, regardless of their different abilities (Bennett and Cass 1988; Simsek and Hooper, 1992; Slavin, 1991; Thurston and Secaras, 1997).

Another argument against heterogeneous grouping in term of abilities is that higher achievers will be held back by low achievers (Robinson, 1990). Research (such as Slavin, 1996) however, shows that both higher and lower achievers benefited in cooperative settings. That is because higher achievers explain and elaborate to lower achievers and giving explanations and elaboration is an effective means for enhancing learning (Webb, 1989). Dillenbourg (1999, p.112) explains that if explaining to oneself can lead to the acquisition of new knowledge, then explaining to somebody else might have the same beneficial consequences.

3.4.3 Phase three: Topic selection for project

Students can select topics for their project from a wide variety of subject curricula. Topics may be assigned by teachers or may be decided by the students (Chard, 1997; Ivers and Barron, 1998). Therefore LRC teachers may prepare a list of topics in coordination with the subject teachers and select topics that can be addressed best by multimedia projects, because alterative approaches can be more effective for desired outcomes with some topics. Also, they can prepare a list of topics that serve the exploration of the particular features of their regions, such as important characteristics, important ruins, the heritage and nature (Appendix 7 depicts some topics prepared jointly by LRC teachers and subject teachers for the purpose of this study).

When students take part in selecting topics for their research, they make the learning objectives their own; according to Bereiter and Scardamalia (1989, p.363) the learning in this sense will be intentional: "we use the intentional learning to refer to cognitive process that have learning as a goal rather than an incidental outcome".

Furthermore, whether teachers, students or both select desired topics for project investigation, topics/activities should have the following features.

- They should be related to students' interest and be regarded as important to them (Becker, Wong and Ravitz, 1999; Ivers and Barron, 1998). That is to say topics or tasks should be meaningful to learners; meaningfulness is the central attribute of the constructivist theory of learning (ibid).
- Topics should promote the use of many resources; not only books, but other resources available inside and outside the classroom. Horwood makes a statement about resources used when implementing project-based activities: "In this program you don't learn from one teacher and one textbook, you learn from everything. You learn from your experience; you learn from observing and asking questions; you learn from everything you do and people you meet" (Horwood, 1995, cited in Yamzon, 1999, p.iv). Consequently, activities should require the use of a wide range of materials available in the LRC and outside school.
- They should be related to the real world of learners (gained skills and knowledge are to be practised and used outside school).

Such topics would lead to engaging students in authentic activities which is one of the main principles of the constructivist approach (Bellamy, 1996). Wilson (1996b, p.3) argues in favour of "meaningful, authentic activities that help the learner to construct understandings and develop skills relevant to problem solving."

Authentic activities are most likely to produce the best results (Jonassen, 1996). Furthermore, authentic activities can be described as those activities that are embedded in realistic and relevant contexts and visually accurate representations of real-world environments, and rich in real-world data and related information (Harper and Hedberg, 1997). Brown, Collins and Duguid (1989, p.34) maintain that authentic activities are "ordinary practices of the culture". Herrington and Oliver (1996) state that authentic activities provide the opportunity to detect relevant and irrelevant materials. In this study these type of activities are referred to as “IT as content” which means the use of technology crosses all content areas as well being a content area in its own right (Moursund, 1999).

A selected topic can be tackled by students in small groups in many ways. The whole class could select one topic and the teacher divides it into subtopics; therefore each group selects a subtopic to investigate. For example, if the topic is about a tree; the teacher might divide this topic into four subtopics such as the leaves, the root, the trunk, and the fruit. So each group can select or the teacher can assign a part of the tree for the group to find out about. Jointly, towards the end of the project, the whole class presents the topic as whole.

3.4.4 Phase four: Brainstorming

Brainstorming is a free-form process that taps into the creative ideas of a group. One person expresses an idea, which reminds someone of another idea which reminds someone else of a different idea, and so on (I-CANS, 2001).

One of Gagne's nine principles for effective instructional events is to gain students' attention to the topic. Therefore, before students engage in brainstorming activities, the teacher should brief his/her students on what the project is about in an interesting and thrilling way. In the briefing session, the teacher can discuss with students the objectives of one instructional unit, such as a topic on trees for the whole class, or discuss several topics, one for each group.

Chen, Looi, Chen, and Hung (1996) reported that the project started with the teacher giving a briefing of what the project is about, doing brainstorming of a topic, discussion with the students, and finally working with each group to decide on the group's research question. The interdisciplinary nature of the project comes from the research questions: students will choose a question that is personally meaningful to them

In Chapter Two (section 2.4.5), the argument was raised about the importance of prior knowledge in a constructivist setting. Brainstorming can serve as a good technique to relate students' prior knowledge to a new learning experience. One way the teacher can elicit students' previous knowledge is by using the what we **K**now, what we **W**ant to Know and what we **L**earned (**KWL**) strategy (Stepien, Gallagher and Workman, 1993). At this stage, students in their small groups put down what they know about their assigned topics. The use of the group brainstorming technique creates an environment that stimulates questioning by students during class. During this session, groups might be asked to summarize what they have learned and what they still feel they need to work on to gain a better understanding of specific concepts using specific forms (Felder, 1997).

It is obvious that students' achievement on a particular task is often related to the extent of their prior knowledge relevant to that task (see for example, Garner 1990; Pitts-

Hill, Barry, King and Zehnder, 1998). Therefore it is argued that during brainstorming activities, students of different prior knowledge would share their prior knowledge and this would lead a levelling up of knowledge among students. Webb and Lewis (1988, p.181) argue that through brainstorming, students "retrieve prior knowledge, evaluate their own and others' answers, ideas, and opinions, confront their own misunderstandings and lack of knowledge, and as a consequence, restructure their own thinking."

Furthermore, during brainstorming students share information on what they know and what they need to know. This leads them to identify questions for their research. Therefore, their research is directed to fill the gap in their information about their topics. McKenzie (1999) proposes seven steps to conducting research in a multimedia project: Questioning, Planning, Gathering, Sorting & Sifting, Synthesizing, Evaluating and Reporting; he maintains that

> The first step in the Cycle is to clarify and "map out" the dimensions of the essential question being explored. The student or student team begins by brainstorming to form a cluster diagram of all related questions. These subsidiary questions will then guide subsequent research efforts.

The teacher can design KWL sheets that are appropriate to desired topics. These sheets can take many forms depending on the topics. Appendix 6, shows an example of these forms used during this study.

3.4.5 Phase five: Information gathering

Before students move to the next phase of their project, it is essential that the teacher reviews what students have brainstormed and what sort of technologies and resources they have suggested to use in their project, to make sure that they are on the right track and have developed some questions of their research (Mergendoller and

Thomas, 2001; Ivers and Barron, 1998). (Appendix 1 shows a list of resources that students can use).

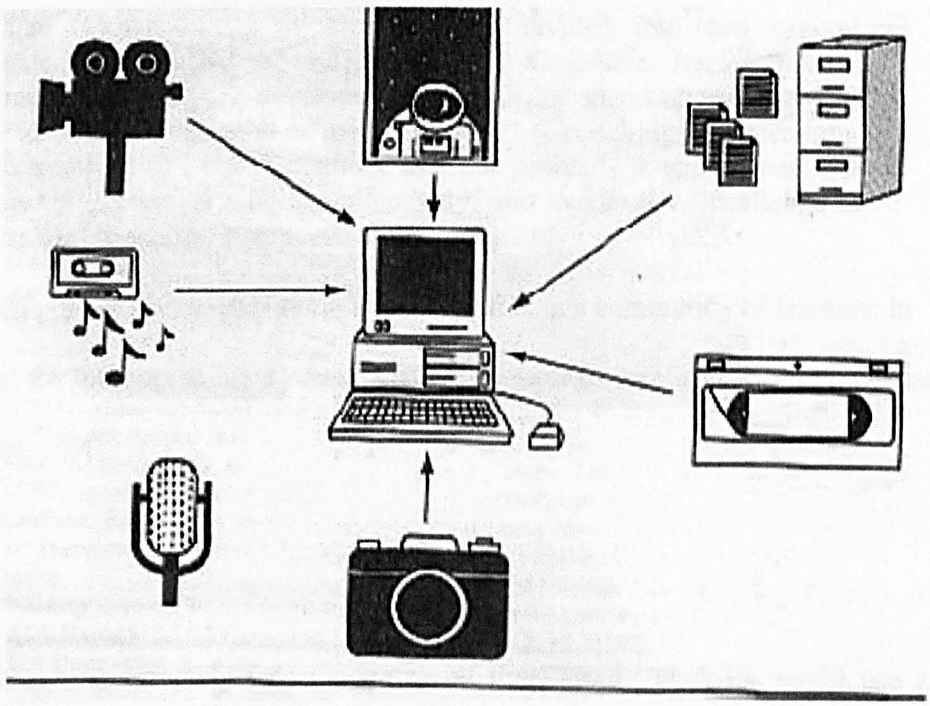
Katz (1994) stresses that the goal of a project is to learn more about a topic rather than seeking right answers. Therefore searching for information and answers for questions should not be restricted to the use of one resource. Students can use resources available in the Learning Resource Centre. They can use computers to access databases and CD ROMs. This type of use is supported by CD ROM based encyclopaedias and reference 'books', e.g. 'Microsoft Encarta', 'The Multimedia Encyclopaedia of Mammalian Biology', 'Multimedia Musical Instruments' (Boyle, 1997). The Internet contains a vast amount of information; students can access the Internet to gather information (Lafer, 1997; Boyle, 1997). They can locate related sound and motion files; capture video clips and record their narration. Other non-computer resources that can be used are textbooks, newspapers and magazines. Students can watch documentary videotapes, listen to audiotapes and take notes of interesting information. McDaniel, et al. (1993, p.75) make the following argument about the use of these resources:

> Students can examine topics of interest using whatever information they can access, and recitation can mean opportunities to share findings unique to each student.

Figure 3.4 illustrates the various sources of information that are available to students in the LRCs, taken from Jonassen, et al. (1999, p.86).

Furthermore, students can make use of resources outside the Learning Resource Centre; they can interview people concerned with their topics, such as experts (maybe a guest speaker, Liu and Chien, 1998), teachers or other people from the community and other organizations to get more information. In addition, students might go for field trips to places such as heritage sites, famous places, farms and factories. They might conduct research at home.

Figure 3.4: Technology and Media for Project-based Learning.



Source: Jonassen, et al. (1999, p.86)

In short, students should learn to use a great variety of resources that are available to them including CD-ROM, Internet, and traditional resources and other resources outside the LRC. They can use the Internet to search for resources. They have to identify various types of technology-related resources available for their topics and learn how to retrieve / use them in an innovative way, as McDaniel, et al. (1993, p.75) remind us with the following statement:

> Nevertheless, we feel that the greatest potential for computer applications is in the area of retrieval, manipulation, and exchange of information. Full utilization of these capabilities means an escape from "2 x 4 learning"—that is, learning bounded by the two covers of the book and the four walls of the classroom.

This leads to engage students in authentic learning in which students have a meaning and purpose for their learning (Wolk, 1994).

The teacher's role in this stage is as a facilitator and coach who provides help and assistance when needed (see Chapter Two, section 2.4.3). Gallagher (1997) argues:

> The responsibilities of the tutor are divided into two general categories, cognitive and procedural. Cognitive responsibilities include guiding the development of students' sound questioning and reasoning through "meta-cognitive" coaching; procedural responsibilities entail ensuring that the problem is appropriate, the group process is working effectively, and the level of challenge is natural to the learning needs of the group.

Simply put, the teacher's role is that of guide in a community of learners; in particular, the teacher facilitates student activities through careful scaffolding (Canada's SchoolNet, 1998).

3.4.6 Phase six: Putting information together

Searching for more information about their topics, students would use a wide variety of resources from inside and outside schools. The acquired information might be in different media and formats, photos, pictures, video, audio and written. This would engage students in thinking about what types of media are suitable for their topic. Savage and Vogel (1996) argue that

> The addition of images or sounds to a traditional presentation naturally raises the question of which images or sounds to add and why. Those who develop even simple multimedia presentations are soon led to reflect on the criteria for using particular types of information, and this leads to identifying topics that may be presented better with these new tools.

Putting these types of information together into the computer to be used later on for designing multimedia presentations requires digitizing some of them. Digitizing means changing their present format of these media to type of formats that can be saved onto computer hard-drive.

Students can transfer acquired information from their notes or whatever forms they used to gather this information, to the computer by typing them in using the MS

Word processor. They have the possibility of checking grammar and spelling. MS Word works as a tool which helps students to locate their mistakes.

Students can produce audio clips, they can record audio elements of their projects or they can incorporate sound from others sources such as CD ROM, and the Internet. Pictures and photos can be scanned using the scanners available in the Learning Resource Centres and students can save them in their folders. Students can use images from other resources as well, for example, from CD ROM and the Internet. Desired photos taken by digital camera can be transferred onto the computer.

Selecting the appropriate clips to support their findings, students can capture video clips. Video can be connected to the computer through a TV/video card. So instead of using TV to watch a video document, students can use video editing software for viewing and capturing such clips.

In this phase of the project, students, with the teacher's guidance and assistance, and with of help of "experts" in their groups (see Phase One), can expand their skills in using IT in the Learning Resource Centres. Students can learn more about using scanners, video capturing, drawing software, word processing, and the Internet.

The teacher can provide coaching and guide students in using the technology. The teacher's coaching will be more effective and efficient if it takes place in small groups; students are given more opportunity to interact with the teacher asking questions and giving guidance. The social interaction appears very clear in this phase.

3.4.7 Phase seven: Presentation phase

During the last two phases, students share information and skills within their small groups and perhaps, to some extent, among other groups. In this phase they share what they have learned with the class as a whole and with audiences from outside the classroom: teachers, head teacher, parents and others (Dexter and McGhee, 2001).

For example, consider a project on the five senses. Few students and, perhaps, teachers are likely to have knowledge about such a topic. Thus, when those students who do have relevant experience are given an opportunity to share their knowledge, the whole class is enriched (Tinzmann et al., 1990).

Strommen and Lincoln (1992) maintain that "the class culminates in a public presentation of the completed projects, to which parents, other educators, and students are invited". Students can be evaluated against each other. Feedback from the class and other audience members can improve the quality of their projects.

This stage is very motivating for the students; according to Mergendoller and Thomas (2001) the most interesting and encouraging part of project-based learning is when students present their work to other audiences.

3.5 Problems of Project-based Learning

Implementing project-based learning, however, is not without its problems. According to Blumenfeld, et al. (1991) many teachers have implemented such types of activities in the classroom only to meet with failure. They maintain that the failure of project-based learning is attributable to many reasons:

> We submit that the projects developed and disseminated without sufficient appreciation for the complex nature of student motivation and knowledge required to engage in cognitively difficult work. Furthermore, there was little regard for considering questions from the point of view of students (as distinguished from experts). Finally, little attention was paid to the nature and extent of teacher knowledge and commitment and the complexity of classroom organization.

In their study Achilles and Hoover (1996) reported poor implementation results for three middle schools and one high school classroom taking part in problem-based learning. The authors reported that students failed to work together well, especially in small groups because students were lacking in social skills. One interesting finding was that girls tended to participate in group work more than did boys. However, according to the authors, project-based learning (PBL) was an effective model for addressing varied learning styles, improved general classroom behaviour, and made teacher-learning experiences more exciting.

In addition to students' problematic behaviours discussed in Chapter Two, section 2.4.4, which can be observed in the normal setting of cooperative and working in small groups without the presence of technology, there are some students' problems associated with a technology-rich environment. Sandholtz, et al. (1997) reported that during project based learning students insulted each other, played with technology, showed resistance to teachers' instructions, and formed a physical shield to hide their off task behaviours. Sandholtz, et al. (1992) found that some students had control over the computer, mouse and keyboard. Ehrich, et al. (1998b) reported similar problems; they reported also that students persisted on computer tasks when they should have been working on non-computer activities or paying attention to the teacher. Cohen (1997) reported a group of students sitting at a scanner or around a computer, laughing and talking about personal matters. Sandholtz, et al. (1993) reported that students' "over-engagement in computer work sometimes creates time management problems". Lundeberg, et al. (1997) found that there were few students who used technology to demonstrate new meaning beyond that found in the resources used by students. Many students simply cut, and pasted information rather than synthesized it.

Since one of the fundamental elements of project-based leaning is working in small groups collaboratively, it requires careful planning on the part of the instructor, and is not without its difficulty for students (Davis, 1999, p.1).

Edelson, et al. (1999) report four challenges associated with project inquiry approach activities. One challenge is sustaining motivation for inquiry. Students often failed to participate or participated in a disengaged manner. Second, students were sometimes not able to access the technology necessary to conduct the investigation; i.e., they were not able to do the work. Third, students often lacked background knowledge necessary to make sense of the inquiry. Fourth, students were often unable to manage extended inquiry activities

Because of the repetitive and long development process during working on projects, students might lose interest and motivation. Liu (2001) found that as students progressed in their project phases they lost interest and motivation due to the repetitive process and the reduced time spent working on the computer.

It is a demanding job for teachers to provide the necessary arrangements and structure for students' learning. Dexter and McGhee (2001) found that project-based learning demanded additional work time and this initially created some stress for the teaching staff. They reported teachers expressing their concern about the extra burden and time they had to carry in implementing project-based learning in addition to their concern about lack of familiarity with ICT skills.

Teachers' content knowledge and skills to implement project-based learning are considered a major problem for the teachers. Blumenfeld, et al. (1991) maintain that one factor that has an impact on implementation of a constructivist approach of learning and teaching is that teachers' content knowledge which can be insufficient to meet with what can be covered in students' learning.

Sandholtz, et al. (1992) found that some teachers were upset because they knew less than their students about hardware and software. Therefore, this made them reconsider their new role and think about their traditional role.

Further, the lack of resources, equipment and technical support are also one of the major problems in implementing such an approach (Hill and Hannafin, 2001). Project-based learning requires the use of a variety of resources and sources, inside and outside schools and different equipment as such scanners, digital and video cameras. It will be argued in Chapter Four, lack of or inadequate, equipment and resources are considered factors influencing teachers' integration of technology into the curriculum.

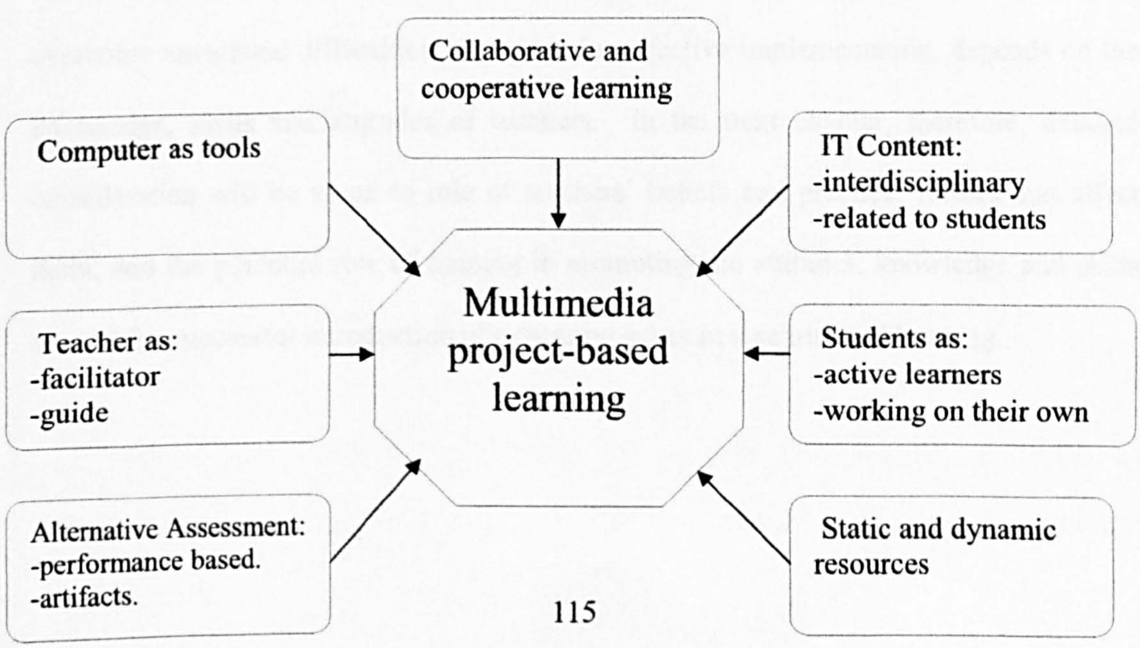
Computer "crashing" and file loss can be the most frequently occurring problems during project-based learning. Liu (2001) found that computers crashed and files were lost often during projects and, as a result, much of students' time was wasted in recovering the lost work. This results in teachers' and students' frustration and annoyance. These problems and the absence of immediate technical support can be a reason for teachers to abandon integrating technology into their teaching (we shall return to this issue in Chapter Four).

3.6 Conclusion

The foregoing discussion on Multimedia project-based learning reveals the value and the effectiveness of the approach. This approach is gaining acceptance in education, especially in Elementary education. The Multimedia project-based approach is an instructional approach that supports a technology-rich constructivist environment that combines both the use of technologies and constructivist teaching to support it. It is an approach through which students can put their knowledge and skills into practice and receive feedback, guidance and support from others such as peers, group members and teachers.

Multimedia project-based learning exploits the potential of cooperative and collaborative learning. In this approach, students' learning is directed towards purposeful goals through topics of interest to them. Therefore, multimedia project-based learning is a technology-rich constructivist approach to learning and teaching. It promotes a technology-based constructivist learning. Figure 3.5 shows the elements of project-based learning which match the elements advocated in Chapter Two.

Figure 3.5: The Elements of Learning Environment and Multimedia-based Learning.



A model for project-based learning using Multimedia/IT has been put forward, consisting of seven sequential phases through which learning should take place. During these phases, both teachers and learners have important roles to play. The teacher is seen as an important element in establishing, organizing and managing the learning environment; s/he provides scaffolding by guiding and assisting students with their learning. Students are actively involved in searching, organizing, analysing and presenting information. Throughout their project-work, they are engaged in metacognitive thinking, which is described by Chiquito (1995, p.211) as "involving thinking about or planning a learning process before the actual learning activity, monitoring the acquisition of new knowledge, or carrying out a critical self-evaluation of the results obtained after a learning process".

Although Multimedia project-based learning is consistent with the framework of Oman's education reforms and offers many potential advantages, it is clear, however, that its implementation cannot be expected to be without difficulty. As indicated in this chapter, there may be student- and technology-related difficulties, as well as problems related to the adoption of constructivist practice (the departure from the traditional practice) such as the difficulty of teachers and pupils adjusting to their new roles, discussed in Chapter Two. The willingness to implement a new approach and to work to overcome associated difficulties, necessary for effective implementation, depends on the knowledge, skills and attitudes of teachers. In the next chapter, therefore, detailed consideration will be given to role of teachers' beliefs and practice, factors that affect them, and the potential role of training in promoting the attitudes, knowledge and skills needed for successful introduction of new approaches in teaching and learning.

CHAPTER FOUR

TEACHERS' BELIEFS, PRACTICE AND TRAINING IN THE CONTEXT OF TECHNOLOGY

4.1 Introduction

The purpose of this chapter is to shed light on some literature about teachers' beliefs, attitudes and practice in relation to using technology. Influencing factors such as dominant teaching belief, belief about technology, unwillingness to change and training will be highlighted. The discussion is presented in two sections: section 4.2 is about teachers' beliefs and practice and section 4.3 about training as a means to change teachers' attitudes and practice.

Brown (1980, cited in AlNabhani, 1996, p.39) defines attitude as follows:

> Attitudes, like all aspects of development of cognition effect in human beings, develop early in childhood and are the result of parents' and peers' attitudes, contact with people who are 'different' in any number of ways, and interacting affective factors in the human experience. These attitudes form a part of one's perception of self or others and of the culture in which one is living.

The concept of belief is used in a variety of ways; and there is as yet no consensus on meaning and the concept has acquired a rather vague usage (Borg, 2001). Regarding the problems with arriving at a consensus definition of belief, Pajares (1992) maintains:

> "...Defining beliefs is at best a game of player's choice. They travel in disguise and often under alias—attitudes, values, judgments, axioms, opinions, ideology, perceptions, conceptions, conceptual systems, preconceptions, dispositions, implicit theories, explicit theories, personal theories, internal mental processes, action strategies, rules of practice, practical principles, perspectives, repertories of understanding, and social strategy, to name but a few that can be found in the literature.

Borg (2001, p.186) defined belief as a proposition which may be consciously or unconsciously held, which is evaluative in that it is accepted as true by the individual, and is therefore imbued with emotive commitment; further, it serves as a guide to thought and behaviour. In the educational context, belief can be defined as a personal construct that can provide an understanding of a teacher's practice (Nespor, 1987; Pajares, 1992).

In his discussion on the difference between attitude and belief, Roussell (1996) maintains that theories have been put forth in an attempt to explain attitudinal changes in relationship to behaviour, beliefs, and intentions. Traditional learning theories have viewed attitudes as predisposing the individual to perform various behaviours based on the attitude, centring on a stimulus-response conditioning model. Attitudes toward an object are related to beliefs about the object. Other attitude theories include expectancy value theory, and balance theory where attitudes and beliefs are indistinguishable and do not vary. Dissonance and attribution theories, however, give no clear explanation of attitude, dealing instead with beliefs.

In this study, belief and attitude are both considered to be "particularly provocative forms of personal knowledge" (Kagan D., 1992) that are reflected in teachers' practice. The terms attitude and belief will be used interchangeably, throughout this study, since the word attitude, according to Henerson, Morris and Fitz-Gibbon (1987) is used broadly to measure feelings, effect, values and belief; in this sense, according to the authors, belief is one facet of attitude.

Recent research (Albion, 1999; Swan et al., 2000) shows that attitude can be classified into internal and external attitudes. External attitudes refer to those evaluations which the teacher directs towards factors outside him or herself, for example, the value of the ICT in learning and teaching. On the other hand, internal attitudes refer to those evaluations which the teacher directs toward factors inside himself such as self-concept or self-esteem. In this sense, teacher attitudes and beliefs strongly affect professional development and technology integration (Swan et al., 2000).

4.2 Teachers' Attitudes and Practice

4.2.1 The importance of teachers' beliefs.

Teachers' attitudes and beliefs towards their daily practice are considered of great importance in evaluating the learning settings. They are informants who may able to provide a detailed description of what is taking place in the learning setting including their behaviour, students' behaviour and learning material.

The constructive learning approach, as indicated in Chapter One, is a child centered approach and according to Trigwell and Prosser (1996) teachers who view teaching as involving changing students' conceptions rather than merely transmitting information are more likely to adopt a student centered approach, which in turn is more likely to result in quality learning outcomes.

Sainsbury (1992, p.124) provides the following indicators of desirable attitudes for a teacher whose aim is to bring about interaction promoted in a constructive setting:

> Instead of regarding herself as the custodian of pure specialised knowledge, she has to see herself as a partner, albeit a more knowledgeable partner, in a conversation. Instead of seeing pupils as empty vessels to be filled with desired information, she must see them as active appliers of meaning, using their present understanding to grapple with new material and bring it within their grasp. She must acknowledge and respect this understanding and these attempts, rather that regarding it as irrelevant interference in her own projects. The emphasis must shift from the adult as teacher to the child as learner, and the teacher must redefine her position accordingly.

Brooks and Brooks (1993, p.100) identify a set of descriptors which reflect teachers' practice as a result of their constructivist beliefs and attitudes. They maintain that "This set of descriptors presents teachers as mediators of students and environments, not simply as givers of information and managers of behavior"

Teachers who teach in a constructivist-learning environment with the use of technology to facilitate students' learning necessarily relinquish some control and consequently accept a different role and ideology (Hannafin and Savenye, 1993). Moseley and Higgins (1999) concur:

> Teachers who are enthusiastic about ICT are likely to favour pupil empowerment as learners and probably like children to work collaboratively. However, it is the teachers with the best-developed ICT skills who are the greatest enthusiasts. Those with negative attitudes about ICT are likely to be more directive in style or may prefer children to work individually without ICT. These differences in thinking, skill and attitude clearly have implications for development and training for teachers in using ICT across the curriculum.

Kagan D. (1992) argues that the study of teachers' beliefs or attitudes is critical to education practice; it is an instrument to determine the quality of interaction one finds among teachers. Pajares (1992, p.324) emphasizes the importance of belief in relation to teachers' practice; he maintains:

> Teachers' beliefs represent a complex and inter-related system of personal and professional knowledge that serves as implicit theories and cognitive maps for experiencing and responding to reality. Beliefs rely on cognitive and affective components and are often tacitly held.

He further maintains that the earlier a belief is incorporated into belief structures, the more difficult it is to alter. Thus newly acquired beliefs are most susceptible to change. Since this study is concerned with multimedia project-based learning, in which technology has a pivotal role, it is of particular importance to consider factors that may impede teachers' integration of technology

Dwyer, et al. (1991) consider that changing teachers' belief and practice is essential when implementing change in education. This, according to the authors, can be achieved by gradually replacing teachers' belief with more relevant beliefs shaped by experiences in a technology-based environment.

4.2.2 Barriers to integrating technology

Many researchers such as Byrom (1998), Ertmer, et al. (1999) and Parr (1999) have looked at the barriers that influence the effective integration of technology into school subjects. Ertmer (1999) and Ertmer, et al. (1999), for example discuss two types of barriers that hinder the integration and the use of technology in the classroom, first order barriers and second order barriers. The first-order barriers, which are external barriers because of being extrinsic to teachers, consist of lack of access to computers and software, insufficient time to plan and implement instruction, and inadequate technological and administrative support and training. On the other hand, second-order barriers are internal; they include teachers' beliefs about teaching, beliefs about computers and technology, unwillingness to change and established classroom practices.

4.2.2.1 Internal (second-order)Barriers: Teachers' attitudes, beliefs and practice

Norton, McRobbie and Cooper (2000, p.88) maintain that teachers' dominant traditional belief and practice of knowledge acquisition can be a major obstacle to the introduction of innovation, such as computers and a constructivist approach in schools. They comment "school cultures and teaching practices are often reported as being conservative by nature."

> Schools are organizations with many different players and constituencies. Some school cultures promote and encourage innovation, others do not. Teachers are only one part of this complex system that includes district administrators, principals, parents, students, local communities, and governmental agencies. (U.S. Office of Technology Assessment, 1995, p.141)

Schifter (1996) maintains that although most teachers seek ways of improving their practice, and many have expressed enthusiasm for constructivist and other reform-based approaches, their underlying beliefs about teaching and learning tend to diffuse efforts to establish constructivist learning environments.

Most teachers teach as they were taught. That is, the teacher is viewed as the dispenser of knowledge and the student is the recipient of that knowledge (Dwyer et al., 1991). Studies (Sandholtz et al., 1997; U.S. Office of Technology Assessment, 1995) have shown that technology allows the student to take an active role in the learning process and the teacher to act more as coach or facilitator. In the Apple Classroom of Tomorrow (ACOT) project, for example, active participation usually takes place in collaborative learning projects which produces "noise" which some of the more traditional-minded participating teachers viewed as contrary to their conception of a proper learning environment.

These differences prompt teachers to question the use of technology or their teaching methodology. Dwyer et al. (1991, p.12) maintain that "... the direction of change towards child-centered instruction; towards collaborative rather than individual tasks; towards active rather than passive learning – each of these dimensions brought deeply held beliefs about traditional schooling into conflict with what teachers witnessed in their classrooms". Beliefs surrounding the need for autonomy, the dislike of cooperative groups and collaborative environments keep others from embracing technology into their classrooms (Parr, 1999). Tann (1988) found that a reluctance to use groupwork by teachers participating in her study was partly due to uncertainty about the perceived benefits of group work and what the children might learn from it.

Furthermore, literature reveals inconsistent findings regarding teachers' beliefs and practice in teaching and learning environments as well as in a technology-rich environment. Prawat (1992, p.354) argues that teachers' beliefs towards a constructivist approach is inconsistent:

> [N]ew constructivist approaches to teaching and learning, which many reformers advocate, are inconsistent with much of what teachers believe—a problem that may be overcome if teachers are willing to rethink their views on a number of issues"

Therefore teachers' beliefs about their present instructional approach pose a major obstacle to educational reform "because of their adherence to outmoded forms of instruction that emphasize factual and procedural knowledge at the expense of deeper levels of understanding" (ibid).

This is because, according to Prawat, constructivism is open to many interpretations and though constructivist views of learning may be well developed, constructivist views of teaching are still vague. Taylor (1990) adds two more obstacles that constrain teachers from adopting constructivist beliefs: the student and the curriculum. Students usually expect the teacher to deliver information directly. With regard to curriculum constraints, teachers have a little or no influence on the national curriculum. Similarly Brooks and Brooks (1993) maintain teachers resist constructivist pedagogy because of a rigid curriculum, concern about student learning, their commitment to their present instructional approach and concern about classroom control.

Teachers' resistance to change may be due to their confidence with their present system and being satisfied with its outcomes. For example, Dalin (1998, p.35) outlines some of the reasons for resistance to change:

> The analyses indicate that people tend to continue with activities which are known and which provide a certain security, rather than enter into activities with unknown consequences .... Self-distrust, insecurity, regression and dependency on authority figures are also identified as conservative influences. There are many patterns of behaviour that can support personality resistance. In most cases, innovations are rejected through ignorance, or through maintaining the *status quo* by following the norms of influential and interpersonal relations, or by creating a substitute.

Brooks and Brooks (1993) maintain that some teachers see no reasons for change because their current approaches seem to work well for their students. Parr (1999) maintains that some teachers feel successful with their current teaching strategies, and believe that integrating technology in their teaching will not help them accomplish anything they are currently doing.

However, resistance to change is seen by some authors as a healthy reaction from individuals. For example, Fullan (1993) argues that, in planning and implementing change, it is necessary to assume resistance and to regard it as "fundamental to successful change."

Further, Fullan and Miles (1992, p.748) suggest that it is counterproductive to label individual attitudes as "resistance" and may divert attention from the real problems of the implementation.

> Change does involve individual attitudes and behaviours, but they need to be framed as natural responses to transition, not misunderstood as "resistance". During transitions from a familiar to a new state of affairs, individuals must normally confront the loss of the old and commit themselves to the new, unlearn old beliefs and behaviours and learn new ones, and move from anxiousness and uncertainty to stabilization and coherence. Any significant change involves a period of intense personal and organizational learning and problem solving. People need support for such work, not displays of impatience.

Some researchers such as Klein (1996) and Collinson (1996) have found evidence among teachers of mixed beliefs and practice, combining elements of the constructivist approach and the traditional approach. Teachers' beliefs and practice were contradictory and selective. Some teachers may maintain a positive attitude towards both approaches; while some may bond to one of them. Others might select some strategies from each. Collinson (1996, p.10) based on a study on K-5 staff development in Missouri State, U.S.A., explains:

> Differing beliefs about teaching/learning were also evident, producing tensions between adherents of behaviorist and constructivist paradigms. There were several teachers who not only understood the differences between the competing paradigms, but who also knew their own position and the reasons for it. Others felt the tension between their personal views of teaching/learning and the state's new mandates that more tightly prescribed curriculum and increased standardized testing, but they did not have specific vocabulary to describe what they felt.

However, some studies such as Bracey (1993) and Schofield and Verban (1988) showed that teachers were more willing to change their practice and shift from didactic teaching to a constructivist approach.

The shift to a "student-centered" classroom, where there is collaboration, discussion, argument and excitement, sometimes seems chaotic to the teacher. According to Byrom (1998) some teachers do not want give up the control and order they have in their classroom. It is this shift which causes many teachers to rethink how they are teaching and how learning should take place. Moreover, Scheffler and Logan (1999) argue that since integrating technology into a classroom requires changing a teacher's role, some teachers, who do not want or like the change in their role, may resist the technology.

Dwyer, et al. (1991) reported that when using technology, some teachers would vacillate between traditional methods used previously, "teacher-centred", and newer "student-centred" approaches. This indecisiveness is due to the teachers' beliefs and perceptions about how instruction and learning should occur. The conflict was in the minds of the teachers as they wrestled with how learning should occur. For example, collaborative learning groups, using computers, grew noisy as students became excited over what they were finding and discussing. From the teacher's point of view, the noise indicated that there was no learning occurring. Students reported insulting each other, playing with the technology, and resisting the teacher's instructions. They used computers as a physical shield to hide their off task behaviours (Sandholtz et al., 1992).

Some individuals had complete control over the computer, mouse and keyboard (Ehrich et al., 1998a; Sandholtz et al., 1992).

In their report of technology diffusion in Queensland, Henderson and Bradey (1999) found that the majority of teachers who attended an in-service training course on project-based learning using technology appeared to change their pedagogy to integrate new ways of teaching and learning into their curriculum. They had struggled with the necessary pedagogical changes to their thinking and practice. The report highlighted the following major results of such integration: increased teachers' confidence; improved competency in computer skills and Internet usage, particularly with search strategies; recognition of their own and others' efforts; ability to integrate CD-ROMs and the World Wide Web (WWW) as learning tools into their curriculum; using CD-ROMs and the WWW with their classes and; witnessing their students' growth and enjoyment.

In Dwyer, et al.'s (1991, p.9) study of teachers' attitude toward the implementation of a technology-rich constructivist approach, they found that teachers at the initial stage, showed resistance to the new learning environment and felt guilty about not teaching the students. Their stand later changed in favour of a constructivist approach to teaching.

> The idea that deeply held beliefs can stand in the way of change is certainly not new. This research contributes to the evidence that teachers' beliefs about instruction and schools is an important factor that underlies the institution's resistance to change and argues that this fact must inform planning and implementation of significant change efforts. This issue gains bold relief in a program where teachers are personally dedicated to the investigation of the potential of modern technology but are held in check by the principles of 19th century instruction.

The authors identified five phases of teachers' belief, ranging from traditional teacher to constructivist teacher: Entry, Adoption, Adaptation, Appropriation, and Invention.

1. Entry: This is the initial stage which involves rewiring and rearrangement of classrooms, generally trying to establish order in radically transformed physical environments.

2. Adoption: In this second stage, concerns shift from connecting computers to using them. Teachers begin to adopt technology to support traditional text-based drill and practice instruction. There is a real use of computers rather than connection only.

3. Adaptation: This stage is characterized by thorough integration of the technology. Lecture, recitation and seatwork remained the dominant forms of student tasks. 30% to 40% of computer activities involve the use of word processors, databases and many computer assisted instruction.

4. Appropriation: In the appropriation stage, there is a shift in roles and new instructional patterns emerge, as teachers gain mastery of the technology. Appropriation is the point at which an individual comes to understand technology and uses it effortlessly as a tool to accomplish real work.

5. Invention: Dwyer, et al. (1991) describe teachers at this stage as "ready to implement more fundamental changes in teaching and learning. They are ready to invent interdisciplinary learning activities that engage students in gathering information, analysing and synthesizing it, and ultimately building new knowledge on top of what they already know".

Hooper and Rieber (1995) categorize similarly teachers' use of technology into five stages: Familiarization, Utilization, Integration, Reorientation, and Evolution. The familiarization stage is that within which the teacher simply becomes acquainted with a technology such as word processing, spreadsheets, assertive discipline, cooperative learning and motivational strategies. The operating principle here is the "how to's" of a technology.

The utilization stage is where the teacher tries out the technology or innovation in the classroom based on the principle, "give it a try". This is probably the highest phase of adoption reached by most teachers who use contemporary educational media, including the computer. However, they will discard the technology at the first sign of trouble, because they have made no commitment to it.

The integration stage is the "break through" stage. This stage occurs when the teacher cannot function without technology. The most frequently used technology is the book and its derivatives. Although the integration stage is the end of the adoption model for many, it only represents the beginning of understanding educational technology.

The reorientation stage requires many changes in the learning setting, in particular changing the instruction from teacher-oriented to student-centred instruction. The learner becomes the subject rather than the object of education. In this stage the teacher is more open to technology that enables student self directed learning and does not feel threatened by being replaced by technology. The last stage is the evolution stage in which the teacher continues to use different technologies to promote student understanding.

Honey and Moeller (1990) conducted a study examining teachers' beliefs about issues such as how and why they use or do not use technology in their teaching. They found that teachers identified as low-tech teachers held their traditional practices in the classroom because they feared that technology might change their relationship of control and authority with students. Within this group of teachers, there were teachers who held a positive belief about child-centred education but were uncertain about using technology because of their personal fears and inhibitions. Another group, classified by Honey and Moeller as low tech teachers, were those who believed in a constructivist approach but did not use technology because of either lack of equipment or scheduling problems in the computer lab.

In contrast, teachers who were identified as "high tech" teachers engaged in a constructivist approach and used strategies such as collaboration, project-oriented work and hands-on activities, discovery based learning and inquiry-based learning. These teachers perceived technology as a tool that facilitates students' learning and enhances the curriculum. Based on the results of their study, Honey and Moeller suggested that for effective integration of technology, changes may be required to include the beliefs of those teachers who are afraid of using technology, as well as change in the education system.

Another study was carried out by Niederhauser and Stoddart (1994) to determine teachers' beliefs towards different uses of computers: as a tool and as a machine. The authors explained these types of computer use. The computer as a tool is used by students to collect, analyse and present information and the computer as a machine is used by teachers in presenting information, giving immediate feedback and tracking student progress (CAI). There were 2,170 teachers involved in the study. It was found that elementary teachers were more in favour of using the computer as a machine and CIA software to educate their students whereas secondary teachers tended to favour computer use as a tool. Teachers' beliefs about effective uses of computers reflected theories of learning behind these uses. Teachers who used more open-ended, constructivist-type software with their students believed that computers can be used more effectively as a tool for student construction of knowledge, while teachers who used more traditional, behaviourist types of software believed that computers were effective as teaching machines. The authors maintain that "the way teachers integrate the use of technology into their teaching will be strongly influenced by their beliefs about the role technology can play in their instructional practice" (ibid: p.1).

In their study of English teachers' beliefs about information technology, Goodwyn, et al. (1997) identified two main groups of teachers according to their beliefs about the use of IT: the fearful group and the optimist group. The latter group, those who favoured IT, represented the majority of student teachers (younger teachers). The former group consisted of those who either feared or rejected IT as a threat to traditional literacy. The authors argued that this attitude was as a result of a particular and predominant view of literature and of an appalling lack of in-service training.

In their report, Moseley and Higgins (1999) found that teachers had a positive attitude towards ICT when it was used by students to demonstrate something to the whole class, and towards having pupils use computers at break times, for major project work and for word processing.

Teachers also have contradictory views towards software. Becker (1994) argues that one reason for not using technology is a lack of access to hardware and appropriate software. Similarly, Lam (2000) found that it was the software and lack of computer knowledge that hindered teachers and students from using computers.

Moseley and Higgins (1999, p.15) link the types of IT use with the teachers' teaching beliefs:

> Teachers who value pupil empowerment as learners are likely to view drill and practice software unfavourably, unless features which allow a high level of pupil choice are built in. Subject-specific software is likely to appeal to such teachers, for example talking books where children have a choice of level or strategy. More demanding uses of ICT linked with pupil investigation, data analysis and problem-solving are likely to be used effectively, and pupils may be able to handle ambitious multimedia projects, such as the production of a class newspaper or the creation of an instructional package.

Computer anxiety is another factor which might influence teachers' perception of integrating technology into the curriculum. Computer anxiety is associated with a fear of computer interaction that is disproportionate to the threat from the computer (Dusick, 1998). Some sources of teachers' computer anxiety come from the fear of feeling foolish and losing authority (U.S. Office of Technology Assessment, 1995, p.132). For example, teachers might be afraid of being embarrassed in front of their students because they know less that the students (Sandholtz et al., 1992, p.491).

McKenzie (1991) identified some descriptions of group of teachers whom he called "late adopters" on the assumption they want to know there will be positive results before investing and are conservative and non-risk takers who want a final, tested product. Earlier he argued that

> "there is some evidence that we have failed to integrate the use of technologies by all teachers throughout classroom curriculum in ways that are meaningful, related and powerful. There is a very large group of teachers who have acted as if technologies were just another form of bandwagon. We might call them reluctants.

However, over time, as teachers move from anxiety over using computer technology in the classroom to increasing comfort, their perceptions and practices also change (CELT report, 1995).

4.2.2.2 Factors affecting second-order barriers

Factors such as teaching experience and age may have an influence on teachers' attitudes and beliefs, i.e., the second-order barriers. According to Grandgenett and Harris (1994), teachers with more years of teaching experience make significantly greater use of computing resources, especially network resources. McCoy and Haggard (1989) found that years of teaching experience correlated positively with amount of computer use. However, Henry (1993) did not find any relationship between years of teaching experience and the amount of technology use and practice in the classroom.

Hannafin and Freeman (1995) carried out a study to determine the relationship between teachers' view of knowledge acquisition and their use of computers in the classroom. The authors assumed that teachers' conception of knowledge acquisition would range on a continuum from objectivism to constructivism and the conception would be reflected in the types of technology used. The results of the study suggest that more experienced teachers are likely to hold more objectivist views of knowledge acquisition than inexperienced teachers. No relationship was found between teachers' view of knowledge acquisition and the likelihood they would use computers in instruction. The authors commented

> If teachers' views of knowledge acquisition are grounded to a greater extent in an objectivist than in a constructivist perspective, as the results of this study seem to suggest, then committing resources to develop constructivist-based software applications may prove fruitless.

Norton, et al. (2000) conducted a study in a technology-rich girls' school. The authors chose this particular school for the purpose of eradicating first-order barriers, e.g., the availability of computers. The study showed that teachers who held traditional perspective, such as teacher-centred and content focused pedagogy, had a restricted image of the potential of computers in mathematics teaching and learning

> Because their non-use was essentially based on their beliefs, they did not feel it was necessary to take action to increase their expertise with software and ensure access. In this way, the teachers could continue to say that access and knowledge of suitable software was a major obstacle to their use of computers, although it may not have been the root reason (p.99)

Furthermore, Scott and Hannafin (2000) found that experienced teachers were more inclined to adhere to an objectivist perspective than those with fewer years of teaching experience; they explain:

> In terms of the classroom learning environment, perhaps more experienced teachers hold beliefs that are more traditional as they are more likely to be entrenched in the school culture. Conversely, teachers with less experience are influenced less by school traditions and perhaps more by teacher education programs that may advocate current and emerging theories of teaching and learning.

In his study, Calderhead (1996) identified two teaching and learning styles, namely, traditional and constructivist approaches. In the former, teachers view teaching as a process of knowledge transmission and in the latter teachers view teaching as a process of guiding children's learning. Calderhead (1996) concluded that teachers in the early years of teaching experience and training are likely to take on the child-centred belief, but as they gain more teaching experience, they adopt a control-oriented belief.

According to Smerdon, et al. (2000), based on their nationwide survey in the United States, more experienced teachers seem to have a more difficult time adjusting to technology integration. They reported that 45% of teachers with three or fewer years of teaching experience felt well prepared to deal with technology compared with 31% of teachers with 10-19 years of teaching experience, and 27% of teachers with 20 or more years of teaching experience. Seventy-six percent of teachers with three or fewer years of teaching experience used computers for planning compared to 63% of the experienced teachers. Ninety-one percent of teachers with three or fewer years of teaching experience used computers to create lessons compared to 82% of experienced teachers.

Howie and Wen (1997) carried out a comparative study in Taiwan and California, U.S.A. to measure high school teachers' attitudes towards the use of computer in teaching. The authors found that Californian teachers had a more positive attitude towards the use of technology in classroom than did Taiwanese teachers. The following are some of findings about Taiwanese teachers' attitude, (1) teachers who had six or more years teaching experience were more negative about using technology in the classroom than those with fewer years of teaching experience; (2) older teachers were more negative in attitude towards using technology in their teaching, and (3) teachers who had higher levels of education were more positive about the use of technology in the classroom.

This is also true for age as a factor that may be related to adopting either traditional or constructivist approaches. Older teachers tend to hold more traditional views about teaching style while younger teachers tend to be more progressive (Scott and Hannafin, 2000). Bennett, Jordan, Long and Wade (1976) and Eiken (1974) (both cited in, Scott and Hannafin, 2000, p.3) for example, found that older teachers held more traditional views about teaching styles, than younger teachers did.

4.2.2.3 External (First-order) barriers: Teachers' training, time and equipment

According to Ertmer et al (1999) the external barriers are easier to deal with than internal barriers. Research identifies five major external barriers that hinder effective training of technology in the classroom:

1. Inadequate teacher training
2. Teachers' lack of vision of technology's potential.
3. Lack of time.
4. Inadequate technology support for teachers.
5. Current assessment practices. (U.S. Office of Technology Assessment, 1995)

Butzin (1992, p.330) listed three reasons for ineffectiveness of technology implementation: (1) lack of a sufficient quantity of classroom equipment, (2) lack of training for teachers, and (3) the inherent difficulty of retrofitting technology to the existing structures of education.

Bosch and Cardinale (1993) maintain that, in many schools, the main reason given for the low level of computer usage is that schools had limited access to equipment and a lack of training. They concurred with Butzin's reasons and maintain that in many schools, the main reasons given for the low level of computer usage were limited access to equipment and a lack of training.

Wang and Holthaus (1999) found that student teachers in their study held positive attitudes toward the use of computers in education and judged themselves to be prepared for computer use in their future teaching. Nevertheless, the pattern of their computer use suggested that these students were only being prepared for computer use in a limited way because of lack of training on integrating technology into educational curriculum courses.

Smerdon, et al. (2000, p.93) discuss five important factors for effective use of computers in the classroom by teachers: (1) training as a major issue for preparing teachers to integrate technology into the curriculum, (2) the availability of equipment such as computers and the Internet, (3) time needed to integrate technology into the curriculum, (4) technical assistance with the use technology into the curriculum and (5) leadership which can provide support assistance and feedback on how to integrate technology into the curriculum. They reported that 71 percent of teachers identified the lack of good instructional software as being a barrier, and 58 percent of teachers identified difficult Internet access. Furthermore, approximately two-thirds of all teachers reported the lack of adequate equipment, training opportunities, technical support or advice, and support regarding ways to integrate telecommunications into the curriculum as barriers.

Dawes (2001, p.62) maintains that the reasons why teachers remain wary of ICT are attributed to equipment, training, uncertainty as to genuine pedagogical purposes for computers, lack of technical support and the unreliability of some equipment.

The same argument is put forward by Bennett (1996, p.45) who argues that one reason that computer technology is not utilized as it could be is due to the lack of knowledge of teachers. Teachers who do not have a background in current technology are less likely to use the computer. Even teachers who do use computers find it difficult to incorporate different programs into a curriculum. Bennett (1996) says briefly that "The lack of training is one of the reasons why only a small percentage of the teachers in the nation [The United States of America] use computers in their classes." Becker (1994) maintains that

> Teachers are not provided with the time or training to learn hardware and software operations. Teachers need continuing training as the technology changes, as new and more effective applications are developed, and as more is learned about learning with technology.

Technical support has been identified as a factor contributing to the successful use of technology in the classroom (Frust-Bowe, 1992). It might be a technical person available on demand, a fellow teacher with some encouraging words, or a principal who believes in technology and commits to implementation (money, time, conferences, specific training). Tate (1998), for example, carried out a study to determine the impact of technical support that teachers received while using technology in classroom as a factor that encouraged teachers to use technology in their teaching. The study was carried out on two groups of teachers; those who received full technical support and those who did not. The results showed significant differences between the groups. The former group utilized technology more effectively than the latter group. The U.S. Office of Technology Assessment (1995, p.119) researchers reported:

> Only 6 percent of elementary and 3 percent of secondary schools have full-time school level computer coordinators; in nearly three-fifths of schools, no one had any portion of their workweek officially allocated to coordinating computer activities.

Russek and Weinberg (1991) described difficulties with equipment as a barrier to implementation.

Barron and Goldman (1994) and Topp, et al. (1995) identify some factors influencing teachers' use of technology such as: (1) limited availability of equipment; (2) lack of faculty training; (3) no clear expectation that the faculty will incorporate technology into academic activities; (4) lack of funds; (5) lack of time to develop the facility in using equipment and software; (6) doubt about the pedagogical validity of using some of the newer technologies since the appearance of literature about these tools is relatively recent; (7) lack of technical support; (8) lack of appropriate materials, particularly integrated media materials suitable for teacher education instruction; and (9) absence of clear programmatic goals for the teacher education programme as a whole.

Further, the U.S. Office of Technology Assessment (1995, p.153) maintained that "other significant barriers mentioned were problems with scheduling enough computer time, too few computers for the number of children, too few printers or other peripherals, inadequate financial support, and not enough help for supervising student use of computers"

Some of the previous studies showed that lack of equipment can be a factor affecting teachers integrating technology in their teaching. Jonassen (1998) emphasises this and attributes the failure of integrating technology to lack of equipment

> Throughout the history of instructional design and technology, projects have failed most often because of poor implementation. Why? Because the designers or technology innovators failed to accommodate environmental and contextual factors affecting implementation. Frequently they tried to implement their innovation without considering important physical (e.g. adequate equipment wasn't available), organizational, and cultural aspects of the environment into which the innovation was being implemented.

It can be argued that the nature of training, such as the way training is delivered and the amount of training teachers received, can be a factor affecting teachers' integration of technology into the curriculum.

Training can be related to both mechanics and application. According to the U.S. Office of Technology and Assessment (1995) much of today's educational technology training seems to focus on the mechanics of operating new equipment, whereas little intention is given to how to integrate technology into specific subjects, how to select and use software and how to organize classes. Such partial training is a barrier to teachers' using technology effectively. Parr (1999) stated that incomplete or partial training can result in teachers feeling confident in computer skills, but not in using them in the classroom. Knight and Knight (1995, p.145) share the same opinion; they comment:

> The role of the teacher is certainly crucial and changes significantly with computer- based learning as the teacher becomes an information source, guide and mentor. However, in the writers' experience, inadequate training for classroom teachers in a technology-based approach will have little impact on students' learning. The teacher remains a key component in the new design.

Swan, et al. (2000) maintain that traditional in-service training has little impact on teaching practices in general. The authors cited the following features of effective teacher training identified by Putnam and Borko:

- Teachers should be treated as active learners who construct their own understanding.
- Teachers should be empowered and treated as professionals.
- Teacher education should be situated in classroom practice.
- Teacher educators should treat teachers as they expect teachers to treat students.

These features show the importance of considering adult learning aspects while training teachers because teachers bring to the training their attitudes, their expectations, their life experiences and their goals relating to what they will get from a professional development (McKenzie, 2001).

McKenzie points out deficiencies in past technology training models. These include off-site workshops removed in place and context with little on-going support, inadequate opportunity to practise and negligible transfer of new skills from workshop to the classroom. Districts provide little money, training is not during optimal time, expenses are not subsidized and the quality of the presenter is poor, due to lack of trainer reimbursement (ibid).

Lecturing is not effective; the information may not be relevant or timely. It does not allow for any practice (McKenzie, 2001). Ropp (1999) maintains that training workshops must provide hands-on experience where interactive learning is taking place.

Participants' reactions in Ringstaff and Yocam's study (1995) to the constructivist professional development training were positive and preliminary data suggests that most participants are using what they have learned about technology integration and constructivist teaching in their classrooms. The authors commented on the difference between the traditional and constructivist training as follows:

> And, even if a greater amount of time were spent on technology training, current methods of professional development are woefully inadequate, because most focus on learning about computers rather than on learning how to integrate computers into the curriculum. As such, these training programs do little but preserve the instructional status quo (ibid: p.24).

The time and place of training are also considered as factors that contribute to effective teachers' integration of technology. According to the U.S. Office of Technology Assessment (1995), a better strategy is to provide training just before teachers need it. Summer institutes and weekend training do not have the desired effect because teachers do not have an immediate chance to apply what they have learnt. Onsite training is also important where teachers can practise dealing with hardware and software. There are opportunities to solve technical problems with the assistance of technicians (ibid). Kearsly and Lynch (1994, p.11) summarise the drawbacks of traditional training in the following:

> Failure to provide adequate training (e.g. in the amount and in the type) is the reason underlying this problem. The amount of time required is often underestimated. Furthermore, most people require 'hands on' practice to properly learn a system; such practice is often overlooked or too minimal. Related to this problem is the lack of adequate time or funds to implement technology, usually due to inexperience or poor planning. Successful use of technology almost always takes more time, money, and training than initially expected.

Further, teachers also ought to be trained on skills that they might implement in their teaching, for example the use of multimedia programs. Backer and Saltmarch (1999) maintain that for teachers' use of computer-based technologies in the classroom, an important factor is effective teacher professional development that involves participants in the design and construction of multimedia software. This would allow teachers to understand their conceptions of multimedia design and execution, the amount of time required to construct even simple multimedia projects and the steepness of the learning curve for some multimedia tools. Murray (1995) contends that:

> The best professional development activities will also model the methodology of collaborative instruction by engaging the participants in an inquiry-based project pertinent to their content area; teachers will finish the course with a tangible product which is immediately applicable in their classrooms.

4.2.2.4 Summary

It can be argued that the first-order barriers are concerned with training, time and money. In the U.S. Office of Assessment (1995) report, it is stated that the lack of training is one of the greatest barriers to integrating technology into the curriculum. It is to some extent possible to overcome these barriers by providing schools with necessary technology and resources and by providing teachers with the needed skills and knowledge through in-service training.

The second-order barriers are the most difficult to modify (Ertmer et al., 1999), unless certain measures are taken. For example, Dwyer, et al. (1991, p.7) consider that changing teachers' beliefs and practice is essential when implementing change in education. According to the authors, this can be achieved by gradually replacing teachers' beliefs with more relevant ones shaped by experiences in a technology-based environment:

> Implementing change in education must include changing teachers' practices and belief. This does not mean abandoning beliefs but gradually replacing them with more relevant beliefs shaped by experiences in an altered context. And it is this altered context that may make the difference. When teachers work with colleagues and administrators who actively support fundamental change, there is far greater opportunity for successful growth of new beliefs and practices.

Indeed, such action might have an impact on teachers' beliefs towards the constructivist approach and technology implementation. Becker and Ravitz (1999), who carried out a study that examined how computer use might influence teacher practice, found that the use of computers did, in fact, seem to produce changes towards more constructivist approaches in a given appropriate environment. Woods (1996) maintains, however, that teachers' belief is not easy to change and teachers cannot simply, at will, change their beliefs by themselves. Teachers should be encouraged to change (ibid). Therefore training which provides teachers with information, knowledge and ideas might influence their beliefs and practice. The next section looks at the training as a means to induce change in teachers' belief and practice.

4.3 The Need for and Importance of Training

In-service teachers and especially ICT teachers need a regular update of the teaching methods used in their teaching and classroom management. ICT teachers always need to know what is new in the field of technology and need to know how to integrate it into their teaching and students' learning (Dawes, 2001; Kennewell et al., 2000). The integration of these new technologies should take place across the curriculum of different subjects (Dawes, 2001, p.65). Handling such integration is not an easy task for teachers. It requires awareness of related practice, knowledge and pedagogy (Hooper and Rieber, 1995 and Dwyer et al, 1991). Blumenfeld, et al. (2000, p.155) elaborate:

> For example, teachers need to understand the science content of the projects; lead classroom discourse so that students grapple with difficult science concepts; manage classrooms that have far more talking, activity, and movement than is conventional; and plan for and adjust to time demands of projects that last 2 months or longer. Moreover, they need to understand and use the power of new learning technologies to support students in their inquiries.

Therefore an environment with technology would be different from a traditional one. For example, the presence of recent technology, e.g., the Internet and multimedia, could lead to changes in the role of the teacher and the students, since there is a change in the way instruction is delivered, and there are new tools involved in students' learning, i.e. new technologies (Barton, 1997; Selinger, 2001).

For some teachers, the new learning environment differs from the one that they are familiar with; the new environment requires them to cope with many more uncertainties (Jager and Lokman, 1999). Such uncertainties include knowing how to organize and manage project environments, and how to acquire ICT skills needed to operate in this environment.

Bailey (1996) states that due to the complexities of working in this environment, teachers need training not only in the technology, but also in adapting to the new role of the teacher as facilitator/guide, as content expert, as a provider of resources and feedback, as reinforcer of focus and objective, as encourager, and as a poser of questions, is important.

Furthermore, teaching is a difficult task. It is multi-dimensional, it contains uncertainty and it involves ethical and social issues. Thus, teachers might have different perspectives about teaching (Anderson et al., 1995). Therefore, the training should address these issues and help teachers to teach well in the midst of such complexity. This is possible, according to Kennedy (1991, cited in Anderson et al., 1995, p.147) by equipping teachers with technical skills, theoretical knowledge of the teaching approach and the capacity for critical analysis.

For example, one of the basic elements of the new learning environment is cooperative learning among students (see Chapter Two, section 2.4.4). Webb (1990) stresses that in order to manage group learning confidently, teachers may need practical assistance from in-service training and school-based curriculum development projects on forms of classroom management, teaching styles and kinds of tasks associated with effective groupwork.

Guskey (1986) saw in-service teacher training as a systematic attempt to bring change in classroom practices of teachers, their beliefs, attitudes, and in the learning outcomes of students.

With regard to successful implementation of educational technologies in classrooms, research emphasizes the importance of training teachers on how to make best use of these technologies in their teaching and students' learning (Matusevich, 1995).

For example, O'Neil (1995) maintains that one of the first mistakes in introducing educational technologies to the classroom was focusing on students rather than teachers.

He argues that training the teachers on how technologies can be integrated into the curriculum is an effective way to address the problems.

Jonassen (1998) goes further to recommend not only training the teachers but also training students and other personnel who are going to be involved in such an environment – a view consistent with the advice on implementation of project-based learning cited in Chapter Three.

Stables (1997) argues that teachers trying to integrate technology into the curriculum of learners must understand exactly what technology education involves. They must also identify the strengths that they already have which can be applied when integrating technology into the classroom, and they must be able to deal confidently with the technology education curriculum. He further states that hands-on experience during training is the best way to help teachers confidently gain these skills.

Similarly, Wilson (1996a) suggests teachers require more than technical training in order to make more use of technology; there should be a shift in thinking about teaching approach. Kennewell, et al. (2000) concur that ICT teachers should not only know how to use technology but also be familiar with how technology can be used in the classroom. Grandgenett and Mortenson (1993, p.56) add that

> Merely supplying teachers with technology often does little good unless the teachers are also carefully trained to use the technology through an appropriate in-service program. However, teacher in-services need to be well planned and delivered to be successful

Another support for training teachers to integrate technologies into subjects' activities and practices is offered by Foa, Schwab and Johnson (1998, p.87) who explain "for technologies to be used optimally, teachers must be comfortable with a constructivist or project-based, problem-solving approach to learning. They must adapt to students progressing independently and at widely ranging paces." Further, Fatemi (1999) emphasises that teachers need professional development focused on integrating technology into the school curriculum.

Blumenfeld, et al. (1991) maintain that for effective implementation of a constructivist approach (project-based approach) teachers must be supported in creating this type of instruction; they further argue that teachers need help to implement alternative methods of assessment such as portfolios, journals and notebook entries in their teaching (see Chapter Two, section 2.4.6).

Druin and Solomon (1996, p.126) argue that even if some teachers are aware of the importance of multimedia and multimedia programs, they are not sure how to integrate them in their teaching.

> When teachers first acquire multimedia authoring tools, many times they are uncertain of what to do with them in their classrooms. They know that these tools can offer a powerful new way to explore diverse subject matters, but they are not sure where to begin with these new tools.

Several studies have proved that training courses can play a major role in bringing about a positive change in teachers' attitudes towards constructivist approaches and the use of technology.

Christensen (1998) carried out an intervention study to determine teachers' attitude towards technology integration into their teaching. The study compared teachers' attitude towards using technology in their teaching before and after a period of training. The result of the study showed that (1) before the training teachers tended to show more negative attitudes towards technology; (2) teachers' attitudes towards the idea of technology integration changed towards more positive ones. The significant difference in the group performance before and after the training was $p<0.04$.

Gilmore (1998) carried out a study to determine the impact of training on changing teachers' attitude conducted a similar study. The study involved two hundred and eighteen participants who were asked to give their attitude towards the use of technology in their teaching. The study showed that teachers' attitude after the training had changed largely in the direction of more positive attitude due to the training courses. The study showed that participants with the greatest length of teaching experience may be more reluctant to adopt new teaching methods, such as the integration of information technology.

Abbott and Faris (2000) carried out a study to examine student teachers' attitudes towards integrating technology into students' learning. Sixty-three undergraduate education students participated in this study by completing pre- and post-course surveys consisting of three attitude-toward-computer instruments. The results of this study suggest that increases in positive attitudes toward computers, after the training, may have resulted from instructional approaches, meaningful assignments requiring technology, and a supportive faculty. The researcher believes that teacher-training programmes should not only teach teachers how to use hardware and software but also teach them how to incorporate computer technology into their teaching strategies and activities.

4.4 Conclusion

The previous argument reveals the importance of teachers' beliefs in understanding the reality of what happens in classrooms. The literature on teachers' beliefs and attitudes provides valuable information about how teachers react to innovation in their practices, such as the constructivist approach and use of technologies. Some teachers' beliefs, practice and use of technologies are inhibited by many factors such as their old beliefs, their age and their teaching experience. Teachers' use of technologies in their teaching is also restricted by lack of training, availability of technologies and time to practise. Also, the literature reveals that training can be an effective tool to change teachers' beliefs and practice.

In implementing project-based learning in this study, the researcher considered factors discussed in this chapter, as likely to influence teachers' integration of technology into their teaching in the Learning Resource Centres of Basic Education Schools in Oman. Thus, training was given to teachers on constructivist principles and effective methods of integration; the impact of teaching experience, residence areas and previous training courses on integration of technology into subject-teaching were considered, and other factors such as technical and behavioural problems that might emerge during teachers' practice were investigated. The methods by which the training intervention was provided, and information was collected on teachers' attitudes and practices, are explained in the next chapter.

CHAPTER FIVE

RESEARCH METHODOLOGY

5.1 Introduction

In education, there are many theories of learning and teaching and most of them try to make assumptions about how children learn. Behaviourism, for example, focuses on the learner's behaviour as a key point and cornerstone of learning, whereas constructivism focuses on the thought of and the active role of learners which take place in a learning setting. The latter emphasizes the active role of learners in constructing their knowledge based on their previous knowledge. Although the learning settings in these approaches are different, as has been discussed in Chapter Two, they are not simple, especially in the presence of educational technologies, which play a major role in these learning environments.

The main objective of the research was to explore teachers' attitudes towards project-based learning (a constructivist learning approach), both before and after the training, and the influencing factors. To achieve the objective of the study required the use of a range of research tools, such as questionnaire, interview and observation. In this sense, both quantitative and qualitative approaches were used. The decision to select one of the approaches or both depends on the nature of the study and its aims and the types of data to be collected and analysed. King (1987) maintains that there is 'no best method' and that the methodology adopted should be suited to the topic being explored. Elton (1977, p. 38) points out:

> The choice between opposing methodologies is not therefore between right and wrong, but between appropriate and inappropriate. The crucial judgment that a researcher must make, at the very beginning of his research, is that which methodology is appropriate for the research that he wishes to pursue. If he chooses an inappropriate one, he will still get results - research is like that - but they will be meaningless.

The literature on research methods tends to classify research tools into two main approaches, quantitative and qualitative (Lincoln and Guba, 1985). The following discussion sheds light on issues concerning conducting research in Oman and the benefits of combining quantitative and qualitative approaches. There follows an account of the data collection instruments. For each method in turn, the development and piloting of the instruments are described, and issues of validity and reliability are considered, the application of the data collection instruments in the main fieldwork is reported, and methods of analysing the data are explained. An account is given of the training in the new approach (PBL) provided for the teachers participating in the study. Some reflections on ethical issues, the role of the researcher, and the difficulties faced during the research are included.

5.2 The Context of the Study

Some consideration must now be given to the cultural context for educational research in Oman, and especially to whether there exist constraints that would prevent the free expression of opinion and compromise the validity of the research.

In Oman, the years before 1970 were characterised by extreme isolation, not only from the developed countries, but also from neighbouring Arab countries, such as the Gulf States (AlHammami, 1999). In 1970, with the accession of H. M. Sultan Qaboos bin Said, the Sultanate of Oman was reborn. As Clements (1980, p. 1) puts it:

> Prior to 1970 Oman was firmly rooted in the past as a result of a deliberate policy of the late ruler and the lack of any real income prior to the discovery of oil in 1967 .... . The whole situation changed radically with the *coup* in 1970 which resulted in the immediate implementation of a programme of reforms in the health services, education and economic development aimed at bringing it into the twentieth century.

Omanis had been deprived of education and of the opportunity to express opinions, and lived in poor conditions. This was, in part, due to the fact that the "political system" at that time was impervious to any effect, whether external or internal.

Since 1970, when the current government took power, Oman has experienced significant social and economic changes and development. It has become an open society in which Omanis can freely express their own opinions and attitudes towards social and economic issues. They are able to express their opinions through formal and informal institutions. Formal institutions include television, radio and newspapers and, above all the *Majlis A'Shura* (the Legislative Council), which consists of members representing the citizens. There are also various informal means such as private letters and professional and social associations. There is also an Omani homepage[11] called "*Sablah*" for posting opinions on various issues.

The constitution which was published in 1996 assures the right of the people to criticize the role of the government (Ministry of Law Affairs, 1996). The policy makers, for example in the Ministry of Education, in their concern to improve standards of the education, have shown willingness to listen to comments from the people. There are special programmes on the Omani television and radio in which parents, teachers and students freely discuss the educational issues and provide suggestions for further reforms. Also, articles published from time to time in newspapers and magazines criticize the Ministry of Education and teachers. Furthermore, during the *Majlis A'Shura* (the

[11] The URL is: www.omania.net

Legislative Council) sessions, the minister of education is frequently asked by the council members to clarify the policy of the reform and other educational issues.

The Omani government wishes the media to support the efforts made to achieve development and spread awareness among citizens on various matters, and education is seen as an essential topic to debate; any idea that seems likely to assist the nation in its struggle to emerge from a widespread illiteracy is welcomed.

A similar climate for expressing opinion can be also experienced in Oman schools. Teachers are used to participating in research projects, such as questionnaire surveys conducted by researchers from various fields in education and from different universities. Some of those researchers are decision makers such as ministers, undersecretaries and general directors. Therefore, there is no reason for respondents to feel intimidated in expressing their opinions, even if these were in some respects critical of current educational policy and practice.

Of course, it might be expected that it would be easier for teachers to express their views through the anonymous vehicle of a questionnaire, than through the more direct personal contact associated with observations and interviews. In these too, however, the current political climate in Oman, together with aspects of the administration of education system, tend to favour the research rather than hinder it.

As regards the observation of lessons, although the presence of the researcher in LRCs during IT lessons could influence the teachers' performance either negatively or positively, it is the researcher's experience that teachers in Oman are used to such circumstances. They are regularly visited by inspectors, school heads and newly qualified teachers. After such visits, it is the usual practice for teachers to sit and discuss openly these lessons with the visitors. Therefore, the potential influence of the researcher's presence would be minimised by teachers' familiarity with such situations. The researcher felt that teachers would behave naturally when being observed during IT lessons, without constraint, and this belief was confirmed when the observations were carried out.

The same freedom prevailed during the interviews. In general, teachers in Oman are encouraged to express their attitudes and opinions about their performance during their lessons. After supervisory and other visits, they usually discuss and argue openly with inspectors and other professional visitors on matters concerning their teaching. Therefore, in the interview, the researcher believes that LRC teachers expressed openly, what they thought about the new approach. This was reflected in their differences in opinions about some elements, such as alternative assessment, as will be seen in a later chapter.

One issue, in particular, that must be considered in relation to research in Oman, as in any Islamic country, is that of gender. This was of particular importance in this study since as a matter of government policy, almost all Basic Education teachers are female. Both Islam and the Arab cultural heritage impose certain constraints on relationships and interaction between male and female, outside the context of marriage and family ties. However, the degree of constraint differs from one society to another. In Oman, although private meetings between males and females would be unacceptable, contact in a legitimate professional context is permitted. In contrast to some states in the Gulf, where strict gender segregation is preserved throughout the education system, and boys' and girls' schools are separately administered, with no face-to-face contact between female teachers and male officials, in Oman, female teachers are accustomed to being visited in their schools by male directors and inspectors. Moreover, women have the same right as men to express their opinions. In this situation, provided the appropriate formalities were observed and proper approaches made through the relevant authorities, there was no impediment to the researcher observing, interviewing and eliciting open expression of opinion from female teachers.

5.3 Research Design

This study was proposed to be conducted within the researcher's own working field, and one function of this field is maintaining the operation of Learning Resources Centres in Basic Education schools.

The researcher already had several themes in mind (listed below) which he wished to explore, and realised that what he wanted was to allow selected respondents to express themselves, focusing on the topics of these themes, through some research tools.

The learning environment can be looked at in terms of the effective, purposeful and meaningful use of technologies and the six elements of the constructivist learning approach identified by Means and Olson (1995a), Jones, et al. (1994) and Moursund (1999). These elements are:

- The role of teacher as facilitator and guide;
- The role of students as active participants and knowledge seekers;
- The context of learning; that is, cooperation and collaboration among students in small groups;
- The content of activities (IT as content), that is, the relevance of learning materials to students' interests, to real life and to other subjects;
- Alternative means of assessment, and
- The goals of technology use.

The researcher initially needed to identify a means of gathering data, and to keep the research within the constraints of time and resources, which were both limited.

Most previous research on technology in education has been quantitative, and this research follows that pattern to some extent. In exploring teachers' beliefs and practices, the researcher wished to include a quantitative element in order to discover what proportion of teachers held particular attitudes or behaved in particular ways. In particular, quantitative data were needed in order to be able to measure the change in teachers' attitude over a period of time, as a result of training and practice in the constructivist approach. Another purpose of gathering quantitative data was as a basis for exploring, statistically, relationships between teachers' attitude and their personal and professional characteristics.

To carry out this study, a questionnaire was employed as the main method of data collection. The researcher felt, however, that a questionnaire alone would not wholly fulfil the purpose of this study, and additional tools were needed to explore more about teachers' attitudes towards using a constructivist approach with technologies. For example, a questionnaire would constrain teachers' responses within a pre-determined framework, rather than allowing them to answer wholly in their own terms and raise the issues and concerns of importance to them. Interviews seemed to be appropriate, therefore, to obtain richer and deeper information on teachers' views. Moreover, there was a question of the possible discrepancy between theory and practice. Teachers might profess to hold cognitivist views, but would they actually transfer such views into their pedagogical practice? To see whether or how teachers implemented the content of the training in practice, classroom observation was appropriate.

In short, the researcher decided to use both qualitative and quantitative methods simultaneously and as complementary modes of inquiry, data collection, and analysis.

This combining of methods was consistent with current thinking in research methodology, where many researchers recognise that methodological mixes strengthen the research design.

Indeed, combining different data collection techniques into a single project can be highly productive. Rieber and Kini (1995) maintain that quantitative and qualitative methodologies offer complementary rather than competing, sources of information in educational research.

For example, Salomon (1991) suggests that the strength of quantitative research is its accuracy, whereas qualitative research provides authentic information. Yin (1994) and Merriam (1988) recommend the use of multiple sources of data. The use of multi methods in collecting data helps to overcome and reduce the weakness of an individual method, and helps to produce an accurate result (Whyte and Alberti, 1983).

Multiple data collecting sources and strategies were employed to ensure validity and credibility of the research, applying the concept of triangulation, whereby the same issue is examined from multiple perspectives and using multiple methods, to obtain a more complete and accurate overall picture (Miles and Hubermann, 1994). The following three sections explain and discuss the research tools used in the study.

5.4 Questionnaire

Questionnaires have certain advantages over other instruments used to collect data. They permit anonymity so respondents can confidently respond to sensitive questions; give them a considerable amount of time to think about their responses; provide greater uniformity; the data they provide can be more easily analysed and interpreted than for example, interviews, and the researcher can make sure that they are accurately distributed (Henerson et al., 1987). However, the misinterpretation of questionnaires might lead to low validity of the information provided and they lack flexibility. Moreover, characteristics of participants, including motivation, reading habits and education level, can influence the validity of the questionnaire. For example, a participant with limited motivation may choose the first option that appears acceptable to him or her without examining all the options. In this study, the respondents were well educated and expected to be motivated, since the survey was presented to them as an effort to improve teaching and the value of their participation was emphasised.

Nevertheless, to obtain valid and reliable data, care in the development of the questionnaire was of paramount importance. In this study care was taken when designing the questionnaire to consider the type of information needed to be obtained from it, as well as the content, structure, format and sequence of the questions was taken into account.

The attitude questionnaire was developed by the researcher based on the researcher's experience in the field of information technology, and the thorough reading of the work of:

Johnson and Johnson (1989),

Jones, et al. (1994, 1995) and

Means and Olson (1995a)

As stated earlier in this chapter, the attitude questionnaire was intended to measure teachers' attitude towards different themes of a technology-rich constructivist learning environment. To achieve high accuracy of data collection, the questionnaire structure was divided into several sections and used a mixture of attitudinal scales. There were seven themes to be measured: (1) The advantages of the constructivist approach, (2) Teachers' attitude toward pupils' role, (3) Teachers attitude towards teachers' role, (4) Teachers' attitude towards cooperation and collaboration, (5) Teachers' attitude towards IT as content, (6) Teachers' attitude towards assessment and (7) Teachers' attitude towards IT goals.

Five and three-point, Likert-type scales were used to measure teachers' attitudes. According to Weng and Cheng (2000) Likert-type scales have been very popular as a means of measuring human attitudes. They were used in this study because, as Bryman and Cramer (1997) maintain, they are a popular approach to the creation of multiple-item measures because a number of items is more likely to capture the totality of a broad concept and allow finer distinctions between people's views to be drawn. For scales, the common 5-point response was used, in which respondents were asked to indicate their degree of agreement or disagreement with a practice and idea, on a scale from 1 to 5, where 1= strongly disagree, 2=disagree, 3=not sure, 4= agree and 5= strongly agree. The researcher adopted a 5-point scale because it is the most practical for most common purposes (Verma and Mallick, 1997, p. 119). It is easy to respond to, straightforward to analyse, and sufficient for most needs in the study. The issue of whether or not to have fewer or more points on the scale was considered at some length. For example, a balanced four point Likert scale without a mid-point, which forces participants to make a clear-cut decision either for or against attitudinal items, was considered. However, since the questionnaire of the study measures a new approach of teaching technology, the researcher was interested in those who would have a neutral or uncertain attitude, so further analysis could be carried out to trace attitude change. On the other hand, using a 7-point scale would involve a degree of sophistication which might be difficult and confusing for teachers, particularly as the content of the questionnaire concerned an approach newly introduced to teaching in Basic Education schools.

A three-point, rather than a five-point scale was chosen to measure teachers' attitudes towards IT goals for two reasons. First, since the constructivist approach and its associated goals are very new in Oman, it was not expected that teachers would have sufficient knowledge to evaluate them with the degree of sophistication required by a five-point scale. Secondly, again because technology and educational reforms have only recently been introduced, teachers might not be familiar with the educational goals associated with constructivist use of technology. Therefore, the researcher's aim was simply to see whether teachers were aware of them at all, in order to plan further training. It was not considered necessary, for this purpose, to distinguish the degree of importance attached to the goals.

5.4.1 Piloting the Questionnaire

The literature on research methods makes clear the importance of a pilot study; many writers have emphasized the importance of pilot testing of the questionnaire. Borg and Gall (1989) and Cohen and Manion (1994) state that the questionnaire should be pre-tested by individuals drawn from the same population as the intended sample before it is used in the study. Hoinville and Jowell (1978) make clear the need for such a test; they maintain, "The creation of a good questionnaire does not have to rely on the researcher's perspective. At some place in the design process the questionnaire should be subjected to a field study".

Piloting the questionnaire before it is presented to the population of study helps to improve the questionnaire items and avoid any ambiguity of these items. Borg and Gall (1989) stated that "every questionnaire must be tested and refined under real world conditions. Even after years of experience, no expert can write a perfect questionnaire". Therefore piloting of the questionnaire of the study was conducted to serve the following purposes:

1) To test how long it would take to complete;

2) To check that the questions were not ambiguous;

3) To check that the instructions were clear, and

4) To eliminate questions which did not yield usable data.

Before piloting the questionnaire, a letter from the Ministry of Higher Education was obtained stating the researcher's intention and the purpose of his study, as the regulation in the country requires a permission to be obtained to conduct research in any organizations. As stated in section 5.2, this letter was important to facilitate the researcher's access to the selected schools since these were female staffed schools (see Appendix 8).

For piloting the study, twenty three LRC teachers were selected from 9 of the 10 regions in the country. One region (the Wustah) was excluded because the teaching of IT skills was only introduced there in the academic year 2000-2001. To have a good sample for piloting the study, two teachers were selected from regions with a small number of Basic Education schools and three teachers were selected from the regions that have more Basic Education schools (those regions which had from 5-6 Basic Education schools).

The researcher took advantage of the presence of twenty three LRC teachers as they were coming for a five-day training course in Muscat (LRC teachers come commonly for in-service training in Muscat from time to time; the training had nothing to do with the training carried out for this study[12], or the themes of the study and was therefore not expected to prejudice the responses. It was simply a convenient opportunity for meeting teachers from a variety of regions.). The researcher obtained permission to see and sit with those teachers on one of these days.

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[12] The training for this study is discussed in detail in section 5.7.

On that day, before the questionnaire was distributed, the researcher explained the purpose of the study, asked the teachers to read the instructions of each section carefully and let the researcher know of any ambiguity in these instructions. Also a request to be very honest with their responses was made.

It took the respondents 35 minutes to complete the questionnaire. Towards the end, the researcher elicited from the teachers their comments on the questionnaire. The general impression was good and their comments were noted down.

Necessary corrections to the Arabic version of questionnaire were made based on their feedback. For example, in scale two, pupils' role, item 6, used to have three words describing the "expert" role of pupil ("teacher", "leader" and "expert"); teachers suggested to put as "a teacher" to clarify the intended meaning in the reader's mind. In scale five, IT as content, teachers recommended providing examples to illustrate the meanings of items 1 and 3, since these types of activities were only recently introduced. In scale six, teachers suggested clarifying what is meant by electronic portfolio by providing an example. An English version of the final questionnaire is provided in Appendix 2.

5.4.2 Validity of questionnaire

In using a questionnaire as a data collection tool for the first time or with a different population, it is important to check whether the questionnaire items meet the objectives of the study, that is to say, whether the items are measuring what they are supposed to measure. According to Bryman and Cramer (1997) the question of how far a measure measures the concept that it purports to measure, is called validity. The validity, which involves the face validity and content validity of the questionnaire is discussed below:

5.4.2.1 Face validity

To obtain face validity for the study, the questionnaire scales were reviewed by the IT consultant in the Ministry of Education. Further, once the Arabic final draft had been produced, one of the Basic Education schools was selected for a pilot study. A Basic Education school was chosen in order that the pilot sample would be as similar as possible to the sample for the main study. Thirteen subject teachers were selected and given the questionnaires to comment on the clarity of items. They were instructed to look for the clarity of the language, the clarity of the meaning and any questions of double meaning. They were also asked to add any comments or correct any items in order to improve the validity of the scales. After the teachers' feedback had been analysed, some items were changed accordingly, in the Arabic version.

5.4.2.2 Content validity

To obtain content validity, the researcher took the following measures:

1. The attitude questionnaire was piloted to find out whether its contents measured the objectives of the study. Copies of it were given to the researcher's supervisor, to the IT consultant in the Ministry of Education in Oman, and to two staff members in the IT department who are in charge of curriculum development.

2. The feedback from the above-mentioned professionals on the questionnaires led to deletion, rewording and addition of some items. For example, scale three, item 10 contains the translation of the word "scaffolding"; this term was found to be ambiguous, so the referees suggested a sentence describing such a role. In scale four, mixed group, means mixing in both gender and abilities (as suggested by the literature; see Chapter Three), but in Arabic there is no word that means implicitly, both gender and abilities. Therefore two items were suggested: one for gender and one for ability as can be seen in the final version of the questionnaire.

3. After amendment, based on the feedback of this piloting, the questionnaire was translated into Arabic by a professional translator in the IT department. The translation was double-checked to avoid any confusion caused by new terminology in the questionnaire items.

4. Because the questionnaire contained some terms that were difficult to understand and translate, as some of them have no equivalent in Arabic, it was a difficult task for the researcher to find the best words to describe these terms. An attempt was made to make them intelligible to an Arabic reader and then to be sure of this, one of the researcher's friends was asked to translate the questionnaire back from Arabic to English.

5.4.3 Reliability of the questionnaire

According to Litwin (1995, p. 6) reliability can be defined as "a statistical measure of how reproducible the survey instrument's data are." That is to say reliability is the degree to which an instrument measures the same way each time it is used under the same conditions with the same subjects. One of the procedures commonly used to determine measurement of reliability of questionnaire is Cronbach's alpha. Cronbach's Alpha measures the internal consistency and homogeneity of a group of items combined to form a single scale; Cronbach's Alpha ranges from 0.0 to 1.0, where 1.0 indicates perfect agreement. In this study Cronbach's Alpha was used to measure the reliability of the seven scales; that is to determine how well the items in each scale measure the same dimension.

A high alpha measure means that the inter-item correlation is high. This indicates that the items measure the same dimension. A low alpha gives an indication of no inter-item corrections for that dimension, i.e., the items are not measuring the same dimension. In the literature on research methodology, views on what is an acceptable score for coefficient alpha, varies from one author to another. Some authors maintain that a coefficient above 0.6 is acceptable in exploratory research; scale values over 0.7 are preferable, however (Bagozzi, 1994). Borg (1981, p. 218) argues that a range of item correlations of values from 0.35 to 0.65 shows a statically significant relationship between variables. Taking the above arguments into account, careful consideration was given to items with correlations less than 0.35 before deciding whether or not to retain them in the scale.

5.4.3.1 The advantages of the constructivist approach scale

In Table 5.1, the alpha coefficient for five items in the awareness of constructivist advantages scale was 0.92 and the item total correlation ranges from 0.72 to 0.92. The Alpha reading was close 1. This gives an indication of the strong correlation among the scale items.

Table 5.1: Alpha Reading for Advantages of Constructivist Approach after Alpha Deleted Items.

No	The items	Item total correlation	Alpha if item deleted
1	Which type of teaching method are you more comfortable to use?	0.93	0.88
2	From which type of methods do you think pupils learn more and gain more knowledge?	0.85	0.89
3	From which type of methods do you think pupils gain more IT skills?	0.72	0.94
4	Which type of methods would most pupils prefer?	0.75	0.91
5	Which type of methods do you think will motivate pupils to learn?	0.92	0.90
	N of Cases=23	N of items=5	Alpha=0.92

5.4.3.2 Teachers' attitude toward pupils' role scale

Table 5.2 depicts the alpha score for teachers' attitude towards the roles of pupils in the new approach. As shown in the table, the total item correlations raged from 0.32 to 0.75 and alpha is 0.82. Item 5 showed a low correlation, though if this item was deleted, there would not be much increase in alpha (alpha including item 5 was 0.83). Therefore, the researcher decided to keep the item because it measures an important aspect of the active role of pupils in group work (i.e. Individual Accountability; see Chapter Three).

Table 5.2: Alpha Reading of Teachers' Attitude toward Pupils' Role after Alpha Deleted Items

No	The items	Item total correlation	Alpha if item deleted
1	I believe students should be passive recipient of information transmitted to them from their teacher.	0.51	0.81
2	I believe students can be actively interacting in thinking about information.	0.75	0.78
3 3	I believe students should choose resources and sources of information when doing project/ activities assignment.	0.53	0.80
4	I believe each student should work alone (independently) in his/her group.	0.51	0.81
5	I believe when in group, students should rely on other members to do his/her part on their task.	0.32	0.83
6	I believe in their groups, students should take the role of the teacher transferring skills and information on certain topics.	0.50	0.81
7	I believe students should not be responsible for his/her learning process.	0.74	0.78
8	I believe students should analyze, evaluate, and synthesize information.	0.66	0.78
	N of Cases=23	N of items=8	Alpha=0.82

5.4.3.3 Teachers attitude towards teachers' role scale

It can be seen from Table 5.3 that item correlations ranged from 0.10 to 0.77. The correlation for item 1 was 0.10; if it were to be removed from the scale alpha would increase from 0.80 to 0.81. However the calculated alpha (0.80) was strong enough to carry out further analysis. Therefore the researcher decided to keep the item as an important aspect of the teacher's role in this approach (see for example, Means and Olsen, 1995a; Hannafin and Savenye, 1993).

Table 5.3: Alpha Reading for Teachers' Attitude towards Teachers' Role after Alpha Deleted Items

No	The items	Item total correlation	Alpha if item deleted
1	Provide students with guidance when they need it.	0.10	0.81
2	Provide students with resources and sources of information to do their tasks.	0.60	0.75
3	Facilitate the cooperation among students in their groups.	0.77	0.74
4	Walk around to check students' work.	0.53	0.77
5	Suggest resources inside and outside LRC for the students.	0.42	0.78
6	Observe students working with computer application and other technologies.	0.54	0.77
7	Discuss with students their choices of material.	0.66	0.75
8	Before students sit in their groups, I assign roles to each member and give a chance for everyone to take turn in IT lessons.	0.36	0.80
9	Give grades to individual group member based on the performance of the entire group.	0.40	0.81
10	Give clues and hints when students ask questions, but not direct answers.	0.61	0.75
	N of Cases=23	N of items=10	Alpha=0.80

5.4.3.4 Teachers' Attitude towards cooperative and collaborative learning scale

Table 5.4 shows that item 2 and item 4 had correlations below 0.35. If these items were deleted, alpha would improve from 0.83 to 0.84. However, the calculated alpha (0.83) was strong enough to carry out further analysis. The researcher decided to retain the two items because they are important aspects of a cooperative learning environment (according to, for example, Means and Olson (1995a); the teachers involved in the piloting might not have been aware of cooperative learning, since it had only recently been introduced in the Basic Education schools). Moreover, for item 2, in Oman, as a traditional Islamic society, it has been common in the past to segregate boys and girls. The recent introduction of mixed sex grouping in Basic Education Schools has been highly controversial, and is disliked even by many teachers in these schools. The researcher therefore, was interested to find out teachers' attitude towards this matter.

Table 5.4: Alpha Reading for Teachers' Attitude towards Cooperative Learning after Alpha Deleted Items.

No	The items	Item total correlation	Alpha if item deleted
1	In each group, members perform different tasks (e.g. some work on computer, others look for resource and write draft)	0.39	0.83
2	Each group should be composed of mixed gender (boy and girls)	0.20	0.84
3	Each group should be consisted of mixed abilities.	0.53	0.82
4	Group members should cooperative to accomplish joint tasks.	0.33	0.84
5	Group members should interact with each other in their group asking and questioning.	0.39	0.83
6	Group members perform different tasks towards one goal.	0.36	0.83
7	Group members should contact other group members to seek help.	0.43	0.83
8	Group member should present their work as group work not as an individual work	0.84	0.79
9	Group members should subdivide a complex task among themselves.	0.58	0.82
10	Group members share information among them.	0.61	0.82
11	Group members should help each other to achieve their goals.	0.64	0.81
12	Groups should see and evaluate each other projects.	0.53	0.82
13	Students will take more initiative to learn when they feel free to move around in the LRC during IT lessons.	0.51	0.83
	N of Cases=23	N of items=13	Alpha=0.83

5.4.3.5 Teachers' Attitude towards IT as Content

Table 5.5 represents the item scores. The item total correlations ranged from 0.23 to 0.74. The correlation for item 1 was 0.23, but since the alpha score was 0.77, this did not cause a problem in the scale; the reliability was still high enough for further analysis. However, if the item were to be deleted, the alpha would be 0.80. A decision was taken to keep the item on the assumption that this was a new technique of using technology, i.e., integrating technology into curriculum and teachers in the pilot study might not have been aware of it.

Table 5.5: Alpha Reading for Teachers' Attitude towards IT as Content after Alpha Deleted Items

No	The items	Item total correlation	Alpha if item deleted
1	IT activities should be integrated across subjects (should contain at least one subject).	0.23	0.80
2	IT activities should be related to students' real life (IT skills can be used outside the schools; contains information for their environment).	0.74	0.67
3	IT activities should involve the use of more that one type of technology applications.	0.46	0.75
4	IT activities should require the use of wide range of material available in LRC.	0.56	0.73
5	IT lessons should be related to students' personal interest.	0.68	0.68
6	IT activities contain skill and ideas transferred from previous activities (background knowledge).	0.45	0.75
	N of Cases=23	N of items=6	Alpha=0.77

5.4.3.6 Teachers' attitude towards assessment scale

As shown in Table 5.6, the alpha coefficient for the items in the assessment section was 0.67 and the item correlations ranged between -0.18 and 0.62. There was a problem in this scale caused by item 5. After deleting the item, the alpha score increased from 0.67 to 0.75 and the item correlations ranged between 0.42 and 0.61. The researcher decided to delete the item as it could be encompassed within subsequent items (6 to 8).

Table 5.6: Alpha Reading for Teachers' Attitude towards Assessment after Alpha Deleted Items

No	The items	Item total correlation	Alpha if item deleted
1	Multimedia presentation of their final work (i.e., PowerPoint, KidPix, and HyperStudio.	0.34	0.46
2	Written reports on their projects	0.62	0.73
3	Self-assessment	0.54	0.31
4	Electronic portfolio (collection of different types of files)	0.48	0.37
5	Standardized tests*	-0.18	0.75
6	True and false test items	0.62	0.55
7	Short-answer and multiple-choice tests	0.54	0.36
8	Extended answer items	0.51	0.35
	N of Cases=23	N of items=8	Alpha=0.75*

*Alpha after deleting item 5; the item was deleted from the questionnaire.

5.4.3.7 Teachers' attitude towards IT goals scale

It can be seen from Table 5.7 that the item correlations for the goals of IT use in LRCs ranged from 0.20 to 0.74 and the alpha score was 0.66. Although removing item 5 from the scale would increase the alpha score to 0.74, the researcher decided to keep the item for two reasons. First, the item is very important because one of the basic goals of education reform in Oman is to use technologies to support the learning of other subjects (see Chapter One); secondly an alpha score of 0.66 is an acceptable value for the coefficient of the scale.

Table 5.7: Alpha Reading for Teachers' Attitude towards IT Goals after Alpha Deleted Items.

No	The items	Item total correlation	Alpha if item deleted
1	To prepare students for future jobs.	0.49	0.59
2	To promote active learning strategies.	0.49	0.59
3	To improve students' achievement scores.	0.38	0.61
4	To deepen students' understanding.	0.74	0.39
5	To support instructional reform.	0.20	0.74
	N of Cases=23	N of items=5	Alpha=0.66

5.4.4 Questionnaire sample for the main study

LRC teachers were selected from different teaching experiences and fields. Their duties are to operate the Learning Resource Centres and to teach IT lessons. The population of this study was those teachers. Two hundred LRC teachers out of 250, almost all the population, were selected to participate in the study. The remaining teachers were excluded. They included LRC teachers who had participated in the pilot study and teachers who had not completed their preparation courses to be LRC teachers (see Table 5.8). The study census contained 187 female teachers and 13 male teachers. The predominantly, female composition of the sample is representative of staffing in Basic Education schools. In grades 1 to 4, the grades covered by the first phase of the reforms and, hence, by this study, it is government policy to employ female teachers. There are a very few male teachers, but these are in non-typical schools, such as those in particularly remote desert areas, which may differ from other Basic Education schools in other characteristics as well as the gender of teachers. Thus, there is no reason to consider that the inclusion of more male teachers would make the sample more representative. Indeed, they would perhaps make it less so.

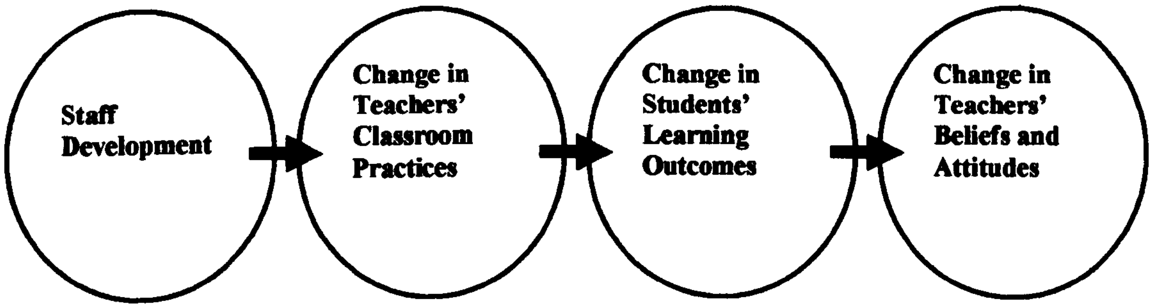
Table 5.8: Sample of the Study

Regions	No. of teachers	Regions	No. of teachers
1- Muscat Region	26	6-Dahirah North	23
2-Batinah South Region	22	7-Dahirah South	25
3-Sharkia North	20	8- Dhakliah	24
4-Sharkia South	28	9- Masndam	4
5-Wustah	4	10- Dhofar	24
Total			200
No of schools			100

5.4.5 Questionnaire distribution

It should be noted that the questionnaire was administered twice, before and after training. The purpose behind this was to document the use of technologies in LRCs and to measure teachers' change in attitude towards the new approach. Guskey (1986, p. 7) maintains that teachers' attitude and beliefs on any form of instruction should be measured as significant to student outcomes. He further argues that teachers see the effectiveness of an innovation as a result of students attaining higher involvement, motivation, contribution and achievement. Taking this into consideration, to measure teachers' attitude to the innovation effectively, it was important that the attitude questionnaire should be given to the teachers both before and after implementation (see Figure 5.1).

Figure 5.1 Guskey's Recommendation for Attitude Questionnaire Administration



Source: Guskey (1986, p. 7)

The first administration of the survey questionnaire started on 15th August 2001. As stated earlier, the study covers 10 administrative regions in Oman including the Wusta region, which is a remote area. It was very difficult for the researcher to distribute copies of the questionnaire to each individual teacher in person because of the geographic distance among those regions. Therefore, for distant regions, either the head of the LRC section or the LRC technician volunteered to help the researcher in distributing and collecting the questionnaire. The questionnaire was sent to some of them by e-mail; then it was printed and distributed to the participants. For neighbouring regions, the researcher distributed the questionnaire. The researcher maintained regular contact with the heads of LRC section and the LRC technicians and made sure that teachers filled in the questionnaire before attending training.

The questionnaire was redistributed towards the end of semester one, mid December of the same year, namely after teachers had experienced the new approach of teaching in a technology-rich environment.

5.4.6 Analysis of questionnaire data

The Statistical Package for the Social Sciences (SPSS) was used to analyse the data from the questionnaires. After data were entered, the researcher double checked data entry then ran frequency screening from the data to make sure that there were no missing cases. Data obtained from the questionnaires were presented in two types: descriptive statistics and inferential statistics.

Before data analysis, the researcher had to decide whether parametric tests or non-parametric tests were most suitable to be used (Bryman and Cramer, 1997). According to Bryman and Cramer (1997), parametric tests are based on measures which describe the distribution of the population, such as the mean and variance. Parametric tests are more powerful tools in statistical analysis (Kinnear and Gray, 1999) because they not only derive from standardized scores but enable researchers to compare a sub-population with the whole population (Cohen, Manion, Morrison and Morrison, 2000). They are also widely used in research. However, one problem with such tests is the assumption that the population from which the data are obtained should be normally distributed, although Bryman and Cramer (1997) argue that approximation to normality is sufficient for such tests. Furthermore, parametric tests are designed to be used with interval or ratio data.

On the other hand, non-parametric tests do not require interval data or a normal distribution of the population. Siegel and Castellan (1988, p. 35) note that some of the characteristics of non-parametric tests are that (1) they make fewer assumptions about the data and may be more relevant to a particular situation; (2) they are suitable for analysing data that are inherently in ranks as well as data whose scores seemingly have the strength of ranks; (3) they are appropriately applied to data measured on an ordinal scale and others to data in a nominal or categorical scale; (4) they are much easier to learn and to apply than the parametric tests and their interpretation is often more direct.

In view of the types of data yielded by the questionnaire, namely, nominal, ordinal and interval data (constructed composite variables in Chapter Six, section 6.4), and taking into consideration the recommendations of Bryman and Cramer (1997) on the appropriateness of parametric and non-parametric tests for categorical data (nominal and ordinal) and interval data, the researcher decided to use parametric statistical tests for data analysis. A non-parametric test (the Kruskal-Wallis test) was used in cases where both the sample sizes and the variances were unequal in order to see whether they yielded significantly different result from their parametric counterparts (as recommended Bryman and Cramer, 1997).

The following discussion sheds light on different types of tests used in this study and the researcher's rationale for selecting these tests.

- **The t-test**

This test is used to determine if the means of two groups differ statistically. An independent sample t test was used in this study to investigate differences in the means of urban and rural variables, and a paired sample t test was used to compare the means of the seven scales in the questionnaire before and after training.

- **One-way analysis of variance (ANOVA)**

ANOVA is an appropriate statistical technique to compare the means of three or more groups. In this study, ANOVA was used to compare the difference in mean scores on the attitude scales, between groups classified according to the independent variables (teachers' years of teaching experience and previous training courses).

Furthermore, the Bonferroni test, a multiple comparison test, was used to determine which means within each group were significantly different from the others. According to Norusis (1993) there are many multiple comparison tests available, of which the Bonferroni test is the simplest. It adjusts the observed significance level based on the number of comparisons.

- **Multiple analysis of variance (MANOVA)**

Multivariate analysis of variance (MANOVA) is simply an ANOVA with several dependent variables. According to Kerr Hall and Kozub (2002), the purpose of using MANOVA is to test for group differences when there are two or more independent variables. In this study, in addition to ANOVA, MANOVA was used to determine the main effect of independent variables (e.g., years of teaching experience and residence areas) on teachers' attitude towards the constructivist approach. There are many tests to report the overall result for multivariate analysis of variance, such as Pillai's Trace, Wilks' Lambda and Hotelling's Trace. According to Brace, Kemp and Snelgar (2000) any of these tests yield the same result and a researcher can use any of them to report the result; therefore Wilks' Lambda test was used to report the overall results.

5.5 Observation

Whereas the above-mentioned instruments of data collection focus on gathering primarily verbally articulated responses, the observation technique collects also non-verbal behaviours such as interaction. It can enrich and supplement data gathered by other techniques and can be a means to match and mismatch data provided by other tools.

Observation combines well with the questionnaire survey and semi-structured interview, to overcome any limitation of either method. Questionnaire and interviews are about perception; observation, on the other hand, shows actual practice, so it can ratify or refute perceptions stated in questionnaires or interviews. For example, if a teacher said shortage of equipment was a barrier, by observation, it would be possible to see what equipment was available and how shortage of equipment affects the class (e.g., sharing, having to wait for a turn). In addition, in this study observation was employed to collect supplementary data for use in interpreting or qualifying findings obtained by other methods (Nachmias and Nachmias, 1996).

Simpson and Tuson (1995, p. 17) maintain that observation can enrich and supplement data gathered by other techniques and can be a means to match and mismatch data provided by other tools:

> Any tool for data-gathering provides only one picture of the social world, and matches and mismatches between data gathered by different techniques help to enrich understanding of what is going on.

There are several observation strategies available. Cohen et al. (2000) identify four types of teacher's role according to the degree of participating and observing in field research: complete participant, participant as observer, observer as participant and complete observer. With a complete participant, the researcher engages fully in the activities of the setting under investigation, but his or her intention is not made explicit to the target participants. In the case of participant as observer, the researcher engages in limited interaction, intervening only when further clarification of actions is needed. S/he adopts an overt role and makes her/his presence and intention known to the group. Another role for the researcher is to maintain a passive presence, being as unobtrusive as possible and not interacting with participants. This is the observer as participant. The end of the spectrum is complete observer, in which the researcher watches from outside, without being noticed and participants do not realize that they are being observed. According to Schatzman and Strauss (1973) each of these types has specific advantages, disadvantages and concerns which must be carefully examined by the researcher. For example, where the researcher is a complete participant, there is a major ethical dilemma associated with whether or not it is legitimate to deceive people about who s/he actually is, and to hide from them, the fact that s/he is studying them. Complete observer, as the name suggests, might miss the depth of what is taking place in the setting. The drawbacks of the complete participant role and the complete observer role mean that researchers should think about taking a role somewhere in between, i.e. as the participant as observer, or the observer as participant, with subtle distinctions between. However, the presence of an observer, as a participant observer, is likely to introduce a distortion of the natural scene; therefore, this might influence the validity of data obtained from observation.

In this study, the researcher chose to be as a participant observer for the following reasons mentioned by Patton (1990, p. 203):

- By directly observing programmes, operations and activities the participant observer is better able to understand the context within which the programme operates. Understanding the programme context is essential to an holistic perspective;
- Firsthand experience with a programme allows a participant observer to be open, discovery oriented, and inductive in approach;
- A strength of observational fieldwork is that the participant observer has the opportunity to see things that may routinely escape conscious awareness among participants and staff;
- The participant observer can also discover things no one has ever really paid attention to;
- The participant observer can learn things about which programme participants or staff may be unwilling to discuss in an interview (Patton, 1990, p. 203-205).

In addition, the researcher felt that teachers needed support during the implementation of the new approach. Therefore, the research involved close, detailed and intensive work of the researcher as a participant in the situation under investigation. This involvement included: (1) solving some technical problems which occurred during the implementation, (2) helping teachers to manage classroom control, and (3) suggesting some trouble shooting ideas for the teachers.

5.5.1 Recording Observational Data

One of the issues to be considered in conducting the observation was whether or not to videotape the classes in question. Videotaping allows repeated and more extensive data examination. According to Mehan's (1979, p. 19) approach to field data collection, interaction is central to social structure. The researcher analyses data that is retrievable, in the form of videotape or films. Observation can be repeated even frame by frame, if necessary. Audio portions may be transcribed, and even nonverbal activity is amenable to analysis from video portions (ibid). Data recorded in this way is also comprehensive. Thus, it helps avoid the tendency of researchers to look only for evidence confirming prior hypotheses or assumptions, and provides additional data about the scene that might result in more information which was not anticipated in setting the objectives of observation. For example, the observer can discover things that have not ever really been paid attention to. The researcher decided to videotape the observation to gain the benefits discussed previously, and for the purpose of carrying valid and further analysis (as will be discussed in sections 5.6.3 and 5.6.4), as, it would be more convenient for the researcher and the evaluators (teachers) to view and analyse the observations after a period of time. In this case teachers' permission was essential allowing videotaping; therefore, the researcher requested teachers' permission by asking teachers to sign a written form, prepared for such purpose (see Appendix 12).

5.5.2 Piloting for the Observation

Using a video camera/camcorder for research data collection is an art. It reflects the values and personal attributes of the researchers. The first aspect to be considered when using video camera is familiarity with video camera functions. To get the full potential of using the video camera is very important in collecting observational data. The second aspect to be taken into consideration is the place where events are to be videotaped, i.e., "mapping". Collier and Collier (1986, p. 29) encourage mapping and surveying the area surrounding the research site during the initial stage of video research, and making a cultural inventory of the site.

For videotaping the sample for the study, a decision was made to use a programmed sampling, which is defined by Sorenson and Jablonko (1975) as a predetermined plan for videotaping – a plan that is either simple or complex. In March, 2001, eight LRCs teachers (4 schools) were selected for piloting the video recording. The researcher spent a week in each school observing and videotaping some IT lessons and taking note of the problems occurring during these lessons

During videotaping, many things can be learnt about this technique. According to Jackson (1987, p. 108) everyone who does research with a video camera or camcorder can learn from their mistakes. What is important is what type of mistakes are so crucial as to cause data distortion. The following are some of the problems which the researcher met during videotaping:

One of the problems was that the presence of the camcorder attracted students' attention. In some LRCs, students popped in front of the camera from time to time, showing their faces. Some teachers, unintentionally, blocked the scene while they were helping the groups during the lessons.

Using the video camera alone for gathering data is inadequate and risky. As a supplementary technique for collecting observation data, the researcher needs to take notes about the events. That is so because of the risk of losing all data if the tapes malfunction. Further, the researcher found that note taking of the events was very important to fill in contextual detail that the camcorder missed. While videotaping, it was very difficult for the researcher to take notes because he had to stand beside the camcorder; the researcher could not manage to take notes on important activities that might be missed and could not be recalled.

To overcome some of the problems encountered in the pilot study that might lead to missing some activities, the researcher came up with the following actions or solutions.

Before beginning videotaping, students should be instructed not to come or stand in front of the camera. Also teachers' attention should be drawn to the presence of the camera while they are helping groups.

To avoid missing any important activity during lessons, the camcorder should be placed in a stationary position, leaving the researcher's hands free for taking notes. However, this would prevent use of the panning technique, moving the camera from side to side to follow a specific event or activity. Attention was given to obtaining enough tapes for each observation.

5.5.3 Observation samples

In selecting the observation sample (the same sample as for the interviews), the issues of ethics and the willingness or unwillingness of participants to provide data were taken into consideration. Therefore, it was left open for LRC teachers to participate in such events. The participants were asked whether they wished to be observed and interviewed.

The researcher received responses from 35 schools (70 female teachers) inviting him to conduct observations and interviews in their schools. From this number, the researcher selected 40 teachers based on area of residence and years of teaching experience strata: (1) urban experienced, (2) rural experienced, (3) urban inexperienced and (4) rural inexperienced (see Table 5.9). The sample of teachers involved in observation and interviews represents 25% of the study population.

Table 5.9: Composition of Observation Sample

Categories	Observation and Interview Sample*	Total female population in the study
Urban experienced	10	47
Rural experienced	7	32
Urban inexperienced	10	44
Rural inexperienced	13	64
Total	40	187

* The sample of each category was almost 21% of the female population

The division into urban and rural groups was based on teachers' answers to the questionnaire. The division into teaching experience categories was also based on the questionnaire data. Teachers had been asked about their years of teaching experience, divided into four groups (see Appendix 2). In classifying the interview sample, categories 0-5 and 6-10 years of teaching experience were combined into one group, labelled inexperienced teachers. Categories 11-15 and 16-20 years were combined into one group, labelled experienced teachers. The reason combining teaching experience categories was to reduce the number of sub-groups in the stratification: if four teaching experience categories had been used, as well as the urban-rural distinction, there would have been eight subgroups, and it is possible that not all of these groups would have been represented.

5.5.4 Collecting observation data

Taking the above points into consideration, the researcher spent some time to get acquainted with the camcorder prior to the observation. Also he visited each LRC prior to observation to survey the setting and to make a decision on the best place to mount the camera.

Video taping of 38 LRC teachers in 18 Basic Education schools implementing a project-based approach resulted in more than 60 2-hour videotapes of teaching and learning activities. Two teachers (female teachers) refused to be videotaped, due to traditions in the region where these schools are located, and the researcher respected their right to object. The videotaping during implementation of activities took place during two phases: during the research phase, in which students were searching for information from and using different technologies, and during their data entry stage, when students started to use technologies applications such as scanner, sound and video recording, word-processing and multimedia software.

Henerson, et al. (1987) identified three procedures for collecting behavioural data in the classroom setting: the highly structured procedure, the semi structured procedure and the unstructured procedure.

In the highly structured procedure, an observation instrument is constructed for tallying the frequency of the target behaviours, described in this instrument. Possible instruments include on-the-spot checklists, coded behaviours records and delayed reported instruments.

On-the spot checklists can be used to record the presence, absence, or frequency of a few behaviours as they are observed. Unlike checklists, coded behaviour records enable the observer to record in sequence quite a few behaviours as they occur within a given period of time. However, gathering data through the coded behaviour record involves a lengthy and complicated procedure. That is, observers must be trained in the use of the code symbols; and once the information is gathered, the symbols must be decoded and interpreted. This might lead to the potential of missing critical events while recording. Delayed report instruments are the most commonly used classroom observation tools. They are different from the previous ones in that they are filled in immediately after the observation period and are less subjective (Henerson et al., 1987).

The semi structured procedure involves preparation of an observational guideline for what is to be observed and details of further behaviours that occur are collected during the observation by the observer. The unstructured procedure involves an expert observer who carries out the observation and provides details of desired behaviours in the classroom settings. This requires a trained observer who can provide a substantial and descriptive details of the observation (in which the researcher was not skilled for this purpose).

The observation data collection in this research was based on the highly structured procedure because according to Henerson, et al. (1987) it yields quantitative data which can be used to support other quantitative data, as is the case in this study. Also it is less time consuming and involves less subjective judgment than the other two procedures (ibid: p.117). Moreover, the instruments used in the study to report the observation was delayed report instruments because they are easier to use by inexpert observers (which was the case for both the researcher and evaluators), they are commonly used classroom observation tools, and provide useful numerical data (Cohen et al., 2000; Henerson et al., 1987). This means of judging the occurrence of behaviours involves making a high degree of inference by the evaluator, rather than simply reporting the observation. This, in return, might lead to low reliability of observation as a result of rating error tendencies[13] and halo effect[14]. The researcher was aware of this problem; therefore, to overcome the problem of unreliability of observation, the researcher carried out the following procedures: firstly, train teachers on how use the observation forms; this included familiarising the teachers with the form, involving them in a trial rating session and providing them with descriptions of the rating guide on the observation forms (see Appendix 4 and 5).

The researcher randomly selected some videotapes and viewed them several times. In the case of the classes where teachers refused to be taped, he re-read the notes made during the observations. Before carrying out any further analysis, he developed categories for coding based on what emerged from the data (videotapes and notes).

The researcher developed three categories including: (1) description of teacher's behaviours while working in a constructivist learning environment (teacher's role), (2) students' behaviours, including cooperation (pupils' role), types of technologies and media used, and (3) disruptive behaviours. These categories were cross-referenced with some of the questionnaire and interview themes. The first two categories could be used to ratify teachers' beliefs. Based on these categories, two observation sheets were developed to evaluate the events of the videotapes, as suggested by Collier and Collier (1986, p. 177), Henerson, et al. (1987) and Swan and Mitrani (1993). (see Appendix 4 and Appendix 5.)

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[13] The tendency of evaluator using only a limited number of option on a rating scale: giving every item a very high rating (the generosity error), giving a very low rating (the severity error), or giving an average rating (the central tendency error).

[14] This means the influence of an observer's general impression of a person on his/her ratings of all the items or questions pertaining to that person's behaviour. (Borg, and Gall, 1989).

5.5.5 Reliability and validity of observation

There are issues involved in relation to the reliability of classroom observation: first, the issue of whether or not an independent researcher could achieve consistent results if working in the same or a similar context and secondly, the issue of the consistency of the procedure of data collection, analysis and interpretation (Curtis and Cheng, 1998).

According to Curtis and Cheng (1998) the researcher can enhance the reliability of the data collection and analysis by employing two approaches: cross checking with existing data and inviting inter-coders. The former involves going back to the video-taped lessons and coding again previously analysed lessons, while the latter involves asking other peer researchers or teacher participants in the study to code data (Collier and Collier, 1986).

Taking the above points into consideration, a team of teachers was formed to analyse the observation tapes. The team consisted of 8 teachers working in pairs. Collier and Collier (1986) maintain that using teams of evaluators to analyse visual data produce a higher level of analysis than one person. Further, they suggest team analysis is taken further when individuals participate in analysis of records of their own activities. Since video analysis is time consuming (Collier and Collier, 1986), sample lessons, as stated earlier, were randomly selected. An average of three lessons for each teacher were selected. This means 120 minutes of recording. The total recording hours and their distribution over the pairs are shown in Table 5.10.

Validity is concerned with the extent to which the observational apparatus and inferences drawn from it will be meaningful, significant, and applicable to further studies. An essential element in achieving validity is reliability — consistency, in which others agree on the categories and description and the frequencies attributed to them (Curtis and

Cheng, 1998). This was assured by the inter-coder method as discussed above. Additionally, content validity was assured by basing the coding procedure on a systematic review of the literature, as indicated in the introductory paragraphs of this section.

Table 5.10: Distribution of the Videotapes over the Evaluators

Group	Recording Hours
Pair 1	4 schools (approx 15 hrs)
Pair 2	4 schools (approx 15 hrs)
Pair 3	4 schools (approx 15 hrs)
Pair 4	4 schools (approx 15 hrs)

5.5.6 Analysis of observation data

To make such analysis possible and fast, the selected videotapes were digitized and burned on CD ROMs as Realplayer files (*.rm), so that they could be viewed using PCs in the Learning Resource Centers. The same idea was adopted by Seaman and Williams (1992) who recommend the use of hypermedia systems, which means transferring videotapes to laserdiscs.

Teachers were divided into 4 pairs to view the recording and the teachers were asked, as recommended by Cohen, et al. (2000, p. 309), to enter a rating according to a four point scale of observed behaviour (of teacher and the students): 1=not at all or very little, 2=a little, 3= a moderate amount, and 4=a lot (Henerson et al., 1987; Simpson and Tuson, 1995). Beside that, they also were asked to record the types of technologies being used.

The evaluators met for a week (5 days). Each analytical session lasted from 8 am to 1 pm, a total of four hours work in each day. However, it is worth mentioning that the purpose of this analysis was to trace teachers' and students' behaviours; it was not to provide a microanalysis of these videotapes.

Using Realplayer Basic software which has features such as forward, backward, stop, they were asked to watch these videos as many times they needed, tracing actions and interactions.

Data from the observation sheets were entered into SPSS software to calculate the frequency of most and least observed behaviours. The means and the standard deviations were found for each item observed, so the results could be cross-referenced with other results.

5.6 Semi structured interview

An earlier section described the questionnaire, which was one of the tools for collecting data in the study. Since a questionnaire survey lacks flexibility, because the number of questions and wording of the questions are the same for all respondents and moreover, response rates for posted questionnaires can be very low, it was important to find other tools to supplement the questionnaire (Henerson et al., 1987). More flexibility can be found through interviews. Bell (1987, p. 70) maintains:

> A skilful interviewer can follow up ideas, probe responses and investigate motives and feelings...The way in which a response is made (the tone of voice, facial expression, hesitation etc.) can provide information that a written response would conceal. Questionnaire responses have to be taken at face value, but a response in an interview can be developed and clarified.

However, in general, interviews are not without problems. Two major problems can be identified with interviews: (1) they are very time consuming; (2) there is the issue of the influence of the interviewer over the respondents (Henerson et al, 1987). The first was addressed in this study through the decision regarding the types of interview, discussed below. The second was addressed through care in the conduct of the interviews. Moreover, the fact that the interviews were one of the three complementary data sources would help to overcome bias.

Patton (1990) suggests three basic approaches that can be used to conduct qualitative interviews: 1) informal, unstructured interviews; 2) semi-structured interviews; and 3) standardized, structured interviews.

For this study, a structured interview would not be adequate because the answers to the questions would be confined to certain responses, which would not be enough to achieve a holistic understanding of the interviewee's point of view. The unstructured interview, on the other hand, although it may yield to substantial data, demands time and effort to analyse and interpret, i.e., it is laborious. In addition, there is the possibility that when using such a type of interview, the informants may sometimes forget that they are being interviewed and they digress from the purpose of the interview. It can then be a challenge for the interviewer to turn the discussion and maintain the focus of the interview. The researcher did not feel sufficiently skilled in the necessary techniques for this style of interview. The choice was therefore narrowed down to the semi-structured form of interview.

5.6.1 Piloting the interview

The researcher developed an interview guide in advance containing a list of topics which were not covered by the questionnaires or needed more elaboration to support the evidence. These questions were developed to elicit teachers' opinions and attitudes on the experience with the constructivist learning approach that the researcher wanted to explore; they cross-reference to some questionnaire themes (based on the literature and discussed in section 5.3). The interview guide was developed to ensure good use of limited interview time, to make the interviewing of multiple subjects more systematic and comprehensive and help to keep interactions focused (Hoepfl, 1997). The guide contained five main questions.

Before piloting the interview questions, they were given to an IT consultant, in the Ministry of Education to examine whether the questions met the objectives of the study and to check the wording before translating them into Arabic. As result, some of these questions were reworded. After the revision, the questions were translated into Arabic, by a professional bilingual translator in the Ministry of Education.

The researcher selected five teachers, from those who participated in the piloting of the questionnaire, to carry out the piloting of the interview. The researcher requested their permission to tape-record the interviews for further analysis to establish how the data should be quantified and the sorts of problems that might emerge during interviews (Borg and Gall, 1989). The main purpose of this piloting was for the researcher to gain experience regarding how to conduct the interviews.

The piloting served to provide an estimate the length of each interview, the clarity of the questions in the guide, and helped to avoid redundant questions and generate follow-up questions. After reviewing the interviews, the researcher found that some questions could be deleted from the interview guide because they could be encompassed by other questions. For example, in the guide there were two questions:

Which aspect/s of this method do you find most interesting?

Which aspect/s of this method do you find least interesting?

These questions could possibility replaced by the following question:

What are its advantages and its disadvantages? (see Appendix 3).

The final questions for the interviews are presented in Appendix 3.

5.6.2 Conducting interviews

In the case of teachers located at great distances from the researcher's base, interviews were conducted immediately after observation, in order to avoid the time and expense of additional visits. For teachers located nearby, however, appointments were made for return visits, in order to conduct the interviews starting towards the end of the semester (starting on 15th December, 2001; as stated earlier the interviewees were the LRC observed teachers).

Interviews were kept very flexible; the respondents were encouraged to talk about the topic raised by the researcher from their perspective. The role of the researcher in semi-structured interviews was as a mediator to direct and control the interview. The researcher probed for more information, by asking follow-up questions when he felt that at a particular point during the course of the interview there was a gap in information which needed to be filled. All interviewees were seen as individuals, except in one LRC where the researcher had to interview two teachers together, due to travelling arrangements. Moreover, since the interviewees were female teachers, the researcher was very sensitive to self-monitor his comments, actions and gestures, in an effort to establish a common rapport with them. Each interview lasted from 20 to 30 minutes.

One of the issues to be considered in conducting the interviews was whether or not to record these interviews. In the research literature there is a dispute over the use of a tape recorder to record interviews. Some researchers, e.g., Patton (1990, p. 348), say that a tape recorder is "indispensable", whereas others do not recommend it. For example, Lincoln and Guba (1985, p. 241) do not recommend recording except for unusual reasons.

Lincoln and Guba ground their point of view on the obtrusiveness of recording devices and the possibility of technical failure. Recordings, however, have the advantage of capturing data more faithfully than hurriedly written notes might, and can make it easier for the researcher to focus on the interview (Hoepfl, 1997, p. 4). In addition, they can be frequently replayed for further analysis. Audio-taping of interviews might be helpful in tracing the themes of this study.

Taking these points into consideration, provided teachers gave their permission, the researcher decided to record the interview sessions and not to write down respondents' responses, in order to keep a coherent discussion flowing and maintain eye contact with them, and in order to carry out further analysis. All interviewees agreed to be recorded.

However, the researcher experienced some problems in tape-recording teachers. On two occasions, tapes were distorted and malfunctioned; the effort of recording went in vain. The respondents concerned, therefore, had to be re-interviewed. For further use of a tape-recorder in interviews, it is very important to check the clarity of the recording before leaving the venue.

5.6.3 Analysis of interviews data

Bogdan and Biklen (1992, p. 153) point out that, "data analysis is the process of systematically searching through and arranging the interview transcripts, field notes, and other materials accumulated, thus increasing the researcher's use of them." This sets the stage for analysis. They continue, "Analysis involves working with data, organizing them, breaking them into manageable units, synthesizing them, searching for patterns, discovering what is important and what can be learned and deciding what you will tell others."

Having transcribed and familiarised himself with the data for each interview, the researcher transferred it onto a wordprocessor document, creating a file for each interview question. The researcher spent time reading and rereading the interviews –

sometimes along with the tape, in order to identify themes and issues, highlighting and colour-coding them. All seven themes used in the questionnaire emerged in the interviews also. In addition, to identify these, the researcher classified them into statements positive and negative towards the project-based, constructivist approach, and quantified each category in order to have a clear idea of the balance of opinion in relation to each theme.

In addition to the anticipated themes, namely, those corresponding to the questionnaire themes, the researcher scanned the interview files in order to identify more themes. A number of additional themes were identified. These were concerns that teachers raised as to barriers impeding implementation of the new approach. Those, too, were colour-coded and quantified.

A summary was then written for each theme. The researcher was able to identify eleven themes: seven themes concerning teachers' beliefs about constructivist learning environments and four themes concerning barriers of implementing the new approach, as shown Table 5.11 (These categories will be discussed in Chapter Seven).

Table 5.11: Interview Categories

No.	Category One: Teachers' belief and experience	No.	Category Two: Barriers
1	The benefits of the new approach	1	Training & Technical support
2	Active pupils' role	2	Time of the projects
3	Teachers as facilitator	3	Students' behaviours
4	Collaboration	4	Lack of equipments
5	IT as Content		
6	Constructivist assessment		
7	IT use		

Carrying out the content analysis in this way had a number of disadvantages. It was very time consuming and there was a risk that important information might be lost or missed during the analysis. Moreover, there would inevitably be an element of subjectivity in interpreting teacher' comments, since the researcher was looking not only at the manifest content (the use of pre-identified key words and expressions) but also at the implied content (statements that were related to a particular theme, even if expressed in words other than the selected keywords).

These problems could have been overcome, at least in part, by using a software program specifically designed for content analysis, such as CAQDAS (Computer Assisted Qualitative Data Analysis Software) and NUDIST. However, this was not possible. First of all, there is not an Arabic version. Consideration was given to translating teachers' comments into English in order to use the English-language software (although the translation of all the interview transcripts, rather than just the illustrative comments selected for presentation in the thesis, would itself have been a laborious task). However, the researcher could not gain access to the relevant software, which is very expensive and not available in the university where the analysis was carried out. After careful consideration of all of these issues it was therefore decided to transcribe the interviews with a wordprocessor in Arabic rather than use the content analysis software described above.

5.7 Training Learning Resource Centre Teachers

LRC teachers who participated in the study were exposed to training sessions before their implementation of the new approach. The training was based on the five considerations recommended by Joyce and Showers (1988, as cited in Dalin, 1998, p. 168):

- Presentation of theory and description of new skills.
- Demonstration of skills, or 'model' teaching.
- Practice in simulated and classroom situations.

- Structured and open feedback situations (in which both candidate and trainer can discuss the level of skill).
- Assistance in implementation - preferably through a two-teacher system in the classroom.

5.7.1 The purpose of training

Since it was considered important to train teachers in how to implement the new approach, LRC teachers were introduced to the theoretical background of constructivist theory and cooperative learning, the project-based approach, their new expected roles and students' roles and some IT skills such as scanning, and audio and video capture skills. Teachers needed these skills in order to be able to make full use of the equipment provided in the LRCs and to show students how to make use of these resources.

5.7.2 How the training was conducted

The way in which training was introduced reflected the way teachers would introduce project-based learning (Blumenfeld et al., 1991). The attempt was made to create a training setting reflecting an actual classroom setting so the effects of the training could be maximized and teachers could be allowed hands-on experience:

> Frequently, in-service training entails a single workshop or course for a group of teachers, with the assumption that "one-shot training" is all teachers need to apply their newly acquired skills, content, or techniques in the classrooms. Yet research has suggested that teachers learn best, not from one-shot lectures by experts, but by seeing methods used in actual classrooms, by trying out new techniques and getting feedback on their efforts, and by observing and talking with fellow teachers (U.S. Office of Technology Assessment, 1995, p. 80).

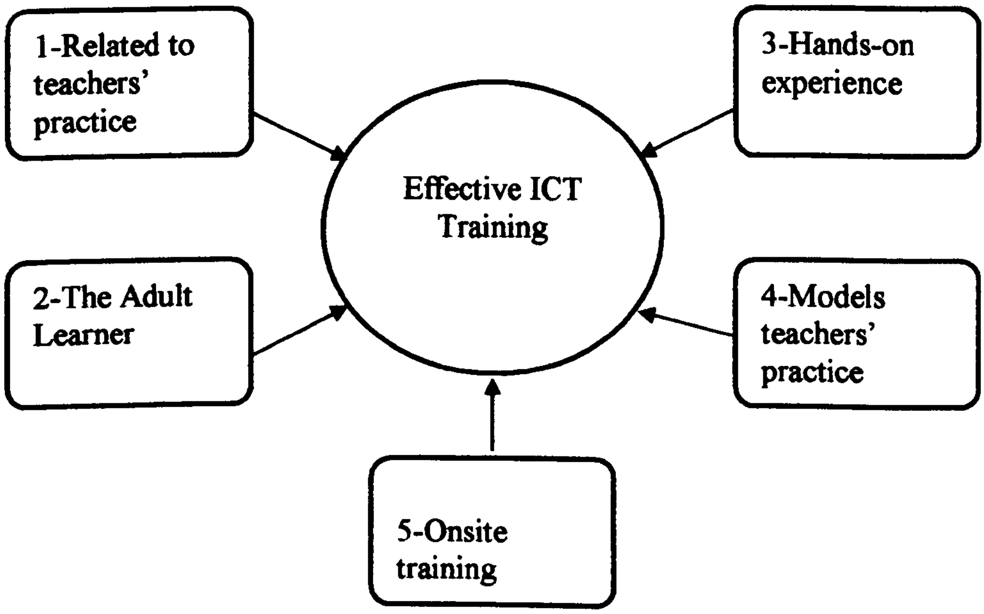
Putnam and Borko (1997, cited in Swan et al., 2000, p. 2) listed three essential features of effective training:

- Teachers should be treated as active learners who construct their own understanding.
- Teachers should be empowered and treated as professionals.
- Teacher education should be situated in classroom practice.

The Panel on Educational Technology (1997) recommended that teacher educators should treat teachers as they expect teachers to treat students; it only makes sense to model best technology integration practices when attempting to get teachers to use them. Swan, et al. (2000) maintain that trainers should encourage inquiry-based, student-centred, constructivist uses of computing technologies, but they do not insist on them. These considerations were kept in mind when the training of the teachers took place.

Therefore, the following model and description depict the above concerns for effective teacher training.

Figure 5.2: Elements of Effective Training Model



1- Training should be related to teachers' practice. What teachers learn during training sessions should reflect what they need in their practice. According to the U.S. Congress, Office of Technology and Assessment (1995), much of today's educational technology training seems to focus on the mechanics of operating new equipment, whereas little attention is given to how to integrate technology into specific subjects, how to select and use software and how to organize classes.

2- Adult learner training. Adult learners bring attitudes, expectations, life experiences and goals relating to what they will get from professional development training.

3- In-service training should also include hands-on experience. Teachers need to practise and be familiar with technologies before introducing them to students. McKenzie (2001) and Ropp (1999) maintain that the professional development must provide hands-on experience for teachers.

4- Training should model teachers' practice. Teachers should be trained in the way that they expect to teach. For example, Backer and Saltmarch (1999) and Murray (1995) maintain that teachers using inquiry based learning should practise such learning themselves before implementation.

5- On-site training: Onsite training is also important, where teachers can practise dealing, for example, with hardware and software (Swan et al., 2000; U.S. Office of Technology Assessment, 1995)

The training was divided into three major sections: section one was delineated to introduce the theory of constructivism; section two was an introduction to cooperative and collaborative learning and section three was to give participants some IT skills which were needed during their teaching.

The training on the theoretical part (the first two sessions) was started by dividing teachers into groups of three. Then teachers were given two papers produced by the researcher. The first paper was about constructivism and covered the following topics:

- Constructivism theory:
    - What is it? – brief history
    - Types of constructivism – cognitive and social constructivism
    - The contribution of constructivist approach to promoting students' learning and Information Technology.

The second paper, on cooperative learning, covered the following issues:

- What is cooperative learning?
- The effectiveness of cooperative learning.
- Setting cooperative groups.

In addition to these papers, teachers were provided with books and other handouts about for example, cooperative and collaborative learning, prepared by curriculum departments in the Ministry of Education. Teachers were also encouraged to use the Internet to find additional information; they were requested to discuss the reading materials, and prepare PowerPoint presentations on what they understood. At the end, each group presented their work to the others and discussed their understanding.

The next session of training included a hands-on activity in the LRCs where teachers learned how to use technologies they would need during implementation of project-based learning. These activities included how to scan and use photo-editing software. In addition, teachers were exposed to skills about how to connect the digital video camera and video into the computer using different cables for this purpose. The training covered the following skills that the researcher felt teachers would need in teaching:

- how to use the following software

  1- WinHTTrack
  2- Hyper Studio
  3- Lotus 123 ScreenCom
  4- Scanner programs
  5- Using video card software (e.g. ATI) program to capture video clips.
  6- Capture audio clips.

- Connections:

  1- how to connect scanner to the PC
  2- how to connect digital camera with PC and upload photos
  3- how to connect video/video camera to the PC and capture images

- Dealing with files:

  1- how to search for different files such as document files, image files, motion files on hard disks, CD ROMs and the local network.
  2- how to create folders.

- Trouble shooting tips:

  1- how to start PCs without a Network
  2- how to create shared folders
  3- how to transfer files through the Network.

- Presentation software:

  1- Skills on how to use PowerPoint;
  2- Skills on how to use Kid Pix;
  3- Skills on how to use HyperSudio.

After the introduction of these skills, teachers were shown some presentations prepared by the researcher illustrating how the project-based approach would work. Then LRC teachers worked in groups on projects that were appropriate for their classrooms, such as projects about geography, history, language and other arts projects using a range of resources and technologies. Towards the end of this session, teachers were asked to present their projects to the rest. An open discussion was held for feedback on the presentations and the training in general.

The researcher worked hard to eliminate or reduce barriers (e.g., technical problems and unavailability of certain hardware) by training the LRC teachers how to implement the innovation and how to use certain software. He also ensured the availability of sufficient sources and resources in the Learning Resource Centres.

However, one feels that this amount of "one shot training" is not sufficient; teachers require continuous training both outside and in their schools. The U.S. Office of Technology Assessment (1995) maintains that:

> (T)here is abundant evidence that "one-shot" or short duration training programs have little impact. Teachers need time to learn, plan, try things out, reflect on their successes and failures, revise, and try again. This takes time—months, if not years.

Therefore, the researcher recommended that, during the implementation of the new approach, teachers should have technical support, from technicians (in each region there are two technicians, in charge of equipment in LRC). The researcher arranged the visits of these technicians with the director of the supervision department in each region. In addition to that, teachers were provided with the researcher's email address and website details for further support.

5.8 Ethical Issues in the Research

When carrying out research, a researcher has to pay special attention to issues of ethics, especially during data collection, analysis and reporting. The confidentiality and privacy of participants should be clear. That is, the researcher has to take care of the safety of the human subjects, preventing them from potential harm. Such harm or undesired consequence, might not merely affect the participants but also the researcher as well. Marshall and Rossman (1999, p. 90) explain the consideration of ethical issues as follows:

> [t]he qualities that make a successful qualitative researcher are revealed through an exquisite sensitivity to the ethical issues present when we engage in any moral act. Ethical considerations are generic—informed consent and protecting participants' anonymity – as well as situation specific.

To Marshall and Rossman, the concern for ethics goes beyond human subjects; it involves situations which the researcher has to consider. Furthermore, the researcher has to consider the rights of those who are involved in his/her research. Blaxter, Hughes and Tight (1996, p. 146) argue that:

> [e]thical research involves getting the informed consent of those you are going to interview, question, observe or take materials from. It involves reaching agreement about the uses of this data, and how its analysis will be reported and disseminated. And it is about keeping to such agreements when they have been reached.

The rule of informed consent rests on the idea that human research subjects should be able to agree to participate, or to not participate in research in the light of comprehensive information about the nature and purpose of the research. It is based on the assumption that individuals have a right to know what is happening to them (Homan, 1991).

The issue of ethics in educational research (and of course in other types of research settings) puts the researcher in a dilemma between chasing truth and of respecting human dignity. In fact, the researcher is confronted by the question of whether to comply with the subjects' rights or to satisfy researchers' professional demands, searching for the truth (Cohen and Manion, 1994).

In this study the issue of ethics was one of the major concerns of the researcher. As stated earlier, the majority of LRC teachers in Basic Education schools are female teachers. The survey questionnaire sample consisted of 187 female teachers and 13 male teachers. The interview and observation samples were 40 female LRC teachers in 20 Learning Resource Centres. Working in such schools is a sensitive issue in some regions in Oman because the presence of men is unacceptable and not permissible unless for professional and official reasons such as visits by inspectors, directors or technicians. Therefore the above issue and the issue of assuring the informants' privacy and confidentiality of their information were addressed carefully by the researcher. To achieve these aims, the researcher took the following means and measures:

- To get permission to conduct research in Basic Education schools, a letter was obtained from the Ministry of Higher Education stating the researcher's intention and the purpose of the research (Appendix 8). The letter was then sent to all educational regions, giving the green light to distribute the survey questionnaire.
- In the survey questionnaires, the objectives of the study were clearly stated in the questionnaire and it was stated that the information provided would be used only for educational purposes (see Appendix 2).
- Permission was obtained from targeted regions to visit these schools to conduct the interviews and observations. Arrangements were made in coordination with the supervision director in each region (see Appendix 10).
- Videotaping of some selected lessons during the implementation phases was also a major issue. Not all LRC teachers were willing to be videotaped because of the tradition in some regions. The researcher allowed teachers to decide whether to be videotaped or not; he asked them to sign letters stating their willingness to be videotaped (Appendix 12). Of 40 teachers, two teachers refused to be videotaped.

Further, ensuring that no personal data is given in the questionnaire, other than a participant's role within the process, would allow anonymity. However, a question of severely reduced anonymity is raised in the interview phase if the researcher conducts the interviews. Here, confidentiality must be ensured. "[The researcher] must be quite explicit in explaining to subjects what the meanings and limits of confidentiality are." (Cohen et al., 2001, p. 62). In interviews, each participant was given a verbal promise of the confidentiality of her viewpoint and that no public connection would be made with the shared information given. In reporting the information from the interviews, the researcher would instead use generic terms such as "one teacher noted", "one participant observed" etc. In one instance, when a teacher stated information about the region she comes from, the researcher deleted the name of that region to protect this teacher's anonymity (see Chapter Seven).

5.9 Conclusion

A triangulation method was applied in this study. Rather than using one tool for data gathering, the researcher used several different tools to ensure the validity and credibility of the research. An attitude questionnaire (administered before and after training and practice) was used as the main tool for gathering data about LRC teachers' attitude towards the constructivist approach. Interviews and observation were used to shed more light on teachers' attitude and to see how far it was consistent with their practice.

In the following two chapters (Six and Seven), the results of the study will be presented. Cross-referencing is used to derive a coherent understanding of the meaning of the collected data. Chapter Six presents descriptive and inferential statistics based on the questionnaire responses. Chapter Seven summarises the findings from the interviews and observations.

CHAPTER SIX

DATA ANALYSIS (Part One)

6.1 Introduction

The main purpose of this chapter is to identify and quantify the differences in teachers' attitude before and after the training and also to determine the factors and the difficulties which affected their attitudes to a constructivist learning approach. The results presented in this chapter will answer some of the research questions and will be used to test hypotheses about teachers' beliefs about a technology-rich learning environment using Multimedia/IT in the Basic Education Schools. The chapter is divided into four sections: section 6.2 discusses the demographic profile of participants, section 6.3 addresses the reliability of the questionnaire for the main study; section 6.4 examines teachers' responses before training and section 6.5 discusses teachers' responses after training.

6.2 Demographic Characteristics of LRC Teachers

The survey questionnaire (see Appendix 2) asked the LRC teachers to provide personal information about themselves related to a number of demographic characteristics and previous experience of training. Details of respondents' age, teaching experience, residence and training courses (in-service training) are given in Tables 6.1 to 6.7.

Table 6.1: Participants' Age

Participants' Age	Frequency	Percent
From 23 to 27	2	1.0
From 28 to 32	99	49.5
From 33 to 37	84	42.
From 38 and over	15	7.5

Table 6.2: Participants' Teaching Experience

Years of teaching experience	Frequency	Percent
From 1-5	2	1.0
From 6-10	104	52.0
From 11-15	78	39.0
From 16-20	16	8.0
Total	200	100.0

Teachers' age and teaching experience

It can be seen from Tables 6.1 and 6.2 that the frequency spreads for teachers' age and year of teaching experience are similar. Therefore, before considering age and teaching experience as two separate entities, it is appropriate to verify whether this notion is applicable to the sample of the study. It was thought that in the Omani context, teaching experience variation over age would be unlikely to exist among Omani teachers since, teachers' diploma in-service training started in the mid eighties; moreover, mid-life career change, which in some cultures could bring late entrants to the teaching profession, is uncommon. Nevertheless, it was considered appropriate to check this assumption. Therefore, a correlation test of the factors was conducted to determine the relationship between them (as recommended by Bryman and Cramer, 1997) to make sure that independent variables were not highly correlated before doing further statistical tests.

Table 6.3: Correlation between Teachers' Age and Teaching experience.

Items	N	Pearson Correlation	P value
Teachers' age vs. teachers' teaching experience	200	.970	.000

The result in Table 6.3, shows that there was a positive significant correlation between the two entities that was close to perfect.

Table 6.4: The Distribution of Teachers' Age over their Teaching Experience.

Participants' Age	Teaching Experience				
	1- 5	6-10	11-15	16-20	Total
From 23 to 27	2				
From 28 to 32		99			
From 33 to 37			81	3	
From over 38			2	13	
Total	2	99	83	16	200

The results of the cross-tabulation, as seen in Table 6.4, indicates that young teachers had fewer years of teaching experience and older teachers were those with more years of teaching experience, as would be expected. Since the two variables are so closely correlated, there is no need to analyse both of them. The literature reveals that teaching experience has a profound impact on teachers' attitude (See Chapter Four, section 4.2.2.2). Therefore teaching experience will be considered as a factor to be tested against the seven dependent variables.

Further, by referring to Table 6.2, it can be seen that there are only two cases in the first category of teachers' teaching experience. This is not enough for carrying out statistical analysis, so the researcher decided to collapse this category within a band of 1-10 years of teaching experience. The three categories were re-coded as follows: low teaching experience=1-10 years; moderate teaching experience=11-15 years, and high teaching experience= 16-20 years.

Table 6.5: Participants' Sex

Sex	Frequency	Percent
Male	13	6.5
Female	187	93.5
Total	200	100.0

Table 6.5 reflects the fact that teachers in Basic Education schools in Oman are predominantly female. Male teachers are the exception in these schools.

Table 6.6 Participants' Residence

Residence Areas	Frequency	Percent
Urban	82	41.0
Rural	118	59.0
Total	200	100

Table 6.7: Teachers' ICT Training

Training Courses	Frequency	Percent	Training Categories
Windows and Ms Word	8	4.0	Basic
All above, Internet and Excel	44	22.0	
All above, Power Point and Multimedia	125	62.5	Intermediate
All above courses and professional courses	23	11.5	Advance

As it can be seen from Table 6.7, that there are only eight cases in the first category of teachers' ICT training. This is not enough for carrying out statistical analysis; therefore, the first two categories (Windows/ Ms Word and Internet/ Excel) were collapsed into single category, labelled Basic. Teachers who had, in addition, received training on Power Point and Multimedia were classed as Intermediate. Those who, in addition to all of the foregoing, had undertaken professional courses, made up the Advanced group. The table shows that the majority of teachers had attended an intermediate training course.

6.3 Reliability of the Questionnaire for the Main Study

During the pilot study the researcher tested the reliability of the self developed questionnaire using the alpha test (Cronbach, 1951). Reliability was again tested in the main study to check the data were reliable, before carrying out further statistical analysis tests. As shown in Table 6.8 the reliability for the seven scales in the pilot study ranged from 0.65, for scale seven (IT goals), to 0.92, for scale one (the advantages of the new approach). The reliability for the main study ranged from 0.75 to 0.94. The lowest reported alpha, 0.75, was for scale three (teachers' role). According to Bryman and Cramer (1997) an alpha of 0.70 is a reasonable standard of reliability.

Table 6.8: Piloting and Main study Reliability of Questionnaire

Scale	**Reliability in the pilot study**	**Reliability in the main study before training**	**Reliability in the main study after training**
Teachers' attitude the advantages of the new approach	Alpha=0.92	Alpha=0.95	Alpha=0.89
Teachers' Attitude towards pupils' role	Alpha=0.82	Alpha=0.77	Alpha=0.90
Teachers attitude towards teachers' role	Alpha=0.79	Alpha=0.97	Alpha=0.75
Teachers' attitude towards learning context	Alpha=0.83	Alpha=0.87	Alpha=0.94
Teachers' attitude towards IT as content	Alpha=0.77	Alpha=0.81	Alpha=0.86
Teachers' attitude towards assessment	Alpha=0.74	Alpha=0.72	Alpha=0.71
Teachers' attitude towards IT goals	Alpha=0.65	Alpha=0.74	Alpha=0.89

Overall the results indicated that the scales are highly reliable. They can therefore be used to measure teachers' attitudes towards a constructivist approach and the results can be used to carry out further statistical analysis.

6.4 Teachers' Responses before Training

In Chapter Four, section 4.3, it has been argued that training and practice can have a profound impact on changing teachers' beliefs about innovation. The paired sample t test was applied to examine the difference between teachers' attitude before and after the training on seven scales. Since the literature and logic of the intervention support the notion that teachers' attitude would improve because of the training and practice, a one tailed test was used.

The first stage in the data analysis process (in both section 6.4 and section 6.5) was to re-code some of the responses as follows: for the purpose of indicating attitude towards a technology-rich constructivist learning environment in such a way that a higher number represented a more positive attitude, the responses on the Likert scale of the negatively stated prompts in items 1, 4, 5, and 7 in section "teachers' attitude towards pupils' role"; items 5, 6, and 7 in the section "teachers' attitude towards type of assessment" were reverse scored by recoding 1 as 5, 2 as 4, etc. Also items 1 and 2, in the section "teachers' attitude towards IT goals", were reversed (Bryman and Cramer, 1997, p.46). Thus, those who disagreed with these items were considered constructivist teachers and those who agreed were considered traditional teachers.

For the purpose of hypothesis testing (in both section 6.4 and section 6.5), a number of composite variables were constructed. That is, rather than treat each item in each scale as a separate measure (as it has been done in descriptive statistics), it is preferable and reasonable to combine them into one index or scale which is defined as a composite variable (Nachmias and Nachmias, 1996; Bryman and Cramer, 1997). To do this, the scores of individual responses are aggregated and then the total score is divide by the number of statements in the scale to obtain the mean score value for that particular scale.

The purpose of this section is to examine the attitudes of teachers towards various components of the constructivist approach to teaching and learning before they received training and practical experience related to that approach. This will provide base-line data against which, in later sections, attitudes after training can be compared, and the impact of training evaluated. The section is divided into two sub-sections. First, descriptive statistics for the whole sample are presented. Then, the data are further analysed to explore the possible influence on teachers' attitudes, of their personal characteristics: teaching experience, residence and previous ICT courses.

6.4.1 Descriptive statistics

In this section, the attitude of the teacher sample as a whole towards the advantages of the new approach is investigated.

6.4.1.1 The advantages of the new approach

This scale in the survey questionnaire was meant to examine the advantages of the constructivist approach. The teachers were asked to indicate their attitudes towards two teaching methods, by reading two scenarios presented in the questionnaire (see Appendix 2, section two). The two scenarios described two teachers, Amira and Habeeba. Amira was a constructivist teacher, whereas Habeeba was a traditional teacher. The scenarios deliberately presented a stark contrast. This was considered necessary in order to make a clear contrast and avoid ambiguity for the teachers, bearing in mind that they were thought unlikely to be familiar with a range of teaching approaches. It should be noted that the terms, traditional and constructivist, were not used directly, as teachers might be unfamiliar with the latter, or be biased by the connotations of the word traditional. The aim, rather, was to explore their feelings towards particular behaviours.

The teachers were asked to indicate their attitude by assigning values from 1 to 5 for their beliefs as follows: "Certainly Habeeba's teaching method", "Tend towards Habeeba's teaching method", "Not Sure", "Tend towards Amira's teaching method" and "Certainly Amira's teaching method", respectively. The Likert scale was intended to counteract the possible biasing effect of the strong contrast between the two scenarios, as teachers did not have to choose one or the other, but could express shades of inclination towards either scenario, or reject both in favour of a neutral response.

It can be seen from Table 6.9, that before the training, teachers were fairly evenly divided between those who felt comfortable with Habeeba's (traditional) approach and those who felt comfortable with Amira's (constructivist) approach (item 1).

Table 6.9: Descriptive Statistics for the Advantages of the New Approach before Training.

Advantages items	Certainly Habeeba	Tend towards Habeeba	Not Sure	Tend towards Amira	Certainly Amira
	%	%	%	%	%
1-Teachers comfortable with method.	18.5	29.0	5.0	25.5	22.0
2-Pupils learn more and gain more knowledge.	11.0	27.0	13.0	29.0	20.0
3-Pupils gain more IT skills	12.0	28.0	13.0	31.0	16.0
4-Method most pupils would prefer.	12.5	22.0	16.0	34.0	15.5
5-Methods you think will motivate pupils to learn.	11.5	29.0	6.5	32.0	21.0

Items overall show a wide spread of responses, with substantial concentrations in all response categories except for the neutral option. Item 1 (approach teachers feel comfortable with) is notable for the almost equal split between those tending to or certainly favouring Habeeba's (traditional) approach and those tending to or certainly favouring Amira' (constructivist) approach. In items 2, 4 and more especially item 5, the combined responses for "Tend towards Amira's" and "Certainly Amira's" are greater than the combined responses for Habeeba's traditional approach. Moreover, for every item, the smallest response (excluding 'Not Sure' responses) is for 'Certainly Habeeba'.

Thus, overall, teachers were favourable towards the new approach, but only moderately so, since "Tend towards Amira's" responses outnumbered "Certainly Amira's". Moreover, almost half the teachers felt more comfortable with the old approach. Prawat (1992, p.354) argues that new constructivist approaches to teaching and learning are inconsistent with much of what teachers believe—a problem that may be overcome if teachers are willing to rethink their views on a number of issues.

Three items in this scale stand out as having more room for change in attitude. Item 1 had the highest level of disagreement, almost 47.5% combined "Strongly Disagree" and "Disagree" responses. The item seems to indicate a problem for teachers' attitude towards the constructivist approach; therefore it will be worth tracing the change of teachers' attitudes after the training. Also particular consideration should be given to items 3 and 4 because of the high levels of teachers' uncertainty. In other words, it will be interesting to see if, after training, teachers become more sure in their attitudes towards the new approach, which may result in fewer "Not Sure" responses.

6.4.1.2 Teachers' attitude towards pupils' role

Teachers' attitude towards the new role of pupils was measured by eight statements (in Table, 6.10). Responses to the statements were measured on a 5 point Likert scale where teachers had to state their attitude by choosing from a range of "Strongly Agree to "Strongly Disagree." These responses were assigned numerical scores of 5, 4, 3, 2, and 1 respectively.

As can be seen from Table 6.10, there were high levels of "Not Sure" responses, ranging from 13.5% for item 2, to 25% for item 4. Items 1, 4, 5 and 7 have large numbers of "Strongly Agree" responses and items 2, 3, 6 and 8 have large numbers of "Agree" responses. Teachers' responses suggest some confusion; for example the response to item 3 contradicts with the response to item 1. This could be a result of teachers' unawareness of pupils' role in the constructivist learning approach. It is interesting to note that some items show a consensus, for example items 2 and 3 with which almost 65% of teachers agreed. But items 1, 4, 5 and 7 show two distinct groups of responses, for example, 30% "Strongly Agree" and 32% "Strongly Disagree". Therefore the scope for change to the constructivist view is limited by the percentage of "Strongly Disagree" responses. As can be seen from the table, items 4, 5, 6 and 8 had very high levels of uncertainty, over 20%. It will be worthwhile to trace the change in these teachers' attitude after the training. Therefore particular attention will be given to those items in the analysis of the post-training results.

Table 6.10: Descriptive Statistics for Teachers' Attitude towards Pupils' Role before Training.

Pupils' Role	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1- Student should be passive recipient of information.	24.5	8.0	16.0	9.0	42.5
2- Student should think about information while learning.	2.5	19.5	13.5	49.0	15.5
3- Student should choose resources and sources.	1.0	15.5	19.0	42.5	22.0
4- Each student should work alone.	30.0	8.0	25.5	4.5	32.0
5- Student should rely on other members do his/her part.	27.5	3.0	22.0	6.0	41.5
6- The use of groups' "experts".	1.5	21.5	23.0	44.5	9.5
7- Student should not be responsible for his/her learning.	28.5	14.0	16.5	6.5	34.5
8- Student should analyse, evaluate, and synthesize information.	3.5	21.0	20.0	44.5	11.0

Overall, teachers wanted pupils to be active in the sense of thinking, and analysing information. This attitude can be an indicator of teachers' willingness to adopt a constructivist approach, as it is consistent with what Sainsbury (1992) proposed as a constructivist attitude: "Instead of seeing pupils as empty vessels to be filled with desired information, she must see them as active appliers of meaning, using their present understanding to grapple with new material and bring it within their grasp". However, teachers were less comfortable about other aspects of the constructivist approach which might have been seen as a relinquishment of the teacher's role (item 1) or contributing to chaos in the classroom. According to Dwyer, et al. (1991) such beliefs are affected deeply by traditional schooling impact. Moseley and Higgins (1999) add that those with negative attitudes about ICT are likely to be more directive in style or may prefer children to work individually without ICT.

6.4.1.3 Teachers' attitude towards teachers' role

Teachers' attitude towards teachers' role in a constructivist learning environment was measured by ten statements describing the teacher's expected behaviours in such a learning environment. A similar scale and instructions were used as for the previous section.

As can be seen from Table 6.11, for items 1-7, the combined "Agree" and "Strongly Agree" responses are greater than the combined "Disagree" and "Strongly Disagree" responses; typically around 50% to 55% for the former and around 40% for the latter, indicating a small majority in favour of the constructivist approach. Teachers with positive responses to a constructivist teacher's role were enthusiastic about the new approach. This is consistent with what Sainsbury (1992) describes as the constructivist attitude towards the teacher's role: "Instead of regarding herself as the custodian of pure specialised knowledge, she has to see herself as a partner, albeit a more knowledgeable partner, in a conversation". Those teachers who responded negatively to the constructivist teacher's role might be influenced by the beliefs that it is their responsibility to deliver instruction to students, as students would expect them (Brooks and Brooks, 1993; Taylor, 1990).

Table 6.11: Descriptive Statistics for Teachers' Attitude towards Teachers' Role before Training.

Teacher's Role	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1- Provide students with guidance when they need it.	12.0	26.5	6.0	28.0	27.5
2- Provide students with resources and sources of information to do their tasks.	12.0	29.0	8.5	27.5	23.0
3- Facilitate the cooperation among students in their groups.	14.0	26.5	5.5	31.5	22.5
4- Walk around to check students' work.	17.5	25.0	6.0	26.0	25.5
5- Suggest resources inside and outside LRC for the students.	8.5	33.5	5.0	37.0	16.0
6- Observe students working with computer application and other technologies.	14.5	25.5	6.0	32.5	21.5
7- Discuss with students their choices of material.	17.0	25.5	6.0	40.0	11.5
8- Assign roles to each member and give a chance for everyone to take turn in IT lessons.	8.0	29.0	18.5	33.0	11.5
9- Give grades to individual group member based on the performance of the entire group.	10.0	24.5	22.5	36.0	7.0
10- Give clues and hints when students ask questions, but not direct answers.	11.5	26.0	12.0	31.5	19.0

However, a different situation emerges with items 8 and 9. Although, the "Disagree" response was smaller for item 9, on the other hand, this item had a particularly high concentration of "Not Sure" responses, as did item 8. This can indicate that the two items may be seen as problematic for a large proportion of the teachers

(23%). It would be interesting to carry out further investigation on these items, especially item 9. According to Rice (1995) teachers are expected to facilitate various learners and incorporate innovative assessment techniques as part of school reform efforts. If those teachers, who were uncertain, could be encouraged by training to move further in the direction of constructivism, it would have a significant impact on the distribution of responses. Therefore, particular attention will be given to those items in analysis of the post-training results.

6.4.1.4 Teachers' attitude towards cooperative and collaborative learning

Teachers' attitude towards cooperative and collaborative learning was measured by thirteen statements mainly describing cooperation and collaboration among students in the learning setting. Similar measures and instructions were used as in the previous two scales.

It is notable that for every item except items 2, 7 and 13, there was a large majority of answers in the "Agree" category, ranging from 53% (item 8) to 67.5% (item 9). Correspondingly, for all items except the three mentioned, there were very small percentages (from 5% to 7%) in the "Disagree" categories and little or no strong disagreement. The three items which elicited greater disagreement also had larger concentrations of "Not Sure" responses. This pattern was particularly marked for item 2, concerning mixed sex groups. This result was to be expected, since grouping boys and girls is one of the disputed issues in the Basic Education schools (as discussed in Chapter Five). However studies such as Means and Olson (1995a), Johnson and Johnson (1987) and Schwartz (1987) showed that mixed ability and cross sex grouping result in more effective learning. A key factor in this finding is probably the cultural context, since these studies were conducted in the U.S.A, where mixing of the sexes is culturally acceptable and customary in most contexts.

Table 6.12: Descriptive Statistics for Teachers' Attitude towards Cooperative and Collaborative Learning before Training.

Cooperative and Collaborative learning	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1-Members perform different tasks (e.g. some work on computer, others look for resource or write draft).	1.5	6.0	10.5	65.5	16.5
2- Each group should be composed of mixed gender (boy and girls).	6.0	23.5	37.0	25.5	8.0
3- Each group should consist of mixed abilities.		6.5	9.5	58.0	26.0
4- Group members should cooperate to accomplish joint tasks.		6.5	12.0	62.0	19.5
5- Group members should interact with each other in their group, asking and questioning.		5.5	9.0	64.0	21.5
6-Group members perform different tasks towards one goal.	0.5	6.5	13.0	61.0	19.0
7-Group members should contact other group members to seek help.	5.0	29.0	31.5	30.0	4.5
8- Group members should present their work as group work, not as individual work.		6.0	19.0	53.0	22.0
9- Group members should subdivide a complex task among themselves.	1.0	5.0	12.0	67.5	14.5
10- Group members share information.		5.5	10.0	58.0	26.5
11-Group members should help each other to achieve their goals.	0.5	7.0	8.5	58.5	25.5
12- Groups should see and evaluate each other's projects.		6.0	12.0	64.0	18.0
13- Students will take more initiative to learn when they feel free to move around in the LRC during IT lessons.	2.0	23.5	21.0	34.5	19.0

In addition, having a disagree attitude towards allowing students to talk to other group members and being worried by pupils' free movement in the LRC during the lessons were predicted because, as the worldwide literature reveals (discussed in Chapter Four), such pupils' behaviours might create chaos in the classroom and teachers might lose control over students; some teachers do not want give up control and order they have in their classroom (Byrom, 1998). However, other teachers might have enjoyed the organized chaos associated with students working together on group projects, such as searching the Internet for research projects or developing multimedia presentations (Craver, McKown and Koeppl, 1995).

For all items, except items 2, 7 and 13, there is little room for change in teachers' attitudes, since the total "Agree" and "Strongly Agree" responses are over 75% for these items. However, there is more room for change in items 2, 7 and 13, because of the high levels of "Not Sure". Because item 2 is related to the core value of tradition and items 7 and 13 are related to teaching practice, it is worthwhile to trace teachers' attitude change on these items after the training and to determine how much impact it has had on teachers' attitudes towards these items.

Moreover, overall, teachers had a positive attitude towards cooperative and collaborative learning. This result is anticipated because most teachers, who teach in Basic Education Schools, underwent in-service training courses before teaching in these schools (Ministry of Education, 1997a). Also this may be related to school cultural influences on teachers' attitude (Becker and Riehl, 1999; Collinson, 1996; Norton et al., 2000). That is, being involved in and observing a successful implementation of cooperative and collaborative learning by science and maths teachers in Basic Education schools may have convinced those teachers of the benefit of this way of learning. Those teachers with a negative attitude towards cooperative and collaborative learning may have beliefs surrounding the need for autonomy, so they dislike cooperative groups and a collaborative environment (Parr, 1999).

6.4.1.5 Teachers' attitude towards IT as content

Teachers' beliefs about information technology (IT) as content were evaluated by six sentences describing the activities of such use. Similar measures and instructions were used as in the previous scales.

The dominant trend, for all items in this section, was agreement. In each case, except for item 2, the largest concentration of responses was in the "Agree" category, with another substantial, albeit smaller, concentration in "Strongly Agree". Percentages in both the "Disagree" and "Strongly Disagree" categories were very small. Particularly strong agreement was expressed for item 2, concerning the relationship of IT activities with real life; this was the only item where "Strongly Agree" outnumbered "Agree". A similar attitude was reported by teachers in the U.S. Office of Technology Assessment (1995, p.49) survey: Teachers who are technology users often report that technology can make learning more relevant to "real" life and more engaging and motivating to students.

Table 6.13: Descriptive Statistics for Teachers' Attitude towards IT as Content before Training.

IT as Content	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1- IT activities should be integrated across subjects (should contain at least one subject).	5.0	4.5	20.5	48.5	21.5
2- IT activities should be related to students' real life.	1.0	5.5	17.5	36.0	40.0
3- IT activities should involve the use of more that one type of technology applications.	1.0	5.0	18.5	46.5	29.0
4- IT activities should require the use of wide range of material available in LRC.	0.5	9.5	14.0	46.5	29.5
5- IT lessons should be related to students' personal interest.	4.0	6.0	20.0	45.5	24.5
6- IT activities contain skill and ideas transferred from previous activities (background knowledge).	3.0	3.5	21.5	55.0	17.0

However, there was a lower concentration of "Strongly Agree" responses for item 6 (relationship of IT activities with previous background). This may indicate that IT has been introduced as a new, discrete curriculum in the reformed schools, and not integrated with students' prior learning.

As can be seen from the table, items 1 and 6 had a low concentration of "Strongly Agree" and a high concentration of "Not Sure". Since the two describe what the literature (e.g., Moursund, 1999) highlights as important features of IT activities of integration (integration across subject areas and the idea of background knowledge discussed in Chapter Two), it would be interesting to trace teachers' attitudes towards these two items after the training and comment on this change.

Moreover, there were large numbers of "Not Sure" responses for all items. This uncertainty can be explained in terms of the knowledge and skills required to carried out such activities. Blumenfeld, et al. (1991) argued that one factor impeding teachers from implementing the constructivist approach was teachers having insufficient content knowledge, and Sandholtz, et al. (1992) maintained that teachers' inadequate knowledge about and skills on hardware and software might influence their practice.

<u>6.4.1.6 Teachers' attitude towards assessment</u>

Teachers' attitude towards assessment was measured by seven items describing two types of assessment: alternative assessment and traditional assessment. Items one, two, three and four describe alternative assessment. Items five, six and seven describe traditional assessment (see Chapter Two, section 2.4.6).

Table 6.14, shows that the largest concentration of responses, for all items, were in "Agree". Thus, each of the alternatives offered had a substantial number of proponents. Teachers' positive attitude towards alternative assessment is in line with what Irvine, et al. (1997) maintains about the inappropriateness of traditional assessment practices, such as the text-based standardized tests in such learning environment. The findings of the U.S.A. National Assessment of Educational Progress (cited in Potter and Small, 1998) suggest that teachers have been responsive to calls for less reliance on traditional assessment.

Table 6.14: Descriptive Statistics for Teachers' Attitude towards Alternative Assessment before Training.

Alternative assessment	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1-Multimedia presentation of their final work.	8.5	14.0	18.0	51.5	8.0
2-Written reports on their projects.	10.0	8.0	30.0	37.0	15.0
3- Self-assessment.	5.0	10.0	21.5	43.5	20.0
4- Electronic portfolio.	4.5	7.0	26.5	43.5	18.5
5- True and false test items.	5.5	15.5	39.5	35.5	4.0
6- Short-answer and multiple-choice tests.	2.5	20.0	32.5	41.5	3.5
7- Extended answer items.	7.0	17.0	38.0	33.0	5.0

However, it is interesting that the concentration in every case was in "Agree" rather than "Strongly Agree". There was, moreover, a particularly high level of "Not Sure" responses for all items, but particularly so for items 5, 6, and 7, the traditional items. The uncertainty can be explained, according to the U.S. Office of Technology Assessment (1995, p.98) because teachers worry about accountability, since technology-related higher order skills may not be measurable through traditional assessment instruments. Because of the high level of agreement (which is expected) and high concentration of uncertainty in these items (items 5, 6 and 7), it is worthwhile to investigate whether, after training in the constructivist approach, teachers' attitude becomes less favourable towards these traditional modes of assessment.

6.4.1.7 Teachers' attitude towards IT goals

Teachers' attitude towards the goals of technology use was explored by a list of five possible goals of using technology. These goals are divided into two types of technology use goals; learning from technology and learning with technology. Responses were on a three-point scale (see Chapter Five, section 5.4 for reason of using this 3-point scale): not important (1), important (2) and very important (3). Items 1 and 3 were meant to measure traditional goals of IT use. According to Means and Olson (1994) traditional uses of technology include: technology as a teachers' presentation tool, technology for remedial instruction, and teaching students about technology. Items 2, 4 and 5 were meant to measure goals of IT use which support constructivist teaching (Becker at al., 1999; Jonassen, 1996) (see Chapter Two, section 2.5 for more detail on the types of use).

The immediately striking feature of this table is the complete absence of responses in the "Not important" category; none of the teachers were prepared to state that any of the five items had no importance at all. It was expected that there would be no responses in the "Not Important" category because the participants were IT teachers and they should have some expectations of the goals of IT use in Learning Resource Centres, whether these goals were traditional or constructivist.

There was, however, a high level of uncertainty for all items, ranging from 19% for "future job" (item 1) to 50.5% for "promoting learning strategies" (item 2). The greatest uncertainty was in relation to items 2 "promoting learning strategies" and 5 "support instructional reform". Teachers' confusion about item 2 can be explained by teachers' lack of knowledge about constructivist IT goals. According to Lundeberg, et al. (1997) teachers could not differentiate between the constructivist and traditional IT goals. Moreover, the high level of "Undecided", in relation to item 5, could be interpreted by the fact that teachers had not been involved before in designing their own learning objects; reform was imposed from above. Therefore, they may not have felt part of the decision making in this respect. These can be considered as factors influencing teachers' attitude according to Parr (1999).

Table 6.15: Descriptive Statistics for Teachers' Attitude towards IT Goals before Training.

Teachers' Attitude towards IT Goals Items	Not important	Undecided	Important
	%	%	%
1- To prepare students for future jobs.		19.0	81.0
2- To promote active learning strategies.		50.5	49.5
3- To improve pupils' achievement scores.		34.5	65.5
4- To deepen students' understanding.		36.5	63.5
5- To support instructional reform.		45.0	55.0

It is noticeable that the item on which there was least uncertainty and a strong consensus among the majority of teachers that the goal concerned was important, was item 1. This response reflects a traditional approach to IT use. The table shows that items 2 and 5 had a common feature; as mentioned before they are constructivist learning goals. Also, they had the highest level of "Undecided" and the lowest level of "Important". Therefore these items are worth further investigation after the training to trace the movement of teachers' attitude towards them.

6.4.2 Relationship between teachers' Attitudes and personal characteristics

In this section, relationships between teachers' attitude and their teaching experience, residence (urban and rural) and previous ICT training are explored.

6.4.2.1 Teachers' Teaching Experience

In Chapter Four, it has been argued that teachers' characteristics such as age and teaching experience may have an influence on teachers' beliefs (a second-order barrier) about innovation. For example, there is evidence that younger teachers are more progressive and open to change than older teachers (Goodwyn et al., 1997; Scott and Hannafin, 2000). Teachers with more years of teaching experience tend to be adherent to their traditional approach to teaching, whereas teachers with less teaching experience are more progressive and are willing to change (Calderhead, 1996; Hannafin and Freeman, 1995; Howie and Wen, 1997; McCoy and Haggard, 1989 and Scott and Hannafin, 2000). Table 6.2 shows the three categories of teachers' years of teaching experience. This section is meant to address the following null hypotheses:

There is no significant difference between teachers' attitude towards the advantages of the approach, before the training, in respect of their teaching experience.

There is no significant difference between teachers' attitude towards pupils' role, before the training, in respect of their teaching experience.

There is no significant difference between teachers' attitude towards teachers' role, before the training, in respect of their teaching experience.

There is no significant difference between teachers' attitude towards cooperative and collaborative learning, before the training, in respect of their teaching experience.

There is no significant difference between teachers' attitude towards IT as content, before the training, in respect of their teaching experience.

There is no significant difference between teachers' attitude towards alternative assessment, before the training, in respect of their teaching experience.

There is no significant difference between teachers' attitude towards goals of IT use, before the training, in respect of their teaching experience.

One Way Analysis of Variance (ANOVA) was applied to see if there was any difference between teachers of different teaching experience, in their attitude towards the various elements of the constructivist approach. The results are shown in Table 6.16

Table 6.16: ANOVA Test for Teachers' Attitude before the Training Compared across the Three Teaching Experience Groups

Teachers' attitude towards:	Source	df	Before F. Ratio	Before P. value	H of V
The advantages of the approach	Between Groups	2	151.95	0.00	S
	Within Groups	197			
Pupils' Role	Between Groups	2	117.79	0.00	S
	Within Groups	197			
Teachers' Role	Between Groups	2	419.68	0.00	S
	Within Groups	197			
Cooperation/ Collaboration	Between Groups	2	38.30	0.00	NS
	Within Groups	197			
IT as content	Between Groups	2	20.24	0.00	NS
	Within Groups	197			
Alternative assessment	Between Groups	2	73.95	0.00	S
	Within Groups	197			
Constructivist IT goals	Between Groups	2	0.19	0.82	NS
	Within Groups	197			

H of V=Test of Homogeneity of Variances; S=Significant; NS=Not Significant (Kruskal-Wallis Test confirmed the ANOVA results; see Appendix 13-A)

The table reveals that participants with different years of teaching experience differed significantly in their attitude towards all except one of the seven scales (Constructivist IT goals).

To locate more precisely the differences between groups, Bonferroni's test was used. The result of Bonferroni's Test shown in Table 6.17, indicates that in scales one, three, four and five, the low teaching experience group had higher mean scores than each of the other groups. These differences were statistically significant, meaning that the low teaching experience group was more positive in attitude to the advantage of the constructivist approach, teacher's role, cooperative learning and IT as content than both moderate and high teaching experience groups. The two more experienced groups did not differ significantly from each other in their attitudes and this confirms the finding of Scott and Hannafin (2000) that more experienced teachers hold beliefs that are more traditional, as they are more likely to be entrenched in the school culture.

Table 6.17: Bonferroni's Test for Teaching Experience Subcategories attitude before the Training.

Scales	No	Mean	Teachers' teaching experience	Low	Moderate	High
The advantages of the approach	101	20.49	Low		*	*
	83	10.90	Moderate			
	16	10.87	High			
Pupils' Role	101	29.93	Low		*	*
	83	23.24	Moderate			*
	16	19.00	High			
Teachers' Role	101	42.57	Low		*	*
	83	20.32	Moderate			
	16	22.31	High			
Cooperation/ Collaboration	101	52.90	Low		*	*
	83	45.13	Moderate			
	16	46.06	High			
IT as content	101	25.08	Low		*	*
	83	21.91	Moderate			
	16	20.25	High			
Alternative assessment	101	25.22	Low		*	*
	83	19.30	Moderate			*
	16	22.00	High			

*The mean difference is significant at the .05 level.

Conversely, teachers with less teaching experience are influenced less by school traditions and perhaps more by teacher education programmes that may advocate current and emerging theories of teaching and learning.

Howie and Wen (1997) maintain that older teachers are more resistant to using technology in their teaching. The lack of significant difference in teachers' attitude, regardless of their teaching experience, towards constructivist IT goals could be due to the fact that teachers were not able to differentiate between the types of IT (see section 6.4.1.7).

On the dimension of pupils' role and alternative assessment, in addition to the difference between the low teaching experience group and both moderate and high teaching experience groups, there was a significant difference between the moderate and high teaching experience groups; as the mean scores show, attitude towards pupils' role was increasingly inclined to the traditional as teaching experience increased. The result is consistent with what Hannafin and Freeman (1995), Kagan D. (1992) and Pajares (1992) maintain, that the greater the number of years of teaching, the more likely it is that the teacher would hold an objectivist view of knowledge acquisition. There was a significant difference between the moderate and high teaching experience groups, as the mean scores show, in attitude towards assessment. The high teaching experience group had a higher mean score than the moderate teaching experience group. It is possible that the high teaching experience group favoured using both kinds of assessment side by side (See section 6.4.1.6). This can be explained by the fact that teachers show mixed belief and practice, combining elements of the constructivist approach and the traditional approach (Klein, 1996; Collinson, 1996).

6.4.2.2 Residence areas

In the past, rural and urban area differences existed in the illiteracy rate and educational attainment of men and women as well as in people's attitude, beliefs and values practice related to women's education and social development (Ministry of Education, 1999). In that report it is stated that until five years ago, the rural population over fifteen as a whole, as well as male and female groups separately, had much higher illiteracy rates than their respective urban counterparts. Moreover, the gender gap was wider in the rural population than the in urban population. Women had significantly higher rates of illiteracy than men. This can be attributed to the tendency for traditional cultural values which constrained women's participation in education being more strongly preserved in rural areas. However, as a result of the Government's determined effort and its mobilization of large resources, the Omani education system today reaches the whole population and provides free Basic Education to all citizens. In the younger population, the gender gap, as well as the regional gap, has been substantially narrowed down (Ministry of Education, 1999).

The following discussion sheds light on the relationship between urban and rural teachers' attitudes towards a constructivist learning approach, before training. For this purpose the following null hypotheses were tested:

There is no significant difference between teachers' attitude towards the advantages of the constructivist approach with regard to their residence areas.

There is no significant difference between teachers' attitude towards pupils' role with regard to their residence areas.

There is no significant difference between teachers' attitude towards teachers' role with regard to their residence areas.

There is no significant difference between teachers' attitude towards cooperative and collaborative learning with regard to their residence areas

There is no significant difference between teachers' attitude towards IT as content with regard to their residence areas.

There is no significant difference between teachers' attitude towards alternative assessment with regard to their residence areas

There is no significant difference between teachers' attitude towards goals of IT use with regard to their residence areas.

The t test results, in Table 6.18, show that there were no significant differences in rural and urban teachers' attitudes on most of the scales, $p>0.05$, except for two scales, pupils' role and teacher's role, $p<0.05$.

The effect of education and socio-economic development in removing differences between urban and rural areas is consistent with the findings in other countries. For example, Morales (1999) carried out a study on teachers and 9th Graders from four States in Mexico to measure attitudes toward computers and electronic mail. Results showed significant differences among states in both children and teachers. It is argued that a differential technological capacity and specific-to-state computer usage models are variables responsible for those differences. However, the study showed that there are no major differences for urban-rural analysis.

Table 6.18: The Independent Sample t-Test Result for Teachers' Residence Areas before the Training.

	Scales	Independent variables		Means	df	Before	
						t	P value
1	The advantages of the approach	Urban	82	14.95	198	-1.52	0.13
		Rural	118	16.30			
2	Pupils' Role	Urban	82	24.70	198	-3.68	0.00
		Rural	118	27.38			
3	Teachers' Role	Urban	82	29.20	198	-2.46	0.02
		Rural	118	33.47			
4	Cooperation/ Collaboration	Urban	82	48.35	198	-1.26	0.21
		Rural	118	49.67			
5	IT as content	Urban	82	22.78	198	-1.65	0.10
		Rural	118	23.80			
6	Alternative assessment	Urban	82	22.06	198	-1.22	0.22
		Rural	118	22.82			
7	Constructivist IT goals	Urban	82	10.18	198	-0.45	0.65
		Rural	118	10.2373			

<u>6.4.2.3 The impact of previous ICT courses</u>

Table 6.7 showed the extent to which teachers had undertaken courses in IT. It may be expected that teachers who had attended more ICT courses and advanced training courses would have more positive attitudes towards some aspects of the new approach because during their training they may be have been exposed to some concepts related to aspects of the recent reforms, such as child-centred education, cooperative and collaborative learning (Ministry of Education, 1997a).

However, those teachers who had attended fewer courses of ICT may be expected to show more negative attitudes towards the approach. In his study, Christensen (1998) found that teachers who reported they had received integration training (IT) had significantly higher (more positive) attitudes on all the teacher attitude subscales measured. The section examines the following null hypotheses:

There is no significant difference between teachers' attitude towards the advantages of the approach before the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards pupils' role before the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards teachers' role before the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards cooperative and collaborative learning before the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards IT as content before the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards alternative assessment before the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards goals of IT use before the training in respect to their previous ICT courses.

For the purpose of testing, teachers were divided into three groups those who had received basic, intermediate or advanced training. This classification was based on the data in Table 6.7. ANOVA of teachers' attitude scores on the first six scales, as shown in Table 6.19, indicated that at the beginning of the present study, participants with different experience of ICT courses differed significantly in their attitude towards the constructivist approach, $p<0.05$. There was no significant difference in their attitude towards IT goals, $p>0.05$.

Table 6.19: ANOVA Test for Significant Differences in Attitude before the Training Related to Teachers' Training Courses

Teachers' attitude towards:	Source	df	Before		H of V
			F. Ratio	P. value	
The advantages of the approach	Between Groups	2	5.45	0.05	NS
	Within Groups	197			
Pupils' Role	Between Groups	2	8.69	0.00	NS
	Within Groups	197			
Teachers' Role	Between Groups	2	5.74	0.04	S
	Within Groups	197			
Cooperation/ Collaboration	Between Groups	2	11.24	0.00	S
	Within Groups	197			
IT as content	Between Groups	2	12.30	0.00	NS
	Within Groups	197			
Alternative assessment	Between Groups	2	4.90	0.008	NS
	Within Groups	197			
Constructivist IT goals	Between Groups	2	1.23	0.295	NS
	Within Groups	197			

H of V =Test of Homogeneity of Variances; S=Significant; NS=Not Significant (Kruskal-Wallis Test confirmed the ANOVA results; see Appendix 13-B)

Table 6.20: Bonferroni's Test for Attitude before the Training, Related to Teachers' Training Courses for Previous Training Subcategories

Scales	No	Mean	Training Courses	Basic	Intermediate	Advanced
The advantages of the approach	52	15.62	Basic			*
	125	15.09	Intermediate			*
	23	19.61	Advanced			
Pupils' Role	52	25.90	Basic			*
	125	25.68	Intermediate			*
	23	30.39	Advanced			
Teachers' Role	52	32.04	Basic			*
	125	30.18	Intermediate			*
	23	39.35	Advanced			
Cooperation/ Collaboration	52	48.08	Basic			*
	125	48.39	Intermediate			*
	23	55.52	Advanced			
IT as content	52	23.35	Basic			*
	125	22.68	Intermediate			*
	23	27.26	Advanced			
Alternative assessment	52	23.08	Basic			*
	125	21.87	Intermediate			*
	23	24.69	Advanced			

*The mean difference is significant at the .05 level.

Bonferroni's test, in Table 6.20, showed that teachers with more advanced training had more positive attitudes, whereas teachers who had attended isolated ICT training courses had more negative attitudes towards the six components of the constructivist approach. The result is consistent with what is reported in previous studies (such as Christensen, 1998 and McCarthy, Main and McCarthy, 2000) that teachers' previous training can influence attitude towards integration. The previous training tended to expose those teachers to the advantages of some elements of integration, for example, cooperative learning.

6.4.3 Summary

The data show that teachers were divided into categories: those who agreed with, those who were uncertain about and those who disagreed with the elements of the constructivist approach.

Those who had a positive attitude towards some aspects of the new approach can be characterised as enthusiastic teachers who are looking for an effective way of integrating technology in the Learning Resource Centre. Because of their attitude, they can be described as constructivist teachers (Brook and Brook, 1993 and Sainsbury, 1992). Moseley and Higgins (1999) maintain that teachers who are enthusiastic about ICT are likely to favour pupil empowerment as learners and probably like children to work collaboratively. According to Ertmer (1999), Bracey (1993) and Schofield and Verban (1988) those teachers have readiness and willingness to change.

Teachers who had negative attitudes about some aspects of the approach were unaware of use of technology supported by the constructivist theory (effective integration) or they were influenced by other factors such as their beliefs about teaching and learning; they were inclined to hold onto their traditional way of teaching (Prawat, 1992 and Brooks and Brooks, 1993); for example, they were satisfied with their current approach to teaching technology.

Teachers' uncertainty might be attributed to that fact that their enthusiasm for the constructivist approach was diffused by their underlying beliefs (Schifter, 1996). Another explanation is that, although they had a positive view, they were uncertain about using technology either because of lack of equipment, or because of the way lessons are scheduled (Honey and Moeller, 1990).

Years of teaching experience had an influence on teachers' attitude towards the element of the new approach. Low teaching experience teachers showed more positive attitudes towards the approach, whereas experienced teachers had more negative attitudes towards the new approach. The findings were consistent with previous claims that more experience teachers are more confined by their traditional approach to teaching (Scott and Hannafin, 2000; McCoy and Haggard, 1989). According to Ertmer, (1999) teachers' internal beliefs are very hard to change, and this presents a challenge for the current project.

There was no significant difference in attitude between teachers in rural and urban residence areas, except for two of the seven scales, pupils' role and teacher's role in favour of the rural teachers rather than urban teachers. This contradicts the assumption made earlier about the possible influence of rural areas on teachers' attitude. The researcher attributes the absence of significant difference to the great attention that the current government is giving to education and civil services, which were not available before 1970, for all Omanis, regardless of their place of residence.

There was a significant difference in attitude between those who had received advanced training and those who had not, in favour of the former. This indicates that the training can influence teachers' attitude. If the ICT courses that teachers had undergone could affect their attitudes in this way, it may be expected that the training provided in this study, which was specifically targeted to a constructivist approach, (see Chapter Four, section 4.3) would have an impact on teachers' attitudes. In the next section, the data on teachers' attitude after training are reported.

6.5 Teachers' Responses after the Training

The purpose of this section is to examine the attitude of teachers towards various components of the constructivist approach to teaching and learning after they received training and practical experience related to that approach, and specifically to identify what changes in attitude took place (see Chapter Five, section 5.4). In tracing attitude change, the focus was on those items identified in the previous section as showing more scope for change, due high levels of "traditional"-style responses, or high levels of uncertainty. For this purpose, rather than simply comparing percentages in the categories of interest, before and after training, further analysis was carried out to investigate exactly which teachers changed their responses, and the nature of the change.

The section is divided into two sub-sections. First, statistics for the whole sample are presented. Then, the data are further analysed to explore the possible influence on teachers' attitudes, and attitude change, of their personal characteristics: teaching experience, residence and previous ICT courses.

6.5.1 Descriptive statistics

This section identifies the attitude change during training, for the sample as a whole. The results for each scale of the questionnaire are presented in turn.

6.5.1.1 The advantages of the new approach

The purpose of this section is to examine teachers' attitudes towards the advantages of the constructivist approach. As shown in Table 6.21, after the training, there was a substantial reduction in the percentages of teachers answering in favour of the traditional approach, and a substantial increase in the numbers answering in favour of the constructivist approach.

The items in this scale which were identified in section 6.4.1.1, as particularly interesting because of the greater room for change shown before training, were items 1, 3 and 4. Accordingly, it is of interest to look in detail at these items.

Table 6.21: Descriptive Statistics for the Advantages of the New Approach before and after Training.

Advantages items	Certainly Habeeba	Tend towards Habeeba	Not Sure	Tend towards Amira	Certainly Amira
	%	%	%	%	%
1-Teachers comfortable with method.	18.5	29.0	5.0	25.5	22.0
	4.5	6.0	7.0	35.5	47.0
2-Pupils learn more and gain more knowledge.	11.0	27.0	13.0	29.0	20.0
	3.5	7.5	6.5	39.0	43.5
3-Pupils gain more IT skills.	12.0	28.0	13.0	31.0	16.0
	3.0	6.0	5.0	33.5	52.5
4-Method most would pupils prefer.	12.5	22.0	16.0	34.0	15.5
	3.0	10.5	7.5	35.5	43.5
5-Methods you think will motivate pupils to learn.	11.5	29.0	6.5	32.0	21.0
	7.0	4.5	4.5	36.0	48.0

The shaded rows indicate after the training and practice.

For item 1, it can be seen that the percentage increase in the "Certainly Amira's" category, at 25%, was more than twice that in the "Tend towards Amira", at 10%.

The implication is that a large proportion of the teachers who had originally favoured a traditional approach moved in favour of a constructivist approach, and that some teachers who tended to favour a constructivist approach before training were strengthened and confirmed in their attitude, after the training. That this was indeed the case is confirmed by Table 6.22.

Table 6.22: Change in Response to Scale One: Item 1

Item	Response before Training	Response after Training				
		Certainly Habeeba	Tend towards Habeeba	Not Sure	Tend towards Amira	Certainly Amira
1	Certainly Habeeba 37 (18.5%)	0	2 (1%)	7 (3.5%)	13 (6.5%)	15 (7.5%)
	Tend towards Amira 52 (25.5%)	2 (1%)	2 (1%)	4 (2%)	16 (8%)	27 (13.5%)
	Certainly Amira 44 (22%)	2 (1%)	2 (1%)	1 (0.5%)	14 (7%)	25 (12.5%)

As the table shows, 37 (18.5%) teachers who, before training, had answered "Certainly Habeeba", after the training 15 (7.5%) answered "Certainly Amira", while a further 13 (6.5%) moved towards "Tend towards Amira". None of them continued to be "Certainly" in favour of the traditional approach after training. There were some teachers whose attitude shifted in the opposite direction, but in most (14) cases this was a change from "Certainly Amira" to "Tend towards Amira", not a move all the way towards a traditional attitude. Moreover, this shift was outweighed by the number of teachers (27) who strengthened their positive stance towards the constructivist approach moving form "Tend to Amira" to "Certainly Amira"

A similar trend can be seen in responses to the other items in the scale. For example, as can be seen from Table 6.21, after the training, the proportion of teachers answering "Tend towards Amira" and "Certainly Amira" for item 3 totalled over 86%, compared to 47.5% before the training, indicating that teachers believed pupils gain more IT skills from this approach. After the training, only 9 % of teachers still believed IT skills can best be acquired through a traditional approach. This attitude conforms with what, for example, Thomas and Sullivan (1998) and Simkins (1999) found, that appropriate use of technology gives students skills, knowledge and insights to meet rigorous content standards and make successful transitions into an ever-changing world.

A shift in attitude was also noticeable for item 4. 79% (combined "Tend towards Amira's" and "Certainly Amira's") of teachers saw this approach as the one that pupils would most prefer (item 4) as compared to 49.5% (combined "Tend to Amira's" and "Certainly Amira's") before the training. Moreover, there was a very large shift from 15.5% to 43.5% in the "Certainly Amira's" category.

Table 6.23: Change in Response to Scale One: Item 3

Item	Response before Training	Response after Training				
		Certainly Habeeba	Tend towards Habeeba	Not Sure	Tend towards Amira	Certainly Amira
3	Certainly Habeeba 24 (12%)	1 (0.5%)	2 (1%)	1 (0.5%)	8 (4%)	12 (6%)
	Tend towards Habeeba 56 (28%)	3 (1.5%)	4 (2%)	1 (0.5%)	18 (9%)	30 (15%)
	Not Sure 26 (13%)		2 (1%)	2 (1%)	8 (4%)	14 (7%)

Table 6.24: Change in Response to Scale One: Item 4

Item	Response before Training	Response after Training				
		Certainly Habeeba	Tend towards Habeeba	Not Sure	Tend towards Amira	Certainly Amira
4	Certainly Habeeba 25 (12.5%)	1 (0.5%)	4 (2%)	3 (1.5%)	9 (4.5%)	8 (4%)
	Tend towards Habeeba 44 (22%)		8 (4%)	2 (1%)	14 (7%)	20 (10%)
	Not Sure 32 (16%)	1 (0.5%)	1 (0.5%)	4 (2%)	12 (6%)	14 (7%)

As can be seen from Tables 6.23 and 6.24, it is interesting to notice the pattern of shift in teachers' attitude towards these items from "Certainly Habeeba" and "Tend towards Habeeba" responses before training, to "Tend to Amira" and "Certainly Amira". What is especially interesting in these items is that, of the relatively large number of teachers who had answered "Not Sure" before the training, only 2 (1%), for item 3, and only 4 (2%), for item 4, were still unsure after training. Almost all the rest had moved clearly towards the constructivist perspective.

This trend of movement towards a constructivist approach throughout the scale, is consistent with Wise and Groom's (1996) finding that, after experiencing multimedia project-based learning, teachers developed a positive attitude about the importance of technology such as multimedia in students' learning, and teachers believed that technology had a re-energizing effect on their teaching and made them more excited and interested. The approach has shown some advantages in terms of student learning because the very act of completing a project requires the students to engage themselves in a complex process of inquiry and design (Blumenfeld et al., 1991; Elliott, 1998; Guzdial, 1998; Katz, 1994). Project-based learning can develop skills in children to enable them to be self-motivated learners (Elliott, 1998; Katz, 1994). Observation data (Chapter Seven, section 7.2.2.1) show that students were highly motivated during IT lessons to the extent they refused to leave the RLC after the lessons. In the interviews (Chapter Seven, section 7.3.1.1) LRC teachers noted students' motivation during IT lessons; they maintain for example, that students were more eager to learn and actively involved and interested.

It can be argued from the descriptive statistics that the number of teachers who favoured the constructivist learning approach increased and the number of those favouring the traditional approach decreased after training and practice. This is in line with the interviews findings; almost 90% of teachers expressed their positive attitude towards the constructivist approach in phrases such as: "interesting", "useful", "successful", "good" and "an excellent way of teaching".

Significance of changes in teachers' attitude towards the advantages of the new approach was investigated by addressing the following null hypothesis:

> ***There is no significant difference between teachers' attitude towards the advantages of the new approach before and after the training and practice.***

Table 6.25: The Result of Paired Sample t-Test for the Advantages of the new Approach.

Items compared	Mean before	Mean after	Mean difference	t-value	df	P value
Teachers' attitude towards the advantages of the new approach.	15.74	20.72	-4.97	-9.73	199	0.00

As shown in Table 6.25, the paired sample t-test based on mean scores before and after training revealed a significant difference between teachers' attitude towards the advantages of the new approach. The mean difference, shown in the table, indicated an increase in positive attitude after the training and practice. Therefore, the null hypothesis was rejected.

6.5.1.2 Teachers' attitude towards pupils' role.

The results in Table 6.26 indicate that teachers had consistently positive attitudes towards the constructivist role of pupils after the training. As can seen from the table, the proportion of teachers answering "Agree" and "Strongly Agree" for the positively worded items, (2, 4, 6 and 8) and the proportion answering "Disagree" and "Strongly Disagree" for the negative items (1, 3 and 7) totalled over 80%. The shift towards a constructivist perspective was less marked for item 5 than other items; the "Disagree" and "Strongly Disagree" responses combined totalled 70.5%.

Further a similar trend can be seen in responses to the remaining items in the scale. For example, in item 1, 50% "Disagree" and 35% "Strongly Disagree" of teachers after training totally agreed that pupil should have passive role against 8.0% "Disagree" and 24.5% "Strongly Disagree" responses, before the training. 11% "Agree" or "Strongly Agree" teachers still believed that pupils should be passive recipients of information, while 4% teachers gave a neutral response. The item had less shift to the constructivist perspective than the remaining items. This gives an indication that teachers were still not confirmed in their attitude that pupils should be active knowledge seekers. However, Dwyer, et al. (1991) maintain that as teachers grow in their use of technology, they become more willing to experiment, and their teaching becomes more student-focused. Dusick (1998) maintains that before teachers will change their classroom instruction to integrate technology, they must change their beliefs and this takes time.

Table 6.26: Descriptive Statistics for Teachers' Attitude towards Pupils' Role before and after Training

Pupils' Role	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1- Student should be passive recipient of information.	24.5	8.0	16.0	9.0	42.5
	35.0	50.0	4.0	5.0	6.0
2- Student should think about information while learning.	2.5	19.5	13.5	49.0	15.5
	2.0	7.0	6.5	39.5	45.0
3- Student should choose resources and sources.	1.0	15.5	19.0	42.5	22.0
	2.0	7.5	6.5	43.0	41.0
4- Each student should work alone.	30.0	8.0	25.5	4.5	32.0
	45.5	38.5	8.0	2.5	5.5
5- Student should rely on other members do his/her part.	27.5	3.0	22.0	6.0	41.5
	39.5	31.0	8.5	6.0	15.0
6- The use of groups' "experts".	1.5	21.5	23.0	44.5	9.5
	3.5	7.5	7.0	42.0	40.0
7- Student should not be responsible for his/her learning.	28.5	14.0	16.5	6.5	34.5
	47.5	34.5	10.0	1.0	7.0
8- Student should analyse, evaluate, and synthesize information.	3.5	21.0	20.0	44.5	11.0
	3.0	7.0	5.5	42.0	42.5

As mentioned in section 6.4.1.2, items 4, 5, 6 and 8 were of particular concern. Item 5, negatively worded had high agreement, and item 4, positively worded, had particularly high disagreement; items 5, 6, 7 and 8 had the highest uncertainty. Therefore, these were all items with comparatively high scope for change.

Table 6.27: Change in Response to Scale Two: Item 5

Item	Response before Training	Response after Training				
		S. Disagree	Disagree	Not Sure	Agree	S. Agree
5	S. Agree 83 (41.5%)	30 (15%)	30 (15%)	5 (2.5%)	6 (3%)	12 (6%)
	Not Sure 44 (22%)	16 (8%)	14 (7%)	5 (2.5%)	2 (1%)	7 (3.5%)

As can be seen from Tables 6.27 and 6.28, after training it seems that there was a shift in attitudes in these items. For item 5, only 12 of the 83 teachers who had originally answered "Strongly Agree" remained unchanged in attitude, most of the rest moving towards "Disagree" or "Strongly Disagree". Of those who had initially been uncertain, in item 5, only 5 (2.5%) remained so. Again the movement was generally towards the "Disagree" and "Strongly Disagree" categories.

Table 6.28: Change in Response to Scale Two: Items 4, 6 and 8

Item	Response before Training	Response after Training				
		S. Disagree	Disagree	Not Sure	Agree	S. Agree
4	S. Disagree 64 (32%)	5 (2.5%)	1 (0.5%)	5 (2.5%)	22 (11%)	31 (15.5%)
6	Not Sure 46 (23%)	1 (0.5%)	3 (1.5%)	4 (2%)	22 (11%)	16 (8%)
8	Not Sure 40 (20%)	0	1 (0.5%)	3 (1.5%) (	21 (10.5%)	15 (7.5%)

As it is shown in Table 6.28, in item 4, there was a shift from "Strongly Disagree" towards "Strongly Agree" and a lesser extent, "Agree". For items 6 and 8, there was a shift from "Not Sure" towards "Agree" and, to lesser extent, “Strongly Agree”. Around 8% of the teachers shifted to “Strongly Agree”. Around 2% of the teachers remained in the “Not Sure” category for these two items. This might indicate that although training had changed teachers’ attitude in these items, still teachers in these categories had not confirmed their attitude.

Teachers’ positive attitude towards the use of “experts” (item 6) is consistent with data obtained from observation and interviews. Observation data (Chapter Seven, section 7.2.3.3) reveals that teachers enlisted the help of some students who knew more than the others, to act as experts during IT lessons, helping both teachers and students. In the interviews (Chapter Seven, section 7.3.1.2) teachers reported their positive attitudes towards the “expert” role of students. For example teachers felt that such a role gave high self esteem to student experts, and freed teachers to work with others.

Overall, Table 6.26 shows an increase in teachers’ positive attitude towards the new role of pupils as active learners. This is consistent with Anderson, et al. (1995), Hannafin and Savenye (1993) and Trigwell and Prosser (1996) who claim that constructivist teachers have a positive attitude towards pupils’ active role in their learning. The result is also consistent with observation data and interviews. Section 7.2.3.2 (Chapter Seven) shows that during IT lesson students were actively engaged in their learning; they search for information using different resources. A further result from interviews (Chapter Seven, section 7.3.1.2) shows that around 80% of teachers concurred with students’ active roles. Teachers expressed that students learnt through experience, were more independent in their learning and used different resources through different technologies.

However, was the increase in positive attitude towards a constructivist role for pupils significant? The following null hypothesis of the study was addressed to test the significance:

There is no significant difference between teachers' attitude towards pupils' role before and after the training and practice.

Table 6.29: The Result of Paired Sample t-Test for Pupils' Role

Items compared	Mean before	Mean after	Mean difference	t-value	df	P value
Teachers' attitude towards pupils' role	26.28	32.66	-6.38	-12.37	199	0.00

The result of a paired sample t-test, shown in Table 6.29, revealed that there was a significant difference between teachers' attitude on pupils' role. The mean difference indicated an increase in positive attitude after the training. Therefore, the null hypothesis was rejected.

6.5.1.3 Teachers' attitude towards teachers' role

The results revealed that after the training, the majority of teachers (more than 90%) reported a positive attitude towards teachers' constructivist role. As can be seen from Table 6.30 there was a broad shift in teachers' attitudes towards this role, as more than 90% of the teachers agreed or strongly agreed with items 1-7 and item 10. This shift was expected in a constructivist learning environment. According to Hannafin and Savenye (1993), constructivist teachers in a hi-tech constructivist learning environment relinquish some control and consequently accept a different role and ideology. Penuel and Means (1999) found that teachers were more likely to be engaged in assisting or helping students by moving about the classroom and responding to student questions or providing help when they see a need for it.

It seems that teachers had little choice but to accept their role in the new approach. According to McKinnon, Nolan and Sinclair (1997, p.7) in response (to learning environment) teachers could not change or adapt their strategies to meet the demands of the new situation.

Further, for example, after the training, 41% "Agree" and 55% "Strongly Agree" of the teachers had a positive belief about item 1 compared to 28.5% "Agree" and 27.5% "Strongly Agree", before the training. Responses to item 1 emphasize a general agreement about teachers' role in providing guidance for pupils. Item 4 and item 6 indicate teachers' acceptance of teachers' role in monitoring pupils' learning process. Teachers had a positive attitude towards their new role as coach, guide, organizer and initiator, similar to those proposed by Hannafin and Savenye (1993) and Means and Olson (1995a).

In item 10, after training 52.5% "Agree" and 42.5% "Strongly Agree" of teachers totally agreed on their role regarding giving clues and hints as compared to 31% "Agree" and 19% "Strongly Agree", before the training. Approximately 40% of the teachers had changed their beliefs about knowledge construction from traditional beliefs, i.e., teacher as a knowledge dispenser, to constructivist beliefs, i.e., teacher provides hints. It is clear that, after the training, only 2% of respondents held the traditional role of the teacher as a knowledge dispenser. This was an anticipated result because it is consistent with item 1 in section 2, where 85.5% "Agree" or "Strongly Agree", of teachers reported having a positive belief about pupils constructing their knowledge. The implication is that the training (and practice) had a particularly strong impact, in respect of these items, in encouraging teachers to take a more constructivist role.

Table 6.30: Descriptive Statistics for Teachers' Attitude towards Teachers' Role before and after Training and Practice.

Teacher's Role	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1- Provide students with guidance when they need it.	12.0	26.5	6.0	28.0	27.5
	1.5	0.5	2.0	41.0	55.0
2- Provide students with resources and sources of information to do their tasks.	12.0	29.0	8.5	27.5	23.0
	1.0	1.0	5.5	51.5	41.0
3- Facilitate the cooperation among students in their groups.	14.0	26.5	5.5	31.5	22.5
	0.5	1.5	4.5	46.0	47.5
4- Walk around to check students' work.	17.5	25.0	6.0	26.0	25.5
	0.5	0.5	5.0	44.5	49.5
5- Suggest resources inside and outside LRC for the students.	8.5	33.5	5.0	37.0	16.0
	1.0	1.0	4.5	48.5	45.0
6- Observe students working with computer application and other technologies.	14.5	25.5	6.0	32.5	21.5
	0.5	1.0	3.5	41.0	54.0
7- Discuss with students their choices of material.	17.0	25.5	6.0	40.0	11.5
	1.0	1.5	5.5	45.0	47.0
8- Assign roles to each member and give a chance for everyone to take turn in IT lessons.	8.0	29.0	18.5	33.0	11.5
	0.5	8.5	6.5	51.0	33.5
9- Give grades to individual group member based on the performance of the entire group.	10.0	24.5	22.5	36.0	7.0
	3.0	10.0	9.0	42.5	35.5
10- Give clues and hints when students ask questions, but not direct answers.	11.5	26.0	12.0	31.5	19.0
	1.5	0.5	3.0	52.5	42.5

The shaded rows indicate after the training and practice.

In section 6.4.1.3, it was noted that items 8 and 9 had the highest number of uncertain responses in this scale. Therefore, further analysis was carried out to trace the attitude in these two categories after the training. Table 6.31 shows that for both items, the trend of the change in teachers' attitude is rather to the "Agree" category than to the "Strongly Agree" category. There is also a trend to change to the negative side; however, this is less than the trend to positive side. Only a few teachers (1%) remained unsure about item 8. This is consistent with observation data; (encouraged by LRC teachers) during IT lessons one of the frequently observed student behaviours was turn taking. For item 9, it is interesting to notice that 9% of teachers were uncertain; and teachers had been unsure before training also, while 6 moved from "Agree to "Not Sure". The result of this item might indicate that teachers are still uncertain how to assign grades for individuals based on group activity. For further training teachers need to be exposed to different types of techniques for evaluating individual students within his/her group, such as those proposed by Bennett and Dunne (1994): post-task interviews, whole-class discussion and post-task written tests.

Table 6.31: Change in Response to Scale Three: Items 8 and 9

Item	Response before Training	Response after Training				
		S. Disagree	Disagree	Not Sure	Agree	S. Agree
8	Not Sure 37 (18.5%)	1 (0.5%)		2 (1%)	21 (10.5%)	13 (6.5%)
9	Not Sure 45 (22.5%)	1 (0.5%)	1 (0.5%)	8 (4%)	18 (9%)	17 (8.5%)

Generally speaking, the training had changed teachers' view of the teachers' role to a more constructivist role of facilitator, guide and monitor. The overall results of teachers' attitudes towards teachers' constructivist role is supported by observational and interview data. In section 7.2.1 (Chapter Seven), observation data show that the teachers often took the role during IT lessons of monitor, facilitator and helper rather the knowledge dispenser. In the interviews (Chapter Seven, section 7.3.1.3), 82% expressed their positive attitude about the new role; they commented that their role during IT lessons was to provide assistance, offer help, guide students with work, and discuss students' inquiries with them.

However, was this change significant? The following null hypothesis was tested:

There is no significant difference between teachers' attitude towards teachers' role before and after the training and practice.

Table 6.32: The Result of Paired Sample t-Test for Teachers' Role

Items compared	Mean before	Mean after	Mean difference	t-value	df	P value
Teachers' attitude towards teacher's role	31.72	43.18	-11.46	-12.67	199	0.00

The paired sample t-test (Table 6.32) indicated that there was a statistically significant difference between teachers' attitude towards teachers' role before and after the training with teachers appearing to favour more a constructivist teacher's role after the training. The difference in teachers' attitude was significant. Therefore the null hypothesis was rejected.

6.5.1.4 Teachers' attitude towards cooperative and collaborative learning

As it can be seen from Table 6.33, for most items, the overall amount of agreement ("Agree" and "Strongly Agree") and disagreement ("Disagree" and "Strongly Disagree") stayed the same reflecting the lack of room for change noted earlier, since the majority of teachers had a positive attitude already towards most the items in the section, before the training. As it can be seen from the table, there was a consistently positive attitude among the teachers in items: 1, 3 to 5 and 9 to 12, after the training, with around 80% (combining "Agree" and "Strongly Agree") of the teachers having positive attitudes. For example, after the training 46.5% "Agree" and 38% "Strongly Agree" of the teachers believed students should perform different tasks towards their team work (item 1), compared to 65% "Agree" and 16.5 "Strongly Agree" before the training.

The main shift, in relation to these items, was from the "Agree" to the "Strongly Agree". In other words, teachers were already positive in attitude before the training, but were even more so afterwards. There was little or no change in the minority expressing disagreement with these items. This positive attitude is consistent with observation data (Chapter Seven, section 7.2.3.4) which reveal cooperation and collaboration among

Table 6.33: Descriptive Statistics for Teachers' Attitude towards Cooperative and Collaborative Learning before and after Training.

Cooperative and Collaborative learning	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1-Members perform different tasks (e.g. some work on computer, others look for resource or write draft).	1.5	6.0	10.5	65.5	16.5
	1.5	7.5	6.5	46.5	38.0
2- Each group should be composed of mixed gender (boy and girls).	6.0	23.5	37.0	25.5	8.0
	1.5	8.0	11.0	50.0	29.5
3- Each group should consist of mixed abilities.		6.5	9.5	58.0	26.0
	1.0	4.5	6.0	42.0	46.5
4- Group members should cooperate to accomplish joint tasks.		6.5	12.0	62.0	19.5
	0.5	5.5	6.0	41.0	47.0
5- Group members should interact with each other in their group, asking and questioning.		5.5	9.0	64.0	21.5
		6.0	7.0	45.0	42.0
6-Group members perform different tasks towards one goal.	0.5	6.5	13.0	61.0	19.0
	0.5	5.5	7.0	44.0	43.0
7-Group members should contact other group members to seek help.	5.0	29.0	31.5	30.0	4.5
	2.0	5.5	11.0	51.5	30.0
8- Group members should present their work as group work, not as individual work.		6.0	19.0	53.0	22.0
		5.5	7.0	36.5	51.0
9- Group members should subdivide a complex task among themselves.	1.0	5.0	12.0	67.5	14.5
	0.5	6.5	7.0	47.0	39.0
10- Group members share information.		5.5	10.0	58.0	26.5
		5.5	7.0	40.5	47.0
11-Group members should help each other to achieve their goals.	0.5	7.0	8.5	58.5	25.5
	1.0	7.5	8.0	44.5	39.0
12- Groups should see and evaluate each other's projects.		6.0	12.0	64.0	18.0
	0.5	7.5	7.5	48.0	36.5
13- Students will take more initiative to learn when they feel free to move around in the LRC during IT lessons.	2.0	23.5	21.0	34.5	19.0
		8.5	6.5	35.5	49.5

The shaded rows indicate after the training and practice.

students in LRCs when observed during off-computer activities and on-computer activities, and that LRC teachers allowed and encouraged a lot of interaction between themselves and their students and among students. In the interviews, all teachers expressed their positive attitude about cooperative and collaborative learning. Their attitude was clear from their statement such as "result in better learning" "Weak students learn from other" and "Students can share information and skills".

It is interesting, however, to note that for items 2, 7 and 13 there were large reductions in the numbers of teachers expressing disagreement. There were also particularly high reductions in the number of "Not Sure" responses for these items, compared with the rest of the scale. The implication is that the training had a particularly strong impact, in respect of these items, in encouraging teachers to take a more constructivist viewpoint.

Table 6.34 shows that, for item 2, there was a shift in teachers' attitude towards the agree side (57 teachers) and a very small shift towards the disagree side (8 teachers). Around 4.5% of teachers were still uncertain.

This indicates that there are some teachers who had some reservations about the idea of mixed sex groups, which is not surprising because segregation is a traditional core value in Oman society.

Table 6.34: Change in Response to Scale Four: Items 2, 7 and 13

Item	Response before Training	Response after Training				
		S. Disagree	Disagree	Not Sure	Agree	S. Agree
2	Not Sure 74 (37%)	1 (0.5%)	7 (3.5%)	9 (4.5%)	36 (18%)	21 (10.5%)
7	Not Sure 63 (31.5%)	1 (0.5%)	4 (2%)	9 (4.5%)	31 (15.5%)	18 (9%)
13	Not Sure 42 (21%)		6 (3%)	4 (2%)	14 (7%)	18 (9%)

For items 7 and 13 (Table 6.34), there were some teachers who were still uncertain, though there was a shift to the agree side. In item 13 the shift was more to "Strongly Agree" than to "Agree". For item 13, this might indicate that after training, teachers saw students' movement in the LRC as essential to look for resources; this can be supported from observation data, as teachers were frequently observed helping students to find and select resources (see Chapter Seven, section 7.2.1). However, students going to other groups' members to seek help might have given teachers the impression that students were not learning (Ringstaff and Yocam, 1995).

A similar point was made by Dwyer, et al. (1991). In their study, teachers wondered how learning could occur in such a noisy learning environment, because students, working in collaborative learning groups, became excited over what they were finding and discussed these findings.

Overall, there was an increase in teachers' beliefs about cooperation and collaboration among students after the training. However, was the change significant? This leads to the testing of the following null hypothesis:

There is no significant difference between teachers' attitude towards cooperative and collaborative learning before and after the training and practice.

Table 6.35: The Result of Paired Sample t-Test for Cooperative and Collaborative Learning.

Items compared	Mean before	Mean after	Mean difference	t-value	df	P value
Cooperative and Collaborative Learning	49.1300	54.4650	-5.3350	-6.716	199	0.00

As shown in Table 6.35, by using a paired sample t-test, the results indicate that there was a significant difference in teachers' attitude towards cooperative and collaborative learning before and after the training.

6.5.1.5 Teachers' attitude towards IT as content

Table 6.36 shows that there was consistency in teachers' beliefs about viewing IT as content before the training and after the training; approximately 73% (combined "Agree and "Strongly agree") of teachers expressed positive views before, and 79% after the training. This is in line with the interview results in which almost 95% of teachers expressed their positive attitudes towards these activities (Chapter Seven, section 7.3.1.5). Robinson (1998) attributed the positive attitude to the meaningful use of technology (IT as activities) in students' learning (through integration). Because teachers were not using these activities during IT lessons before, they developed a positive attitude about their usefulness. However, as can be noticed from the table, even after training, there was a high proportion of "Not Sure" responses in several items of this scale, compared with the previous ones. Since IT activities required the use of different technologies, teachers' uncertainty might be explained by not having enough technology to complete the activities, not having sufficient content and technical knowledge or by the fact that teachers encountered technical problems during their implementation.

Boettcher (1995) argues that the core principles of access to all types of instructional technology depend on the technical support provided for teachers. It might be argued that if technical problems occurred repeatedly and teachers had to wait for a long time to get them solved, then they might abandon the attempts to integrate technology into their teaching. Liu (2001) found that computers crashed and files were lost most frequently during project-based learning.

Conte (1998) identified several technical problems encountered by teachers while integrating technology, for example, broken equipment, network problems, machines that are not working properly and server problems. Research (e.g. Honey and Moeller, 1990; Wise and Groom, 1996) suggests that these problems can negatively influence teachers' attitude towards technology integration.

Teachers might have felt uncertain because they did not have content or technical knowledge. Blumenfeld, et al. (1991, p.382) maintain that one factor that has an impact on the implementation of constructivist approach to learning and teaching is teachers' content knowledge, which can be insufficient to meet the standards covered in students' learning. Sandholtz, et al. (1992) maintain that some teachers were upset because they knew less than students about hardware and software.

In fact, teachers during interviews (Chapter Seven, section 7.3.2.1) raised those points which affected their integration practice. Teachers mentioned that they lacked insufficient teaching experience of how to use technologies; they encountered technical problems such as the inconsistency of the network, regular computer crashes and difficulties in sending files over the network. They also reported insufficient equipment. LRC teachers considered these issues as barriers for effective integration. These problems were also highlighted during observation (Chapter Seven, section 7.2.3); teachers were seen to struggle to solve these problems.

Table 6.36: Descriptive Statistics for Teachers' Attitude towards IT as Content before and after Training.

IT as Content	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1- IT activities should be integrated across subjects (should contain at least one subject).	5.0	4.5	20.5	48.5	21.5
	5.0	**3.5**	**6.5**	**46.0**	**39.0**
2- IT activities should be related to students' real life.	1.0	5.5	17.5	36.0	40.0
		7.0	**9.5**	**46.0**	**37.5**
3- IT activities should involve the use of more that one type of technology applications.	1.0	5.0	18.5	46.5	29.0
	0.5	**5.0**	**17.5**	**36.0**	**41.0**
4- IT activities should require the use of wide range of material available in LRC.	0.5	9.5	14.0	46.5	29.5
		7.0	**13.0**	**44.0**	**36.0**
5- IT lessons should be related to students' personal interest.	4.0	6.0	20.0	45.5	24.5
	1.0	**5.5**	**19.0**	**40.0**	**34.5**
6- IT activities contain skill and ideas transferred from previous activities (background knowledge).	3.0	3.5	21.5	55.0	17.0
	0.5	**5.0**	**19.0**	**43.5**	**32.0**

The shaded rows indicate after the training and practice.

It is interesting to note that teachers valued the importance of integrating IT across different subjects and relating IT activities to students' real life after training, more than before the training. Table 6.36 shows that 85% of the teachers (46% "Agree" and 39% "Strongly Agree") believed in IT integration (item 1) after training, compared to 70% of them (48.5% "Agree" and 21.5% "Strongly Agree") before training, indicating a more positive attitude towards integrating IT across subjects. For item 2, 83% ("Agree" or "Strongly Agree") of the teachers believed that IT activities should be related to students' real life. The implication is that the training had a particularly strong impact in these items as the teachers saw the best and most successful way of teaching IT is by integrating across other subjects. Wetzel and Chisholm (1998) found that the majority of teachers who participated in their programme highly valued the integration of technology (multimedia) across language and arts. Hewitt and Scardamatia (1998) found that teachers in their study held the same attitude to IT content.

Similarly, Abbott and Faris (2000) found that teachers in their study after training had a more positive attitude towards the ideas of integrating technology into other subjects. According to Hooper and Rieber (1995), to use information technology effectively, teachers should integrate technology across the curriculum. Research does suggest that integrating technology leads to gains in the higher-order skills of thinking critically, and solving complex problems. For example, McKinnon, et al. (1997) in New Zealand, found that integration of technology across some subject areas contributed to higher performance in English, mathematics, and science.

Table 6.37: Change in Response to Scale Five: Items 1 and 6

Item	Response before Training	Response after Training				
		S. Disagree	Disagree	Not Sure	Agree	S. Agree
1	Not Sure 20.5% (41)	1.5% (3)	0.5% (1)		20.5% (41)	7.5% (15)
6	Not Sure 21.5% (43)		1% (2)	3% (6)	10.5% (21)	7% (14)

As stated in section 6.4.1.5, items 1 and 6 caused some concerns because of the high uncertainty in teachers' attitude towards the two items, so further analysis was carried out to see the exact nature of attitude change. As can be seen in Table 6.37, the trend of attitude change was more towards "Agree" than "Strongly Agree". In item 1, it seems that teachers who had previously been unsure, made up their mind after the training, whether to agree (41 teachers) or disagree (15 teachers). Similarly, in item 6, 43 previously uncertain teachers moved to "Agree" and "Strongly Agree", respectively. Only 6 (3 %) remained uncertain towards item 6.

The findings give an indication that most teachers were in favour of the new IT activities. For example, referring to Chapter Seven, section 7.2.3.5, the teachers' behaviours observed from the videotapes and observational notes revealed that after teachers had told the students about the topic, they checked their prior knowledge. It can be argued that training to some extent influenced teachers to change their minds in favour of the new approach.

It can be argued that teachers' beliefs before the training tended towards constructivist beliefs, a trend that was increased after training. However, was there any significant difference in teachers' beliefs about IT as content before and after the training and practice? The following null hypothesis was tested.

There is no significant difference between teachers' attitude towards IT as content before and after the training and practice.

Table 6.38: The Result of Paired Sample t-Test for IT as Content

Items compared	Mean before	Mean after	Mean difference	t-value	df	P value
IT as content	23.38	24.48	-1.10	-2.50	199	0.013

The results of a paired sample t test, shown in Table 6.38, revealed that there was a statistically significant difference in teachers' attitude towards IT as content. The table shows that the mean score of teachers' attitude after the training was higher than before the training. Therefore the null hypothesis was rejected.

6.5.1.6 Teachers' attitude towards assessment

Table 6.39, shows that after the training, more teachers agreed on the usefulness of alternative assessment in this setting, and more teachers believed a traditional assessment was not useful. For alternative assessment about 84% (combining "Agree and "Strongly Agree") of the teachers saw items 1, 3 and 4 as very useful and essential after the training. For example, the table shows that 37.5% and 49.5% of the teachers agreed and strongly agreed on the value of multimedia presentation, respectively. Item 2 had fewer proponents than the previously mentioned item; taking "Agree" and "Strongly Agree" categories together, approximately 74% of the teachers favoured this item. This may be due to teachers' understanding that writing a report can be considered a form of traditional assessment.

Table 6.39: Descriptive Statistics for Teachers' Attitude towards Alternative Assessment before and after Training.

Alternative assessment	S. Disagree	Disagree	Not Sure	Agree	S. Agree
	%	%	%	%	%
1-Multimedia presentation of their final work.	8.5	14.0	18.0	51.5	8.0
	2.0	4.0	7.0	37.5	49.5
2-Written reports on their projects.	10.0	8.0	30.0	37.0	15.0
	1.5	5.5	19.0	49.0	25.0
3- Self-assessment.	5.0	10.0	21.5	43.5	20.0
	1.5	5.5	6.0	47.5	39.5
4- Electronic portfolio.	4.5	7.0	26.5	43.5	18.5
	0.5	5.5	10.0	50.5	33.5
5- True and false test items.	5.5	15.5	39.5	35.5	4.0
	30.5	9.5	22.0	29.5	8.5
6- Short-answer and multiple-choice tests.	2.5	20.0	32.5	41.5	3.5
	30.0	11.0	16.0	31.5	11.5
7- Extended answer items.	7.0	17.0	38.0	33.0	5.0
	30.5	12.5	19.5	30.0	7.5

The shaded rows indicate after the training and practice.

There was a greater tendency among teachers to disagree with traditional assessment after the training. Overall, approximately 41% (combined "Disagree" and "Strongly Disagree") of the teachers disagreed after the training, compared to approximately 23% of the teachers before the training. For example, 24% of the teachers disagreed with the use of extended answer items (item 7) before training compared to 43% of the teachers after training and implementation.

However, as can be seen from Table 6.39, the proportion of teachers favouring traditional assessment, i.e., those who answered "Agree" or "Strongly Agree" for items 5 to 7, was larger than the proportion who rejected constructivist assessment (those who answered "Disagree" or "Strongly Disagree" to items 1 to 4). It therefore seems that although teachers were, after training, more aware of the value and use of alternative assessment than they had been previously, they still favoured a mixture of methods. This can be explained by the fact that teachers show mixed belief and practice, combining elements of the constructivist approach and the traditional approach (Klein, 1996; Collinson, 1996).

As further analysis to trace changes in "Not Sure" responses, in items 5, 6, and 7, was proposed in section 6.4.1.6. Table 6.40 shows the outcome. The general shift in attitude among teachers who answered "Not Sure" before training for items 5, 6, and 7 was more to disagree, (19% combined "Strongly Disagree and "Disagree") than to agree, (11% combined "Strongly Agree" and "Agree"). It is interesting to note that the change in attitude to disagree was in the "Strongly Disagree" category, while change in attitude, towards agree, was in the "Agree" category. This can indicate that although training and practice influenced some teachers who were uncertain, still some teachers preferred the traditional assessment.

Table 6.40: Change in Response to Scale Six: Items 5, 6 and 7

Item	Response before Training	Response after Training				
		S. Disagree	Disagree	Not Sure	Agree	S. Agree
5	Not Sure 79 (39.5%)	33 (16.5%)	6 (3%)	15 (7.5%)	18 (9%)	7 (3.5%)
6	Not Sure 65 (32.5%)	32 (16%)	6 (3%)	6 (3%)	14 (7%)	7 (3.5%)
7	Not Sure 76 (38%)	29 (14.5%)	10 (5%)	10 (5%)	23 (11.5%)	4 (2%)

Teachers' overall attitude towards alternative assessment after training was slightly more positive than before the training. Teachers' different values to assessment are in line with the interviews result (Chapter Seven, section 7.3.1.6) which indicates that 80% of teachers were in favour of constructivist assessment and 20% in favour of traditional assessment. For example, in the interviews, teachers saw alternative assessment as a relief for them; it took the burden off their shoulders.

Such a result is consistent with David's (1996) viewpoint: teachers struggled with fundamental incongruities between traditional assessment measures and the kinds of learning occurring in their classrooms. In fact, assessment problems proved to be the most resistant to solutions and many remained unresolved. Lundererg, et al. (1997) reported that teachers were not sure how to assess students using projects their students created.

To see whether the attitude change was significant, the following null hypothesis was tested:

There is no significant difference between teachers' attitude towards alternative assessment before and after the training and practice.

Table 6.41: The Result of Paired Sample t-Test for Alternative Assessment

Items compared	Mean before	Mean after	Mean difference	t-value	df	P value
Alternative assessment	22.51	26.17	-3.66	-10.47	199	0.000

The result of a paired sample t-test of the above hypothesis is presented in Table 6.41. The result revealed a significant difference in teachers' attitude. The mean difference indicates that teachers' attitude after the training tended more towards alternative assessment. Therefore, the null hypothesis on alternative assessment was rejected.

6.5.1.7 Teachers' attitude towards IT goals

From Table 6.42, for traditional IT goals, items 1 and 3, there was an increase in the percentages of teachers who were undecided and a reduction in the percentages of teachers who viewed these goals as important. Also, as can be seen from the table there was a shift from "Important" to "Undecided". For example, in item 1, after training there was a substantial increase in the percentage of teachers (25%) who were undecided and a similar decrease in the percentage of teachers (25%) who saw this goal as important, giving an indication that teachers became less in favour of using technology to prepare pupils for future jobs.

For two of the items reflecting constructivist IT goals, items 2, and 5, after the training there was a reduction in the percentages of teachers who were undecided and an increase in the percentages of teachers who these goals as important, although in item 5 the change was very small. For item 4 there was a small reduction in the percentage of teachers who saw the goal of IT as deepening students' understanding. It seems that some teachers had changed their minds about the importance of this goal. This may be due to the fact that those teachers had not seen this goal of technology use fulfilled during the implementation of the new approach, since understanding is a complex process.

Table 6.42: Descriptive Statistics for Teachers' Attitude towards IT Goals before and after Training.

Teachers' Attitude towards IT Goals Items	Not important	Undecided	Important
	%	%	%
1- To prepare students for future jobs.		19.0	81.0
		44.0	56.0
2- To promote active learning strategies.		50.5	49.5
		31.0	69.0
3- To improve pupils' achievement scores.		34.5	65.5
		49.5	50.5
4- To deepen students' understanding.		36.5	63.5
		39.0	61.0
5- To support instructional reform.		45.0	55.0
		41.5	58.5

The shaded rows indicate after the training and practice.

After the training, although the shift in the 'undecided' category in items 4 and 5 was minimal compared to item 2, teachers' responses in this category for these items remained high (31% for item 2, 39% for item 4 and 41.5% for item 5). The high level of "Undecided", in relation to IT goals, could be interpreted by the fact that teachers were not involved in designing their own learning objects and they may not have felt part of the decision making with respect to the innovation. This can be considered as a factor influencing teachers' attitude (Parr, 1999).

In item 2, after the training teachers became more in favour of using technology to promote active learning strategies. After the training there was a reduction in the percentage of teachers (31% after compared to 50.5% before training) who were undecided and an increase in the percentage of teachers (69% after compared to 49.5% before) who thought that technology should promote active learning strategies. The implication is that the training (and practice) had a particularly strong impact, in respect of this item, in encouraging teachers to take a more constructivist view. The result was anticipated because the goal of technology in a constructivist learning setting is to support and promote active learning strategies rather than promoting discrete skills (for example, Collins, 1991 and Kommers, Jonassen and Mayes, 1992). Traditional computer use (drill and practice) demonstrates little advantage in enhancing students' learning (Becker, 1994; Mergendoller, 2000).

As can be seen from the table, after the training, the number of teachers who favoured traditional IT use had decreased and the number of teachers in favour of constructivist IT use had increased. In the interviews (Chapter Seven, section 7.3.1.7) teachers reported the use of IT as a processing tool for understanding, as a searching tool to obtain information, and a manipulating tool. Similar uses were proposed by Hill and Hannafin (2001) in resource-based learning.

Further inquiry was needed to explore the relationship between teachers' attitude towards IT goals before and after the training, by testing the following null hypothesis of the study:

There is no significant difference between teachers' attitude towards goals of IT use before and after the training and practice.

Table 6.43: The Result of Paired Sample Test for IT Goals

Items compared	Mean before	Mean after	Mean difference	t-value	df	P value
IT Goals	10.21*	10.82*	-0.61	-6.51	199	0.192

*The means of 3 point-Likert-scale.

The result of a paired sample t-test, shown in Table 6.43 revealed that there was no significant difference in teachers' attitude before and after the training indicating that teachers valued the importance of goals related to both kinds of technology use. This finding is consistent with what Lundeberg, et al. (1997) had to say in this regard. Therefore the null hypothesis was accepted.

6.5.1.8 Summary

After the training, teachers' general attitude towards the constructivist learning environment was positive. Table 6.44 shows the composite mean scores before the training and implementation which, except for IT Goals, were slightly above average, and mean scores after training, which (again, except for IT Goals) were close to strong agreement.

Table 6.44: The Composite Means and Standard Deviations of the Seven Scales before and after Training.

Sections	Before Training		After Training	
	Means	S.D.	Means	S. D.
Teachers' attitude towards the advantages of the new approach	3.15	1.24	4.14	0.91
Teachers' Attitude towards Pupils' Role.	3.29	0.65	4.10	0.87
Teachers' attitude towards teachers' role.	3.17	1.22	4.32	0.41
Teachers' attitude towards cooperative collaborative learning.	3.78	0.57	4.19	0.68
Teachers' attitude towards IT as content.	3.89	0.72	4.10	0.71
Teachers' attitude towards assessment.	3.22	0.53	3.74	0.69
Teachers' attitude towards IT goals.	2.62*	0.28	2.60*	0.29

*The means and St. Deviation based on 3 point-Likert-scale.

The highest mean score (4.32) was for teachers' role in the learning environment, suggesting that teachers strongly supported teachers' role as facilitators, monitors and guides. The change in teachers' beliefs about assessment was small because, although they took a more positive stance, after the training, towards alternative assessment, they did not necessarily reject traditional assessment. Hence, this scale had a comparatively low mean score, (3.74). One dimension on which teachers' attitude remained unchanged was IT goals. The mean score of 2.60 reflects the high level of uncertainty in relation to this scale.

6.5.2 Relationship between teachers' Attitudes and personal characteristics

In the previous section evidence has been presented that training changed teachers' beliefs; the findings in that section showed that there was a change in teachers' attitude towards the constructivist learning approach after training. However, although the results in that section suggested the direction of improvement, they did not suggest which teachers were most affected. Therefore, the important question to be asked is: Was the improvement in attitude influenced by teachers' characteristics? Also, did it influence those who had a negative attitude, more?

This section looks at the relationship between teachers' attitude and personal characteristics. Section 6.5.2.1 discusses the influence of training and practice on improving attitude for teachers of different levels of teaching experience. Section 6.5.2.2 discusses the relationship between teachers' residence and the impact of training. Section 6.5.2.3 examines the impact of previous ICT training on change in response to the present training.

In order to examine such relationships, the same parametric and nonparametric tests used in section 6.4.2, were also applied in this section.

6.5.2.1 Teachers' Teaching Experience

It can be argued that the training that teachers undergo would improve teachers' attitude, but such improvement may vary in relation to teachers' teaching experience.

In this section, differences in attitude after the training between teachers of different teaching experience are examined. ANOVA was carried out to see if teachers with different teaching experience had different attitudes towards the elements of a constructivist learning environment, after the training. The following null hypotheses were tested:

> ***There is no significant difference between teachers' attitude towards the advantages of the approach, after the training, in respect of their teaching experience.***
>
> ***There is no significant difference between teachers' attitude towards pupils' role, after the training, in respect of their teaching experience.***
>
> ***There is no significant difference between teachers' attitude towards teachers' role, after the training, in respect of their teaching experience.***
>
> ***There is no significant difference between teachers' attitude towards cooperative and collaborative learning, after the training, in respect of their teaching experience.***
>
> ***There is no significant difference between teachers' attitude towards IT as content, after the training, in respect of their teaching experience.***
>
> ***There is no significant difference between teachers' attitude towards alternative assessment, after the training, in respect of their teaching experience.***
>
> ***There is no significant difference between teachers' attitude towards goals of IT use, after the training, in respect of their teaching experience.***

For scales 1, 2, 3 and 6, the test of Homogeneity of Variances indicated that a non-parametric test be used to confirm the ANOVA result. The results, as shown in Table 6.45 and Table 6.46 indicate that there were no significant differences among teachers with regard to their teaching experience, in the mean scores on four of the seven scales: advantages of the new approach (this appeared significant on the ANOVA but this was not confirmed by the nonparametric test; therefore the nonparametric test was considered for the reason provided in Chapter Five, section 5.4.6), teachers' role, and cooperative and collaborative learning and constructivist IT, $p>0.05$.

Therefore the null hypotheses for these scales were accepted. It can be said that after the training, regardless of their teaching experience, LRC teachers had more positive attitudes towards the advantages of the new approach, teachers' role, cooperative learning and constructivist IT goals.

Table 6.45: ANOVA Test for Teachers' Attitude after Training Compared across the Three Teaching Experience Groups.

Teachers' attitude towards:	Source	df	Before		H of V
			F. Ratio	P. value	
The advantages of the approach	Between Groups	2	3.38	0.04	S
	Within Groups	197			
Pupils' Role	Between Groups	2	10.86	0.00	S
	Within Groups	197			
Teachers' Role	Between Groups	2	2.87	0.07	S
	Within Groups	197			
Cooperation/ Collaboration	Between Groups	2	1.78	0.17	NS
	Within Groups	197			
IT as content	Between Groups	2	4.61	0.01	NS
	Within Groups	197			
Alternative assessment	Between Groups	2	49.25	0.00	S
	Within Groups	197			
Constructivist IT goals	Between Groups	2	2.06	0.13	NS
	Within Groups	197			

H of V=Test of Homogeneity of Variances; S=Significant; NS=Not Significant (see Kruskal-Wallis Test result below).

Table 6.46: Kruskal-Wallis Test Teachers' Years of Teaching Experience after Training[15]

Scale	Teachers' years of teaching experience and Mean Ranks						Chi-Square	d.f	P. value
	Low teaching experience		Moderate teaching experience		High teaching experience				
	N	MR	N	MR	N	MR			
1	101	105.07	83	99.47	16	77.00	3.36	2	0.17
2	101	112.42	83	91.25	16	73.25	10.06	2	0.01
3	101	104.63	83	99.64	16	78.91	2.80	2	0.25
6	101	132.60	83	69.94	16	56.41	64.06	2	0.00

However, significant differences between teaching experience groups were found in relation to teachers' attitude towards pupils' role, IT as content and alternative assessment, $p<0.05$. The null hypotheses for these scales were rejected. This suggests that teachers' teaching experience had an impact on teachers' attitude towards pupils' role, IT as content and alternative assessment, after training.

15 Kruskal-Wallis Test, a nonparametric test, was used because of the reasons stated in Chapter Five, section 5.4.6.

Since after training, differences were exhibited among the three teaching experience groups in relation to pupils' role, IT as content and alternative assessment, further analysis was carried out to clarify the location of this difference.

Table 6.47: Bonferroni's Tests for differences in Teachers' Mean Attitude Score among Teaching Experience Subcategories after Training.

Scales	No	Mean	Teachers' teaching experience	Low	Moderate	High
Pupils' Role	101	34.51	Low		*	*
	83	31.20	Moderate			
	16	28.62	High			
IT as content	101	24.90	Low			*
	83	24.55	Moderate			*
	16	21.50	High			
Alternative assessment	101	28.68	Low		*	*
	83	23.77	Moderate			
	16	22.75	High			

*The mean difference is significant at the 0.05 level.

As can be seen from Table 6.47, the results of Bonferroni's test revealed that there was a significant difference between the responses of low, moderate and high teaching experience teachers. There were significant differences in attitudes towards pupils' role and alternative assessment between the low teaching experience group and the two more experienced groups. After the training, the low teaching experience group tended to be more positive about pupils' role and alternative assessment than both the more experienced groups. The result of pupils' role is consistent with commonly held beliefs that experienced teachers are more likely to believe that students cannot be responsible and manage their own learning than less experienced teachers (Hannafin and Freeman, 1995; Hannafin and Savenye, 1993). According to Blumenfeld, et al. (1991) these teachers often view learning as a process of obtaining information rather than an active process of knowledge construction. In general, this can indicate that although the training had influenced the experienced groups, their attitude still did not reach the level of the low experienced. It is safe to say that some personal beliefs are not easily resolved through professional development (Ertmer et al., 1999).

For IT as content, there was no significant difference in attitude between the low teaching experience groups and the moderate teaching experience group, but there was a significant difference between these two groups and the high experience group. The high teaching experience group showed some resistance to change in their attitude towards IT as content. This could be explained by either their preference for traditional IT activities and discrete IT skills activities, or their having a difficult time adjusting to the integration. The Panel on Educational Technology (1997, p.128) distinguishes between isolated basic skills and the integration of meaningful and creative uses of computer technology. They maintain that the greatest promise of educational technology "... lies in the possibility of utilizing computers and networks as an integral part of virtually all aspects of the curriculum" (Panel on Educational Technology, 1997, p.116). Smerdon, et al. (2000, p.75) found that more experienced teachers seem to have a more difficult time adjusting to technology integration.

Comparing the results in Table 6.16 (in section 6.4.2.1) and Table 6.45, it can be seen that there were significant differences in teachers' attitude towards pupils' role, IT as content and alternative assessment both before and after the training giving an indication that the training did not entirely eliminate the impact of teaching experience-related differences in teachers' attitude. However, significant differences that appeared in teachers' attitude towards the advantages of the new approach, teacher's role and collaborative learning before training were not found after the training. It seems that training had an impact in reducing teaching experience-related differences in attitude for teachers' role and cooperative learning.

Moreover, comparison between Table 6.17 (in section 6.4.2.1) and Table 6.47 reveals that differences between the moderate and high teaching experience groups which were significant before training were not significant after training. Looking at the mean scores, the implication is that the high teaching experience group changed more than the moderate group for some scales. These findings are consistent with the conclusion of Smerdon, et al. (2000, p.104) based on their empirical findings, that teachers who participate in professional development training usually benefit from the training, regardless of their teaching experience.

To explore further the effectiveness of training on each teaching experience category in relation to the others, gains in teachers' attitude on the seven scales after training were analysed. This was done by computing the attitude difference on each of the seven scales before and after training and practice, for each participant (i.e., after training scores minus before training scores).

To examine whether gains differed for the three teaching experience groups, MANOVA tests (for main effects) were carried out.

Table 6.48: Wilks' Lambda's Test Result for Teachers' Teaching Experience after Training

Source	Wilks' Lambda	F	df	Error df	P. value
Teaching experience	0.232	29.39	14.00	382.000	0.00

The Wilks' Lambda aspect of the MANOVA test, presented in Table 6.48, revealed that there were significant differences in gain scores among the three categories.

Table 6.49: ANOVA for Teachers' Teaching Experience after Training

	Mean Difference Scales	df	Mean Square	F. value	P. value
1	The benefit of the approach	2	2058.99	64.66	0.00
2	Pupils' Role	2	353.01	7.03	0.01
3	Teachers' Role	2	11825.36	261.31	0.00
4	Cooperation/ Collaboration	2	917.62	7.765	0.01
5	IT as content	2	180.92	4.789	0.01
6	Alternative assessment	2	97.08	4.093	0.02
7	Constructivist IT goals	2	3.669	2.148	0.12

Since the Wilks' Lambda's test) revealed statistically significant difference, follow-up univariate tests (ANOVA) were performed on these scales. The three groups differed significantly on the advantages of the approach, pupils' role, teachers' role and cooperation/collaboration, IT as content, and alternative assessment. There was no significant difference among the three groups on constructivist IT goals, as shown in Table 6.49.

Table 6.50: Bonferroni's Tests for Mean Difference for Teaching Experience Subcategories after Training.

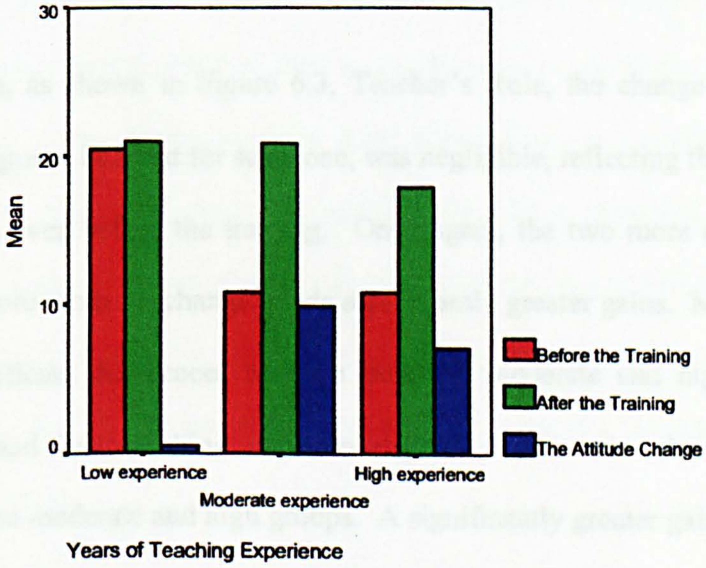
Scales	No	Mean difference	Teachers' teaching experience	Low	Moderate	High
The advantages of the approach	101	0.55	Low		*	*
	83	9.96	Moderate			
	16	7.06	High			
Pupils' Role	101	4.57	Low		*	*
	83	7.96	Moderate			
	16	9.63	High			
Teachers' Role	101	0.76	Low		*	*
	83	23.12	Moderate			*
	16	18.56	High			
Cooperation/ Collaboration	101	2.48	Low		*	
	83	8.83	Moderate			
	16	5.19	High			
IT as content	101	-0.18	Low		*	
	83	2.67	Moderate			
	16	1.25	High			
Alternative assessment	101	3.46	Low			
	83	4.47	Moderate			*
	16	0.75	High			

*The mean difference is significant at the .05 level.

To clarify the nature of the significant differences in the previous six scales, a Bonferroni's test was conducted. As shown in the Table 6.50, overall, the training generally had the most benefit for the moderate and high teaching experience groups, who had been less positive in attitude before the training.

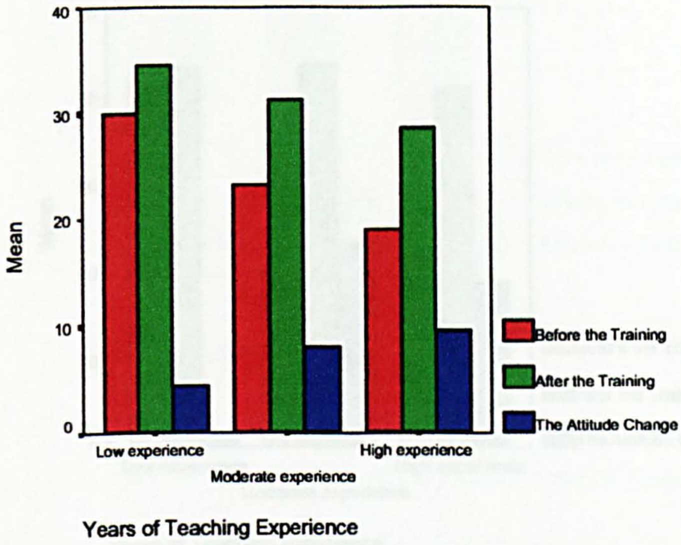
In scale one, the advantages of the new approach, as shown in Figure 6.1, the gain for the low teaching experience group, which already had a very positive attitude before the training, was negligible. However, there were noticeable greater gains for both the moderate and high teaching experience groups. This indicates that the impact of training had been much greater on the more experienced groups, who had initially been less positive in attitude and so had more room for change. The gain for the moderate teaching experience group was slightly higher than for the high teaching experience group but, as the Bonferroni result showed, the difference between these two groups was not statistically significant; they had responded similarly in becoming more positive towards the advantages of the constructivist approach, through the training.

Figure 6.1: Attitude Changes by the Three Teaching Experience Groups on Scale 1



On scale two, pupils' role, again, the smaller gain was made by the low teaching experience group, which had least room for change (see Figure 6.2)

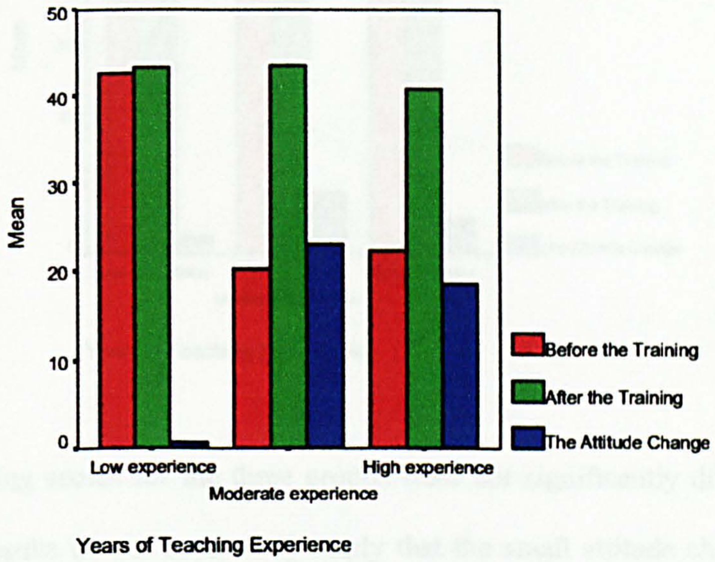
Figure 6.2: Attitude Changes by the Three Teaching Experience Groups on Scale 2



The gains made by the two more experienced groups were around twice the size of the gain made by the less experienced group, and, as the Bonferroni revealed, these differences were statistically significant. Although the amount of change shown by the high teaching experience group was greater than that shown by the moderate teaching experience group, the difference was not statistically significant.

In scale three, as shown in Figure 6.3, Teacher's Role, the change in the low teaching experience group, like that for scale one, was negligible, reflecting the very high scores of this group, even before the training. Once again, the two more experienced groups, which had more room for change, made significantly greater gains. Moreover, in addition to the significant differences between both the moderate and high teaching experience groups and low teaching experience group, there was also significant difference between the moderate and high groups. A significantly greater gain was made by the moderately experienced group. This possibly reflects the greater room for change shown by this group in the pre-training result. Overall, the impact of training was to bring the attitude scores of both more experienced groups to approximately the same level as that of the less experienced group.

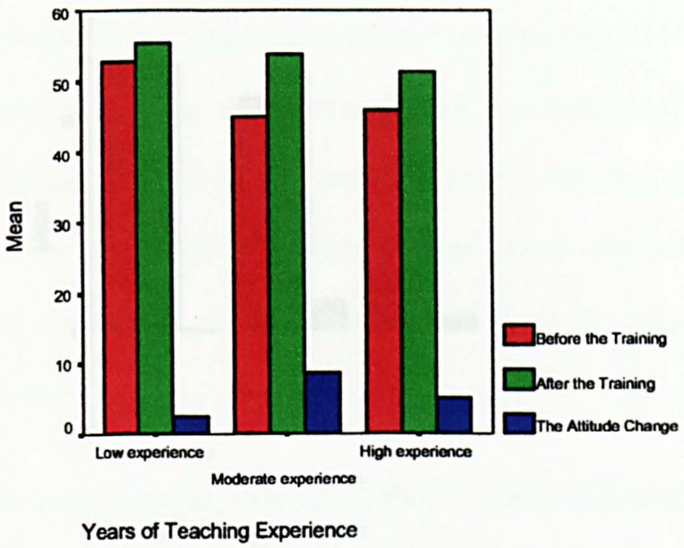
Figure 6.3: Attitude Changes by the Three Teaching Experience Groups on Scale 3



Thus, for the first three scales, both moderate and high teaching experience groups gained significantly more during the training than the low teaching experience group. The same does not apply, however, to the next two scales.

It can be seen from Figure 6.4 that on scale four, Cooperation/Collaboration, there was less room for change than in the first three scales, because of the higher pre-training scores, for all groups. After the training, all three groups showed a small gain. The change shown by the moderate group was significantly higher than that of the low teaching experience group. However, the change shown by the high teaching experience group was less than that shown by their moderately experienced counterparts; as the Bonferroni results showed, it was not significantly greater than the change in the low teaching experience group.

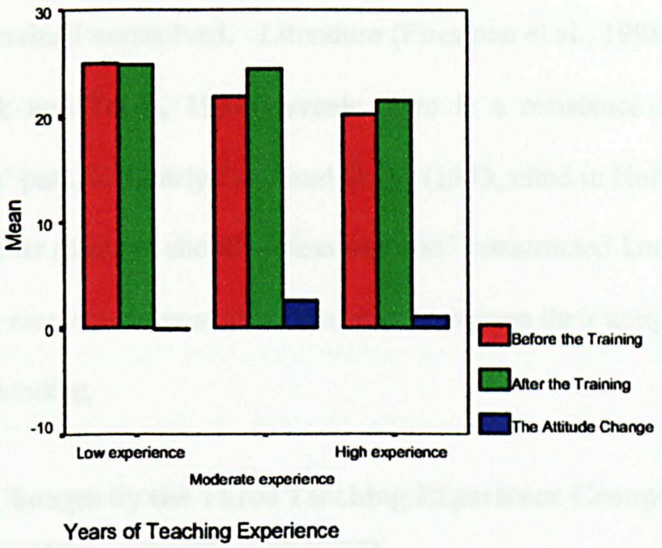
Figure 6.4: Attitude Changes by the Three Teaching Experience Groups on Scale 4



Since the post-training scores for the three groups were not significantly different (see Table 6.45) these results do not necessarily imply that the small attitude change in the high experienced group was due to resistance.

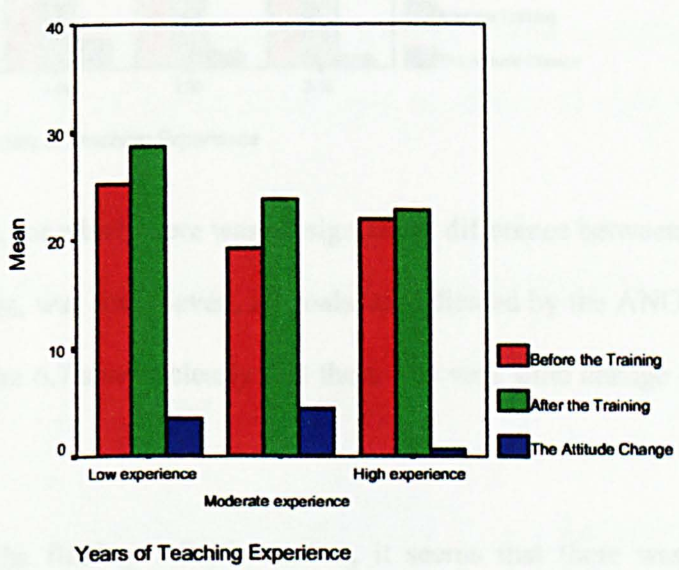
For scale Five, IT as Content, Figure 6.5: shows that not only were pre-training scores low but gains were very small. Indeed, there was a very slight decline in score in the low teaching experience group, though this was not statistically significant. The Bonferroni results show that the greater gain made by the moderate teaching experience group is statistically significant. Nevertheless, the generally low level of change in this scale, despite the benefits of training and practice, raises the question whether teachers might have encountered some problems during their integration process, such as technical problems (e.g. those identified by Honey and Moeller, 1990; Sandholtz et al., 1992; Wise and Groom 1996, in similar learning settings) which influenced their attitude. In fact, teachers were seen to struggle to solve these problems during observation, and in the interviews they reported problems such as the inconsistency of the network, regular computer crashes and difficulties in sending files over the network (see Chapter Seven).

Figure 6.5: Attitude Changes by the Three Teaching Experience Groups on Scale 5



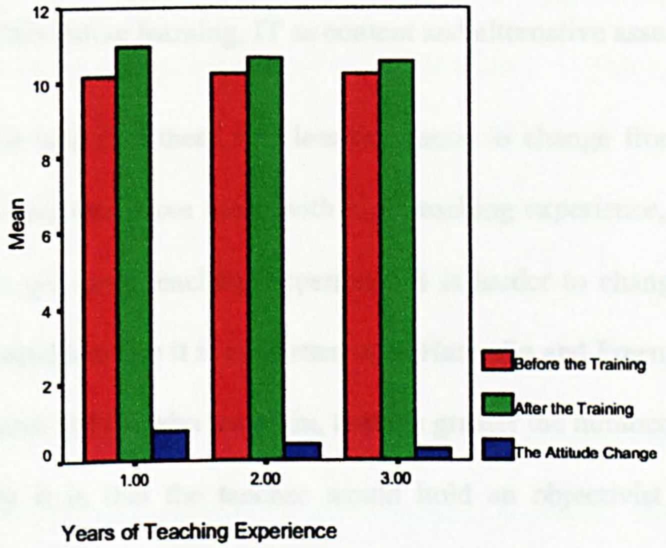
In scale six, alternative assessment, again, the amount of change was generally low, and the shift in scores in the high teaching experience group, in particular, was negligible. (see Figure 6.6).

Figure 6.6: Attitude Changes by the Three Teaching Experience Groups on Scale 6



The low level of change experienced by the moderate and high teaching experience groups, relative to the amount of room for change, suggests that there may have been greater resistance to change on the part of more experienced teachers. In fact according to David (1996) assessment problems proved to be the most resistant to solutions and many remained unresolved. Literature (Firestone et al., 1998; Hannafin & Freeman, 1995; Tyack and Tobin, 1994) reveals there is a resistance to alternative assessment on teachers' part. Similarly Dana and Davis (1993, cited in Holloway, 1999), for example, wonder how teachers should assess students' constructed knowledge; they maintain that teachers' assessment must allow learners to express their unique experience of learning and understanding.

Figure 6.7: Attitude Changes by the Three Teaching Experience Groups on Scale 7



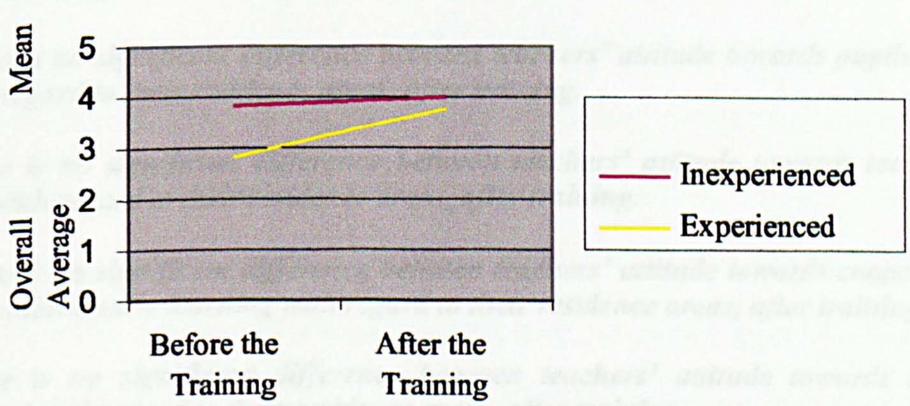
The one scale, for which there was no significant difference between the groups in size of attitude change, was scale seven, IT goals, as indicated by the ANOVA results in Table 6.49, and Figure 6.7 shows clearly that there was very little change in attitude for any of the groups.

To sum up the findings of this section, it seems that there was a reciprocal relationship between the impact of training and teachers' teaching experience. In this study, the tendency for longer teaching experience to be associated with more negative attitudes to new educational approaches was reduced by the training. From the statistical evidence, it can be said that the low teaching experience teachers began with positive attitudes towards the constructivist approach and, after some training, they developed more confidence towards the new approach. Smerdon, et al. (2000) found that less experienced teachers felt well prepared to deal with technology integration. Moderately experienced teachers responded well to the training and gained a more positive attitude after the training.

Highly experienced teachers were influenced by two factors, the training and their old beliefs. They changed their attitude towards some aspects of new approach, e.g., pupils' role, teachers' role, but held tight to their beliefs in relation to others, e.g., cooperative/collaborative learning, IT as content and alternative assessment.

It can be said that there was less resistance to change from moderate teaching experience teachers than from those with high teaching experience, giving an indication that as teachers get more teaching experience it is harder to change their beliefs. The result is anticipated because it is consistent with Hannafin and Freeman (1995), Kagan D. (1992) and Pajares (1992) who maintain, that the greater the number of years of teaching, the more likely it is that the teacher would hold an objectivist view of knowledge acquisition.

Figure 6.8: Overall Teachers' attitude before and after the Training



Overall, teachers' attitude had changed due to the training. As can be seen from Figure 6.8, there was no significant change in attitude for low teaching experience teachers, since those teachers started with positive attitudes. This may be to due to the fact that more recently qualified teachers are more likely than their more experienced colleagues to have been exposed to technology integration in college and graduate work (Smerdon et al., 2000, p.115). But there was significant change in the attitude of experienced teachers. Within the experienced (combining moderate and high teaching experience) categories there were teachers with different attitudes. These different attitudes can be described by the teachers' profile of similar teaching experience groups, identified by Hadley and Sheingold (1993, p.284-285): a) enthusiastic beginners, (b) supported integrators, (c) high school naturals, (d) unsupported achievers, and (e) struggling aspirers.

6.5.2.2 Residence areas

The following discussion sheds light on the relationship between urban and rural teachers' attitudes towards a constructivist learning approach, after training. For this purpose the following null hypotheses were tested:

> ***There is no significant difference between teachers' attitude towards the advantages of the constructivist approach with regard to their residence areas, after training.***
>
> ***There is no significant difference between teachers' attitude towards pupils' role with regard to their residence areas, after training.***
>
> ***There is no significant difference between teachers' attitude towards teachers' role with regard to their residence areas, after training.***
>
> ***There is no significant difference between teachers' attitude towards cooperative and collaborative learning with regard to their residence areas, after training.***
>
> ***There is no significant difference between teachers' attitude towards IT as content with regard to their residence areas, after training.***

There is no significant difference between teachers' attitude towards alternative assessment with regard to their residence areas, after training.

There is no significant difference between teachers' attitude towards goals of IT use with regard to their residence areas, after training.

The results of the analysis are shown in Table 6.51. The table shows that with regard to residence areas after the training there was no significant difference in all the seven scales. Therefore all the null hypotheses were accepted, since p>.05.

Table 6.51: The Independent Samples t Test Result for Teachers' Residence Areas after the Training.

	Scales	Independent variables		Means	df	After	
						t	P
1	The advantages of the approach	Urban	82	20.64	198	-.191	0.19
		Rural	118	20.77			
2	Pupils' Role	Urban	82	32.01	198	-1.39	0.19
		Rural	118	33.12			
3	Teachers' Role	Urban	82	43.10	198	-.25	0.08
		Rural	118	43.25			
4	Cooperation/ Collaboration	Urban	82	53.93	198	-.72	0.48
		Rural	118	54.84			
5	IT as content	Urban	82	23.85	198	-1.76	0.08
		Rural	118	24.92			
6	Alternative assessment	Urban	82	25.66	198	-1.36	0.18
		Rural	118	26.52			
7	Constructivist IT goals	Urban	82	10.63	198	-1.57	0.10
		Rural	118	10.95			

It can be argued that training had eliminated the significant differences in the Pupils' role scale and the Teacher's role scale before the training. Again, the researcher attributes the result of this section and section 6.4.2.2, to the great attention that the current government is giving to education and civil services, which were not available before 1970, for all Omanis, regardless of their place of residence. Therefore, place of residence cannot be seen as a major factor influencing Omani teachers' attitude. Generally speaking, in this study, Omani teachers were not influenced by their areas of residence. This means that urban and rural residence is not significantly correlated with teachers' attitude.

6.5.2.3 The impact of previous ICT courses

This section examines the following null hypotheses:

There is no significant difference between teachers' attitude towards the advantages of the approach after the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards pupils' role after the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards teachers' role after the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards cooperative and collaborative learning after the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards IT as content after the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards alternative assessment after the training in respect of their previous ICT courses.

There is no significant difference between teachers' attitude towards goals of IT use after the training in respect to their previous ICT courses.

Table 6.52: ANOVA Test for Significant Differences Attitude after Training Related to Teachers' Training Courses

Teachers' attitude towards:	Source	df	Before		H of V
			F. Ratio	P. value	
The advantages of the approach	Between Groups	2	0.73	0.48	NS
	Within Groups	197			
Pupils' Role	Between Groups	2	0.36	0.69	NS
	Within Groups	197			
Teachers' Role	Between Groups	2	0.34	0.71	NS
	Within Groups	197			
Cooperation/Collaboration	Between Groups	2	0.38	0.68	NS
	Within Groups	197			
IT as content	Between Groups	2	0.02	0.98	NS
	Within Groups	197			
Alternative assessment	Between Groups	2	4.34	0.01	NS
	Within Groups	197			
Constructivist IT goals	Between Groups	2	1.61	0.20	NS
	Within Groups	197			

H of V=Test of Homogeneity of Variances; S=Significant; NS=Not Significant

The result of the ANOVA tests, in Table 6.53, showed no statistically significant differences among the three categories in six scales, $p>0.05$. There was significant difference in the responses on alternative assessment, $p<0.05$.

Bonferroni's Test in Table 6.53, shows that for this scale there was a difference between teachers with more advanced training and those who had attended intermediate courses. It seems that those who had completed advanced courses were more inclined to support alternative assessment.

Table 6.53: Bonferroni's Test for Previous Training Subcategories attitude after Training.

Scales	No	Mean	Training Courses	Basic	Intermediate	Advanced
Alternative assessment	52	26.96	Basic			
	125	25.50	Intermediate			
	23	28.00	Advanced		*	

*The mean difference is significant at the .05 level.

Also this indicates that teachers who had attended the intermediate courses were more in favour of the traditional approach. Interview data reveals that almost 20% of teachers wanted to see traditional assessment used to evaluate pupils' performance.

The results in this section support the assumption that the amount of ICT training (in-service training) teachers had previously received had an influence on their attitudes and practice, but these differences were to a great extent eradicated by the training provided in the present study. Research (Knight and Knight, 1995; McKenzie, 2001; Swan et al., 2000; U.S. Office of Technology Assessment, 1995) maintains that traditional professional development is less effective; there is a need for a new approach of training teachers which takes in consideration issues such as how adults learn, hands-on experience, the appropriate time of training and the relevance of training to teachers' practice (see Chapter Four).

6.6 A Brief Summary of the Results

The data analysis in this chapter revealed that training had changed most teachers' attitudes towards the constructivist learning approach to become more positive. Those who had already had positive attitudes became even more positive in attitude (a shift from "Agree" to "Strongly Agree"), while there was also a shift away from "Strongly Disagree" and "Disagree", as well as a reduction in the number of "Not Sure" responses. This is in line with findings of studies such as Abbott and Faris (2000), Christensen (1998) and Gilmore (1998) which showed that training on how to integrate technology across the curriculum had increased teachers' attitudes towards the importance of such integration.

Training, however, did not have equal impact on all dimensions of the constructivist approach. For example, many teachers continued to favour traditional assessment methods. Moreover, they continued to favour traditional as well as constructivist goals for using IT.

It has been shown that there is a relationship between teachers' teaching experience and change in attitude towards the new approach. Teachers with fewer years of teaching experience showed more progressive attitudes and an openness to change before training and practice. The training had more impact on more experienced teachers who had originally expressed more traditional views. Highly experienced teachers were, however, to some extent resistant to the constructivist approach, even with the influence of training.

Data analysis also showed that there was a reciprocal relationship between training and teachers' teaching experience. For example, training had changed the attitude of experienced teachers on some aspects (scales) of the constructivist approach, but it seems that the teaching experience of those teachers made them less inclined to change their traditional beliefs about pupils' role so they did not reach the same level of enthusiasm as less experienced teachers, for example.

Generally speaking, it seems that teachers' residence area had no effect on their attitude towards the new approach. Before the training, data showed there were significant differences in attitude between urban teachers and rural teachers (in favour of the latter) on two scales: Pupils' role and Teacher's role. However, after the training such differences did not exist.

Training had an influence on teachers with different levels of training courses. As can been in section 6.4.2.3, there were significant differences between teachers who had attended advanced course and teachers who had not. The training carried out by this study, smoothed away the differences in attitudes on all scales except for alternative assessment. The data showed that there were significant differences between teachers who had attended advanced courses and teachers who had attended intermediate courses. This can indicate teachers with less ICT training were more in favour of a traditional approach.

CHAPTER SEVEN

DATA ANALYSIS (Part Two)

7.1 Introduction

The purpose of this chapter is to analyse qualitative data obtained from the interviews and observations. It is intended to examine teachers' practice during the implementation of project-based approach using Multimedia/IT. It was argued earlier, that LRC teachers' attitude and beliefs might influence their practice. For example, teachers' positive attitude might lead to successful practice, while a negative attitude might lead to futile practice. This chapter is divided into two sections: section one is concerned with the outcome of observation (videotape) of teachers and students' interaction during IT lessons, and section two is devoted to analysing teachers' interviews.

7.2 Observations

The purpose of this section is to interpret teacher and student behaviour (mainly interaction) and try to determine the roles of both the teachers and students during constructivist learning activities in different Learning Resource Centres. The analysis will be used to highlight LRC teachers' attitudes and beliefs about such environments.

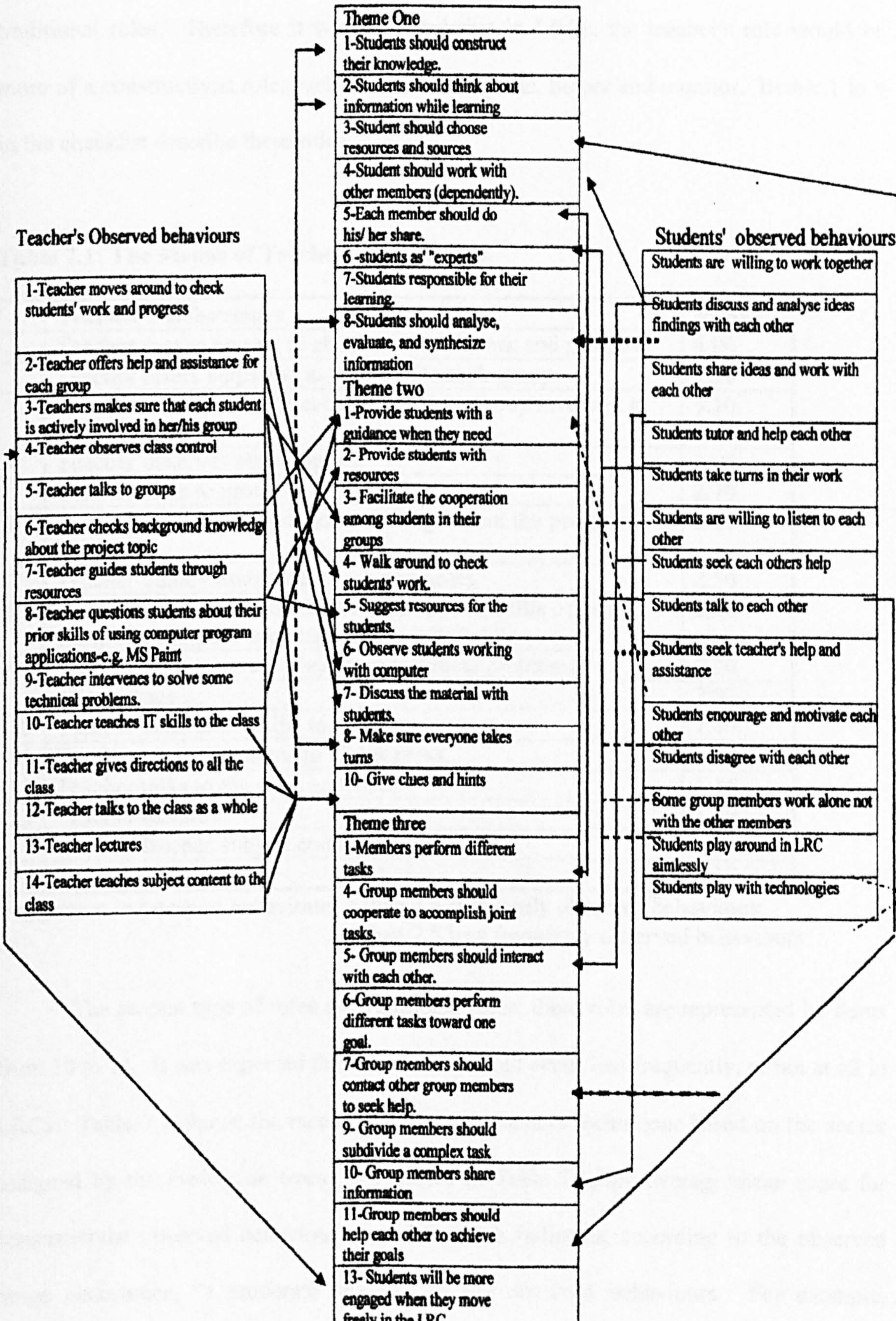
As stated in Chapter Five, a team of LRC teachers was formed to evaluate the observation videotapes, in order to increase the validity of the observation. The team consisted of eight teachers, divided into 4 pairs (see Chapter Five, section 5.6.4). They were instructed on how to measure teachers' performance and students' behaviours during IT activity lessons, assigning scores of 1=not at all or very little, 2=a little, 3= a moderate amount, and 4=a lot. The researcher developed a matrix (Figure 7.1) that cross-references some teacher and student behaviours in the questionnaire with some observed teachers and students' behaviours. Although the observation, as stated earlier, was concluded to increase the validity of the questionnaire, it was also meant to provide supplementary information which teachers might, through bias or other reason, fail to provide in the self-response questionnaire. Therefore the matrix does not depict all observed behaviours, but only ones that correspond to the questionnaire items in scales two, three and four.

This section is divided into the following subsections: sections 7.1 and 7.2 discuss both teachers' and pupils' observed roles in a technology-rich learning environment. Section 7.3 looks at how teachers' attitudes and beliefs are reflected in their practices. Data drawn from observation checklists, the researchers viewing of the videotapes and field notes were used to analyse this dimension. However, due to time constraints, the focus will be on identifying some examples that fulfil the aims behind the observation tool.

7.2.1 Teacher's role

In the observation checklist, as shown in Table 7.1 teachers' behaviours were classified into two types: constructivist behaviours (roles) and traditional behaviours (roles).

Figure 7.1: Matrix of Teachers and Students' Observed Behaviours Cross-referenced with Teachers and Students' Behaviours in the Main Study Questionnaire



It was assumed that teachers who believed in constructivist roles would frequently exhibit constructivist roles in their teaching and would less often or never exhibit traditional roles. Therefore it was expected that in LRCs, the teacher's role would be more of a constructivist role, such as facilitator, guide, helper and monitor. Items: 1 to 9 in the checklist describe these roles.

Table 7.1: The Means of Teachers' Behaviours.

	Teacher's Behaviours	Means
1	Teacher moves around to check students' work and progress	4.00
2	Teacher offers helps and assistance for each group.	3.30
3	Teacher makes sure that each student is actively involved in her/his group.	3.10
4	Teacher observes class control.	3.05
5	Teacher talks to groups.	2.70
6	Teacher checks background knowledge about the project topic	2.60
7	Teacher guides students through resources.	2.50
8	Teacher questions students about their prior skills of using computer program applications-e.g. MS Paint.	2.40
9	Teacher intervenes to solve some technical problems.	2.20
	The average	2.87
10	Teacher teaches IT skills to the class.	1.40
11	Teacher gives directions to all the class.	1.20
12	Teacher talks to the class as whole.	1.15
13	Teacher lectures.	1.10
14	Teacher teaches subject content to the class.	1.00
	The average	1.17

Suggestion to interpret behaviours > than 2.5 frequently observed behaviours.
< than 2.5 less frequently observed behaviours

The second type of roles are traditional roles; these roles are represented by items from 10 to 14. It was expected that such roles would occur less frequently, or not at all in LRCs. Table 7.1 shows the means of observed teachers' behaviour based on the scores assigned by the evaluation team. As shown in Table 7.1, the average mean score for constructivist observed behaviours was 2.9 which indicates, according to the observed range occurrence, "a moderate amount" of the observed behaviours. For example, "Teacher moves around to check students' work and progress" had a mean score of 4.00

indicating that this practice was the most frequently observed behaviour among LRC teachers. Item 8, "Teacher questions students about their prior skills of using computer program applications" was the least frequently observed behaviour among the constructivist teacher roles, with mean score of 2.40.

In contrast, teachers' traditional role, as knowledge dispenser, was absent or less frequently observed. As can be seen from Table 7.1 the average mean score for traditional roles was 1.17, suggesting close to "little occurrence." For example, "Teacher teaches IT skills to the class" had a frequency mean score of 1.40. "Teacher gives direction to all the class" had a frequency mean score of 1.20. "Teacher teaches subject content to the class" was not observed in any of the 40 Learning Resource Centres.

7.2.2 Pupils' roles

When analysing students' interaction in small groups or pairs, Kumpulainen and Wray (2002) suggest analysing three dimensions of such interaction: functional analysis of verbal interaction, analysis of cognitive processing and analysis of social interaction. Functional analysis of verbal interaction focuses on the purpose for which verbal language is used in a given context. Analysis of cognitive interaction is concerned with examining the ways in which students approach and process learning tasks in their social activity. Analysis of social interaction aims to look at the social relationships and types of participation in peer/small groups. In Table 7.2, Kumpulainen and Wray (2002, p.39) provide a classification of social interaction:

Since this section is delineated to looking at students' cooperative and collaborative behaviours, the focus here is on analysing the social interaction.

Table 7.2: Kumpulainen and Wray's Classification of Social Interaction

1-Collaborative	Joint activity characterised by equal participation and meaning-making.
2-Tutoring	Student helping and assisting another student
3-Argumentative	Students are faced with cognitive/social conflicts that are resolved and justified in a rational way.
4-Individualistic	Student(s) working on individual tasks with no sharing or joint meaning-making.
5-Domination	Student dominating the work, unequal participation.
6-Conflict	Social or academic conflicts that are often left unresolved.
7-Confusion	Lack of shared understanding, student(s) do not understand the task or each other, often includes silent episodes.

As will be seen in the following discussion, a member of the behaviours corresponded with various categories of Kumpulainen and Wray's framework. The observed students' behaviours suggest a high level of social interaction while students were working in their groups, corresponding to the collaborative category in the Kumpulainen and Wray's classification. A detailed examination of the nature of the small-group interaction suggests that students often exchanged information, knowledge and skills. Students' interaction was observed in their frequent engagement in discussing and analysing ideas and findings with each other, with a mean score of 3.35, (see Table 7.3).

Further, the mean score of observed students' behaviours of sharing ideas and working with each other was 3.35, indicating that students in the 40 LRCs were often observed engaged in such activities. Students not only exchanged information and skills but also they took turns in using ICT. This corresponds with Kumpulainen and Wray's 'Argumentative' classification. The item related to turn-taking during work with ICT had a mean score of 3.20, indicating a high frequency of such behaviour.

Table 7.3: The Means of Students' Behaviours.

	Students' behaviours in the groups and in LRC	**Means**
1	Students are willing to work together.	3.60
2	Students discuss, analyse ideas and finding with each other.	3.40
3	Students share ideas and work with each other.	3.35
4	Students tutor and help each other.	3.20
5	Students take turns in their work.	3.20
6	Students are willing to listen to each other.	3.15
7	Students seek each others help.	3.10
8	Students talk to each other.	3.10
9	Students seek teacher's help and assistance.	2.95
10	Students encourage and motivate each other.	2.80
11	Students disagree with each other.	2.35
12	Some group members work alone, not with the other members.	1.70
13	Students play around in LRC aimlessly.	1.70
14	Students play with technologies.	1.70

Suggestion to interpret behaviours > than 2.5 frequently observed behaviour.
< than 2.5 less frequently observed behaviour

Students' interaction was apparent in their tutoring and helping each other to achieve their goals, mean score of 3.20, giving an indication that students were teaching each other IT skills and helping each other to pronounce words, read and write sentences. This behaviour corresponds with Kumpulainen and Wray's 'Tutoring' classification.

The cooperative atmosphere encouraged students to care for each other by encouraging and motivating each other to learn and work within their groups, with a mean score of 2.80. The most frequently observed student behaviours were willingness to listen to each other (mean score of 3.15) and to talk to each other (mean score of 3.10). Students not only often sought each other's help (mean score of 3.10), but they were also observed seeking the teacher's help and assistance (mean score of 2.95). Similar student behaviours were reported by studies such as Cohen (1997); David (1992); Dwyer (1994); Dwyer, et al. (1991); Knight and Knight (1995); Hudson (1995); Means and Olsen (995a); Nath and Ross (1996); Penuel and Means (1999); Penuel and Yarnall (2000); Rice and Wilson (1999); Turner and Vito (1997), and Underwood (1994). Some students were seen as "experts" helping other students and teachers. Similarly, Cohen

(1997), Ringstaff and Yocam (1995) and Lundeberg, et al. (1997) observed that teachers often took the role of facilitator, while some students were frequently called upon to play the role of expert.

7.2.2.1 Students' motivation

According to Sharan and Sharan (1992, cited in Barak and Maymon, 1998, p.3) pupils' motivation on a task can be measured by the degree of involvement and level of purpose and energy the pupils demonstrate in relation to their work and the degree to which they are prepared to devote extra time beyond regular school hours in order to achieve their goal.

In many instances, students in the study were observed to remain in the Learning Resource Centres in order to finish their work after their lessons; they were observed continuously working without time constraints and staying during break times. In some cases they refused to leave the LRCs and argued with the teachers that they had insufficient time to finish their work. Similar behaviour was observed by Sandholtz, et al. (1992, p.481) who reported that students were so enthusiastic that it was very difficult for the teachers to keep the students off the computers. However, such behaviour might result in unequal opportunities for everyone. Similarly, Barak and Maymon (1998) observed that pupils worked in their groups continuously and without time constraints, staying behind to work during recesses and after school hours. These behaviours reflect high motivation, which was perceived among the pupils during IT activities.

7.2.2.2 Students' problematic behaviours

Students' problematic behaviours which held back small group cooperation and collaboration were exhibited in some groups. For example, 'free-rider' students were observed in some lessons where those students did not contribute to their group's work. This corresponds with Kumpulainen and Wray's 'Confusion' classification. Such problems contributed very much to those groups' failure to achieve their goals (see Appendix 14-G). Bennett and Dunne (1994) also noticed this type of problem as a consequence of group members' behaviours. Further, bickering within group and poor contribution to the group's activities were reported in Nath and Ross's (1996) study. Cohen (1997) reported a group of students sitting at a scanner or around a computer, laughing and talking about personal matters. Sandholtz, et al. (1993) reported that students' "over-engagement in computer work sometimes creates time management problems" (see Appendix 17).

In some LRCs, students were observed quarrelling with each other. This corresponds with Kumpulainen and Wray's 'Conflict' classification. The mean score of such behaviour was 2.35 (Table 7.3) which indicates that the behaviour occurred often among some groups. Similar observations were made by Nath and Ross (1996) and Sandholtz, et al. (1992) who observed that students insulted each other, played with technology, resisted the teachers' instruction, and used the computers as a physical shield to hide their off task behaviours. Some group members worked alone, not with the other members corresponding to Kumpulainen and Wray's 'Individualistic' classification. Some students played around in the LRC aimlessly and some students played with technologies during IT lessons; the researcher noticed this occurred when groups had more that three members, but the low mean score, 1.70, indicates that this happened rarely. This is consistent with what Ringstaff and Yocam (1995) observed in a similar learning environment, where students were reported working off-task. Some students had complete control over the computer, mouse and keyboard corresponding to Kumpulainen and Wray's 'Domination' classification. Similar behaviour was reported by Ehrich, et al. (1998a) and Sandholtz, et al. (1992). Another problem was students persisting on computer tasks when they should have been working on non-computer activities or paying attention to the teacher. Similar problems were reported by the teachers in Ehrich, et al.'s (1998a) study. Although these behaviours were frequently observed, they may have been caused by students who did not know what to do, or who were distracted by extroverts, or less motivated students. One explanation can be offered by Edelson, et al. (1999) who reported that if students are not sufficiently motivated or they are not motivated by legitimate interest, they either fail to participate in project activities, or they participate in them in a disengaged manner that does not support learning.

7.2.3 Teachers' practice as reflection of their beliefs

The previous section shed light on the frequency of teachers' and students observed behaviours. Generally speaking, these behaviours can be described as constructivist behaviours. The teachers were observed to act as monitor, guide, helper and facilitator and students were observed as active learners who worked cooperatively and collaboratively in their small groups (see Appendix 17).

This section is delineated to look at how teachers' belief/attitude was turned into practice – how their practice was influenced by their attitude. The survey questionnaire results reveal in general that most LRC teachers had a positive attitude towards the new approach. Therefore, it could be expected that teachers' practice during observed lessons would be constructivist, to some extent. For example it would be expected that the role of the teachers in Learning Resource Centres changed from the major source of information and the transmitter of that information to a facilitator or coach who engages and encourages students to explore and form their own explanations. They would be expected to motivate students and engage them in discussion and reflection.

The researcher felt that to give a good picture of such a relationship, by consulting the videotape results, observation notes and the researcher's experience during observation as well, it was important to develop a set of descriptors that would give an indication of teachers' constructivist roles. Some of the descriptors were adopted from Brooks and Brooks' (1993) framework which discusses some observed behaviours in a constructivist learning environment.

7.2.3.1 Students' autonomy and initiative vs. Teacher as knowledge dispenser: (Active learners vs. passive learners)

Self-directed learning, autonomy and initiative, is one of the basic tenets of the constructivist approach. According to Brooks and Brooks (1993) students should be encouraged to think, explore, generate hypotheses and test them, pose questions related to their inquiries and take initiatives to find answers to them. In this way students become responsible for their own learning and become problem solvers. Therefore, constructivist teachers allow and encourage students to be active learners.

In the study questionnaire, after the training, LRC teachers' overall attitude towards pupils' active role was positive. The mean score was 4.10 with SD=0.87 indicating their attitude was above the agreed level (see Table 6.44, Chapter Six). For example, teachers had a positive attitude towards each of the following:

- students should be active knowledge seekers (mean score 4.03 and standard deviation 1.07);
- students as experts (mean score 4.07 and standard deviation 1.04);
- students should be responsible for their learning (mean score 4.08 and standard deviation 0.90);
- students should analyse, evaluate, and synthesize information (mean score 4.14 and standard deviation 1.01 (see Appendix 18).

During IT lessons, the way teachers set up the learning environment, promoted and allowed students' self-directed learning. The teachers' behaviours observed from the videotapes and observational notes reveal that after teachers had told the students about the topic and checked their prior knowledge, they allowed students to search for answers to their questions and further inquiries. It was clear from the observation analysis, Table 7.1, that teachers did not deliver information to the students, nor did they teach them IT skills as they had done previously.

According to Anderson, et al. (1995) and Hannafin and Savenye (1993) teachers who hold a positive attitude towards knowledge construction, work hard to help students construct their knowledge. The Cognition and Technology Group at Vanderbilt (1992, p.73) found there was a shift in the teacher's role "from authoritarian provider of knowledge to a resource who at times is consulted by students and at other times can become the student whom others teach." Becker and Ravitz (1999) observed that teachers were more willing to cede their authority to students. The teacher encouraged students' active exploration in PowerPoint and other software. In a similar environment, Turner and Vito (1997) found that teachers encouraged students' exploration of new technology, and described the teacher's involvement as "teaching on a need-to-know basis".

Analysis of videotapes (Table 7.1) shows that one of the non/seldom-observed behaviours was teacher lecturing in the classroom, that is giving information on specific content to the class. This was in marked contrast to the behaviour observed before training, when teachers adopted a very directive, traditional approach and a lecturing style of teaching predominated (see Chapter One). One way some teachers helped students to inquire was by providing them with a **KWL** form (what we **K**now, what we **W**ant to know, what we **L**earnt; see Appendix 6). By using this form, teachers were able to check students' prior knowledge, and encourage them to come up with some questions for their research. Students used these questions for further knowledge-seeking about their topics.

For example, the topic during one observation was about heritage sites in Oman. The teacher started the lesson by telling the students about the topic, then she divided the students into groups giving each group a KWL form. In their groups students discussed what they knew and wrote questions about matters on which they needed to know more, such as location, who built it, why it was built etc. The teacher walked around to check students' work and provided help and suggestions for those who needed them. In another observation, the topic was about plants. The teacher started the lesson by refreshing students' knowledge about the plants and then asked the following:

"Are plants the same?"
"What are the differences among them?"
"How do they store their food?"

Then the teacher told the students they had to search for information about how different plants store their food. Such practice reflects teachers' belief about the active role of the students.

Further, another description of constructivist teachers is that they design learning settings whereby students perform active mental tasks, such as gathering, analysing, and discussing information. It is believed that constructivist teachers use and encourage cognitive terminology such as "classify," "analyse," "predict," and "create" (Brooks and Brooks, 1993).

It was clear from the observation analysis of both teachers' and students' behaviours that students were put in a situation where they were self directed learners and involved in cognitive thinking such as gathering, evaluating and analysing information.

Such student behaviours were the second most observed behaviour during the students' practice as can be seen from Table 7.3, with a mean score of 3.40. This also coincides with teachers' behaviour, which can be interpreted as guiding and facilitating during students' learning (see Table 7.1 for more detail). In most observations, the researcher noticed that after they had gathered their information, students sat in their groups to discuss what they had found; the teachers helped students to identify the right information. However, while walking around and helping students, the researcher noticed some students cut and pasted information without working on it, or copied exact words from the resources. This indicated that students did not use technology to construct new meaning beyond that found in the resources used by students, i.e. students did not analyse, evaluate, or synthesize information while learning, an observation also made by Lundeberg, et al. (1997).

7.2.3.2 The use of multi-resources vs. textbook

It is argued that constructivist teachers use raw data and primary sources, along with manipulative, interactive and physical materials in their teaching rather than constraining students to use textbooks.

In the post-training questionnaire, overall, LRC teachers expressed a positive attitude to the items related to use of multi-resources in students' learning. Teachers saw that IT activities should involve more than one type of technology, with a mean score of 4.12 and standard deviation 0.91; they also had a positive attitude towards the use of a wide range of materials in the LRC, with a mean score of 4.09 and standard deviation 0.88 (see Appendix 18).

As mentioned before, LRCs in all schools contain various kinds of media and authentic materials that students need for most of their projects. Instead of learners being forced to read the "set text" that the teacher or textbook provides, they can use the Web, books, CD ROMs and computers to locate information for their projects; thus giving learners more choice, more flexibility, and more autonomy. The most used technologies and media reported by the evaluators were books, pictures, scanner, digital camera, audio tapes. In this way the teachers gave students a choice in the use of technology, and in how and where they would work on their projects. The students had responsibility for the success of their projects, so they were active in searching and asking for information. In studies (for example, Cohen, 1997; U.S. Office of Technology Assessment, 1995) teachers, in a similar learning environment, encouraged students to use a variety of resources such as the Internet, images, newspapers and CD ROMs.

For example, in the present study, in one project on rocks and minerals, the teacher encouraged students to use the internet to search for information about the topic. She arranged a trip for the students to a nearby mountainous area to study and collect some rocks, and encouraged students to identify their types and classify them. In another school, LRC teachers arranged a visit to some farms in the area for students to study different types of local animals, their types of food, their features, how they reproduce and so on. Students took notes and pictures, they videotaped these animals and recorded their voices. Another teacher took her students for a trip to the motorway to report about the traffic. Using a specially designed form, the students took notes about different types of vehicles, colours, speed, number of passengers etc. They also took photos using digital cameras.

7.2.3.3 Teachers as mediator, facilitator and guide.

Those teachers who believe in constructivist teaching are seen as mediators of students' learning and try hard to ease difficulties that students encounter while engaged in learning.

In the post-training questionnaire, teachers showed a more positive attitude towards the teacher's role as a mediator, facilitator and guide. The mean score was 4.32 with standard deviation 0.41, indicating a more positive agreement with such a role (see Chapter Six, Table 6.44). For example, teachers had a positive attitude towards: providing students with guidance when they need, with mean score of 4.47 and standard deviation 0.71; walking around to check students' work with mean score of 4.42 and standard deviation 0.66; discussing the material with students with mean score of 4.35 and standard deviation 0.74; and giving clues and hints with mean score of 4.34 and standard deviation 0.70 (see Appendix 18).

The researcher's observation and result of videotape analysis of teachers' behaviours was consistent with the above description. Most observed LRC teachers can be regarded as holding positive beliefs about being a mediator. Items 2, 5, 6 and 7 in Table 7.1, describe the role of the teacher as mediator. These behaviours had mean scores ranging from 2.50 to 3.30, indicating that teachers were often mediating students' learning. The role of teacher as mediator and coach has been observed in similar constructivist hi-tech environments. Studies (Dwyer et al., 1991; Penuel and Means, 1999; U.S. Office of Technology Assessment, 1995) have shown that students took an active role in the learning process and the teacher acted more as coach or facilitator. Hudson (1997, p.268) found that in such a learning setting, teachers provide scaffolding by promoting group interaction and direct intervention.

The researcher witnessed many occasions whereby teachers were involved in smoothing out difficulties that faced students' learning such as solving minor technical problems, and helping students with locating and selecting their resources. In accordance with teachers' mediating role, students also were observed seeking teachers' help with their learning. For example, the item, "students seek teacher's help and assistance", item 9, had a mean score of 2.95, in Table 7.3, giving an indication that teacher's mediation is important for students' learning. Järvinen (1998) found that students were not able to proceed independently and had to be supported. This support could come from peers or from the teacher.

For example, in one observation, students in one group did not know how to insert a picture into the PowerPoint presentation. One of them went to the teacher for help; she came and indicated how to do it and said, "Those who know teach those who do not know." Similarly, Ringstaff and Yocam (1995) observed that teachers often took the role of facilitator, while students frequently were called upon to play the role of expert.

Constructivist teachers should allow students to attempt to find answers for their inquiry and solve problems by trial and error. Constructivist teachers should not impose their understanding before students have made their own attempts, and allowing students the time to so do is also crucial.

LRC teachers gave students opportunity and time to learn by themselves without interfering in their learning process, and gave them plenty of freedom. In Table 7.2, item 1, teachers were observed walking around and checking students work, rather than lecturing to them and providing them with information. Teachers allowed students to discover knowledge by themselves and gave the students time to research and try different ways to reach answers for their inquiries and problems.

However, the researcher was aware of some incidents where two teachers did not withhold their information and reverted to their traditional roles offering students' answers for some of their questions. Brooks and Brooks (1993) give several reasons for such behaviours: (1) the teacher might want to share information with the students; (2) the students may be impatient; and (3) the teacher might adhere to the old belief about knowledge being power.

7.2.3.4 Allowing cooperation and collaboration vs. individualism

According to Brooks and Brooks (1993) social discourse is a powerful way to change and reinforce conceptions. Therefore in an appreciation for such action, constructivist teachers encourage interaction between themselves and students and among students. That is teachers who have positive attitudes towards constructivist teaching allow cooperation and collaboration among their students. They encourage students to engage in dialogues both with the teacher and with one another.

In the questionnaire, the LRC teachers expressed their positive attitude towards cooperative and collaborative learning. The overall mean score was 4.19 and standard deviation 0.68, giving an indication of a positive attitude towards cooperative and collaborative learning (see Table 6.44, Chapter Six). For example, teachers showed a positive attitude towards: group members sharing information (mean score of 4.29 and standard deviation 0.82) and group members interacting with each other (mean score of 4.23 and standard deviation 0.82) (see Appendix 18).

The observed LRC teachers allowed and encouraged much interaction between themselves and their students and among students (see Appendix 14-A and 14-F). As shown in Table 7.1, Item 3, with mean score of 3.10 and item 5, with mean score of 2.70, were among the most observed teachers' behaviours. That is to say LRC teachers talked more to individual students and to small groups than to the class as a whole (item 12). These findings are consistent with reports by Collins (1991), David (1992) Dwyer (1994), Means and Olson (1995a) and U.S. Office of Technology Assessment (1995), that in a constructivist high technology classroom, teachers spent less time lecturing and more time overseeing small groups or working one-on-one with students. These studies showed that teachers, in a technology-rich constructivist learning setting, facilitated both cooperation and collaboration among students. The researcher's observation suggests that teachers also interacted more with low achieving students. Collins (1991) reported that low achievers received two to four times more attention from the teacher than high achievers in technology-rich classrooms.

LRC teachers were keen to see students cooperating with each other to accomplish their own tasks. This is also consistent with students' observed behaviours in each group. Students' behaviours such as working together (item 1), listening to each other (item 6), helping each other (item 7) and talking to each other (item 8), in Table 7.3, were observed during IT activities, in both off-computer and on-computer tasks. There was much cooperation and collaboration among students within their groups and among groups as well. In some cases, LRC teachers were observed trying to establish coherence among group members, when individuals tried to go away from their groups. Students' cooperation and collaboration in this study is supported by previous studies which found that students exchanged skills and knowledge (Turner and Vito, 1997), and that students learned from one another (Järvinen, 1998).

Further, cooperation and collaboration among students in LRCs were observed during both off computer activities and on computer activities. However, they more frequently occurred during on-computer activities. This might give an indication that the computer was a tool which increased the amount of cooperation, because students discussed among themselves what they had found, what information was appropriate to use and how to present it, and also they corrected each others' mistakes. Similar findings were obtained by Gayle and Thompson (1995) and Honey and Henríquez (1996) who found that cooperative and collaborative activities were more common in such learning environments. McLoughlin and Oliver (1998) found that working on tasks around computers increased students' collaboration and group interaction. Such student engagement fosters cognitive change. This reflects Vygotsky's notion of particular aids being necessary to promote students' learning. Such aids can include language or computers (Warschauer, 1997; Jonassen, 1996).

However, videotape analysis shows that some students were unwilling to cooperate and work in their groups. As shown in Table 7.3, Item 11, with mean score of 2.35 and item 12, with mean score 1.70 indicate the existence of individuals' resistance to cooperate. Also, the researcher noticed the occurrence of this behaviour within some groups and in some events (at least three students in every observation). There were students who walked away from their groups, there were students who teased, hit and insulted one another and there were students who cornered all the work and had control over the PC (as discussed in section 7.2.2.2.).

7.2.3.5 Promoting students' prior knowledge

Learners' prior knowledge is an important element of constructivist teaching. Teachers should base their teaching on what students already know and have previously acquired. Therefore, the constructivist teacher poses questions or inquiries to elicit what students know (Brooks and Brooks, 1993, p.106). Techniques (as proposed by Christen and Murphy, 1991; see Chapter Two, section 2.4.5), such as brainstorming the topic, asking specific and/or general questions about the topic or posing a problem or scenario were used by LRC teachers to check students' prior knowledge.

In Table 7.1, item 6, with mean score of 2.60 and item 7 with mean score 2.40 were frequently observed behaviours, indicating that teachers were often involved in knowledge checking activities. In the first session of each project in all observed LRCs, the researcher noted that teachers started their lessons by checking students' prior knowledge about the topics of the projects. For example, in a project about regions in Oman, the teacher started the lesson by asking the students the following questions: What is your town's name? In what region is it? What do people do for a living? Then the teacher linked this discussion to the topic of the project. Another teacher checked student' prior knowledge by giving them the (KWL) form. Then she walked around to check students' responses on what they knew about the topic.

LRC teachers also checked students' IT skills background assuming that some students might know some IT skills because they had computers at home. In Table 7.1, item 8 with mean score of 2.60, scores above average, indicating that teachers practised checking students' IT prior knowledge. This behaviour can be linked with students' frequently observed behaviours: item 3, students share ideas and work with each other, item 4, students tutor and help each other, and item 10, students encourage and motivate each other.

The researcher's observation concurred with this result. The use of "expert" students is a good example, whereby some teachers took advantage of some able students who had previous experience with IT and asked them to help their friends.

7.2.3.6 Adopting "let go" vs. full control

In a constructivist setting students need to move around to search for and gather information. It is assumed that constructivist teachers will allow students' free movement in the classroom and students will be allowed to be responsible for their own behaviours.

In the main study questionnaire, LRC teachers showed a positive attitude towards allowing students to move freely in the LRC. The mean score was 4.26 with standard deviation 0. 91 (see Appendix 18).

Observed LRC teachers during the implementation were seen to maintain a good control over the learning environment. They allowed a lot of freedom for their students to move around the LRC to collect information and hold discussions about their topics, while also keeping their eyes open to any problematic behaviour which might occur. This is consistent with teachers' positive attitude after training towards students' movement in the LRC (Chapter Six, section 6.5.1.4, item 13). Item 4 reflects the class management skill. In Table 7.1, item 4, with mean score of 3.05, indicates that teachers frequently observed students' behaviour. This is consistent with what Moseley and Higgins (1999), Hannafin and Savenye (1993), Honey and Moeller (1990) and Penuel and Means (1999) reported, that teachers (who hold constructivist views), in a constructivist setting, relinquish some of their control. For example, Moseley and Higgins (1999) reported that enthusiastic ICT teachers are likely to favour pupil empowerment as learners, whereas those with negative attitudes about ICT are likely to be more directive in style or may prefer children to work individually without ICT. LRC teachers' willingness to give students freedom reflects their positive attitude towards the constructivist approach. This result contradicts Byrom's (1998) finding that some teachers do not want to give up the control and order they have in their classroom.

Teachers used various techniques to keep control. For example, in one observation, the teacher noticed that one student was not in his group; therefore, she approached him and asked him to join his group. She did this with other similar cases as well. In another instance, the teacher was obliged to move one student from his group because he was fighting with other members. In another observation, one teacher maintained control by calling misbehaving students by their names, for example: "Rashid?" or "Ahmed?". As soon as those students heard the teacher, they kept quiet. Another teacher used LRC enjoyment as a tool to retain control. "If you do not stop such behaviour, I am not going to let you in next time." She addressed students individually. Similar techniques were applied by teachers who were classified as being in the 'Mastery" stage in the model presented by Sandholtz, et al. (1991).

7.2.3.7 Using direction to groups vs. direction to the whole class

It was expected that teachers in a constructivist environment should not talk to the class as a whole but rather direct their instruction to groups. In Table 7.1, item 11, with a mean score of 1.20, reflects how teachers directed students' activities during IT lessons, indicating that they did not address the whole class, but rather addressed individuals and groups. Studies such as Collins (1991), David (1992) Dwyer (1994), Means and Olson (1995a) and U.S. Office of Technology Assessment (1995) showed that teachers in a similar learning setting spent less time giving instruction to the whole class and more time with groups and individual students.

However, there were some teachers who gave instructions to the whole class but with not all of the students paying attention to these instructions. Such teachers' behaviour was reported by Ringstaff and Yocam, (1995, p.12) "...a variety of instructional approaches are used, including traditional activities such as whole-class instruction mixed in with more constructivist, project-based teaching". For example, some LRC teachers gave explanations, instructions and demonstrations while students were busy with their work. One teacher gave a very important instruction: "You should write clearly, so you can read your notes when entering them into the computers", but the students did not pay attention to it. Another teacher asked the whole class to "Find clear supportive pictures for your topics to scan them." Failure to hear such an instruction might result in students picking up pictures which are irrelevant to their topics. In another observation, the teacher directed the whole class to save their work before they left the LRC, but as a result of not paying attention to or not understanding the instruction, some groups left without saving their work.

7.2.4 Summary

Overall, the observation analysis showed that teachers' positive attitude towards the new approach and their beliefs had an impact on their practice during their implementation. LRC teachers' observed roles can be described as constructivist. They acted as monitors, facilitators and helpers.

Further, they were observed allowing and promoting students' activities such as the autonomy of students, collaboration and cooperation and freedom for students to use the resources. Such action reflected the importance of students' behaviours which gave an indication of teachers' positive attitude.

Technical problems and problematic behaviours among students were observed during most of these lessons. Sudden computer shutdown and crashes, or malfunctioning of the sound system, printer and scanner were some examples of technical problems. Students teasing and fighting each other and unwillingness to cooperate with their groups members were examples of students' problematic behaviour.

7.3 The Interviews

This section presents a summary of teachers' beliefs and practice about a technology-rich learning environment based on interviews. That is to say the main focus of this section is on describing teachers' belief and experience in this environment.

The process of analysing the interview involved coding using key words (see Chapter Five, section 5.5.4 for procedures involved in analysing interviews). The outcome of the analysis was eleven categories representing issues concerning the implementation of project-based learning using IT/Multimedia. These eleven categories were then grouped into two broader groups: (1) teachers' beliefs about their experience and practice in a constructivist learning environment, which encompassed teachers' expression of the advantages of project-based learning and (2) barriers (factors) that teachers felt affected their implementation of the approach. Table 7.4 shows the two main categories and their subcategories. Within category one, seven more specific sub-categories were identified as a result of coding the data and four subcategories identified within category two. These categories are as follows:

Table 7.4: Interview Categories

No.	Category One: Teachers' beliefs and experience	No.	Category Two: Barriers
1	The benefits of the new approach	1	Training & Technical support
2	Active pupils' role	2	Time of the projects
3	Teachers as facilitator	3	Students' behaviour
4	Collaboration	4	Lack of equipments
5	IT as Content		
6	Constructivist assessment		
7	IT use		

7.3.1 Teachers' beliefs about their experience and practice in a constructivist learning environment.

In this section, teachers' attitudes are reported under seven headings, corresponding to the seven sections of the questionnaire, that is, the seven dimensions of the constructivist approach.

7.3.1.1 The advantages of the new approach

As stated earlier, in Chapter Six, section 6.5.1.1, after the training, the overall attitude of LRC teachers was favourable towards the rich-technology constructivist learning environment, regardless of their personal characteristics. In the questionnaire, teachers expressed positive attitudes after the training and practice. Similarly, the overall perception of such an environment was expressed in interviews with 40 LRC teachers. However, they also expressed some concerns that had negatively affected their belief and practice. For example, it was common for a teacher to express the belief that the use of project-based learning allowed improvement in her teaching while simultaneously arguing that she lacked the necessary time and training to achieve effective use of the approach. During the interviews, LRC teachers were asked to express their opinions about the benefits of the new approach. 90% of the teachers expressed positive attitudes. When asked what they thought of new methods of teaching and learning, most teachers used terms such as the following to describe it: "interesting", "useful", "successful", "good" and "an excellent way of teaching". For example, one teacher maintained that

> Although the new approach is demanding, students benefited from it a lot. They gained IT skills in addition to information in a wide subject area. (School#5)

In school#7 a teacher saw the new approach as a revolutionary way of teaching:

> I have more than six years of teaching experience as a subject teacher and almost 3 years of teaching experience as LRC teacher. I have to say that I have not come across an experience like this which allows freedom for both teacher and students. Students are not confined as they used be in the traditional classroom; in this method they have freedom to select their resources and sources of information.

Another teacher expressed the influence of the approach on her teaching:

> Because of a number of reasons, I have found myself moving more towards the child-centred approach with my students. That is to say I am trying to become more the "guide on the side" as opposed to the "sage on the stage". I have found that such an approach offers involvement of resources and access to many sources which help foster students' learning and promote the types of activities/opportunities that I want to create. However, this type of approach can be very demanding, it requires a great deal of time and lots of organization and background work. (School#11)

Teachers had a positive attitude towards the new approach and they saw in it the potential for effective learning. They recognized that there was a change in the role of teacher and students:

> This approach is based on the use of many resources. It can help create a learning situation whereby the teacher is not the source of information but a guide and students realize that they should take the initiative to learn by themselves. (School#10)

One teacher believed students' active involvement in their learning is very important:

> This approach encourages students to be responsible and independent learners which is a good idea and one of the objectives of the reform in the country. (School#18)

Participants in this study expressed the belief that project-based learning had an influence on the motivation of students learning. Teachers noted that students are "more interested in doing research this way than from books", that they "get very actively involved and interested", that they tended "to be more eager to learn", "creative in their use of technology", "never wanted to leave the LRC after the lessons" and were "actively involved and interested ".

For example, in one school the teacher concluded that "Students showed their willingness to learn about the use of different technologies, especially, sound recording." (school#8). Another teacher concurred: "There was a desire and passion for work." (School#6). One teacher maintained that students were motivated to practise their skills outside the school: "One student told me that she taught her family how to make a presentation using PowerPoint." (School#1). In the same vein, Turville (1999) reported that students were motivated to use computers to work on writing projects and benefited from such facilities as editing and checking spelling. Another teacher was impressed with how quickly students learned: "I think they now know some skills that we do not know yet; they discover more than us." (School#2). Similar beliefs are reported by Ehrich, et al. (1998a, p.7) who found that students began their own discoveries and taught themselves about things such as sound processing and PowerPoint. Students in that study mastered PowerPoint before the teachers. Moreover, teachers also acknowledged that because students were so motivated, they hardly wanted to leave the LRCs. A similar finding was reported by studies such as Blumenfeld, et al. (1991); Liu and Rutledge (1997) McKinnon, et al. (1997), and Moursund (1999) in which students were highly motivated, highly engaged in their learning and used various resources during project-based learning.

When the 90% of teachers who favoured the new approach were asked why they believed the approach was more effective than the traditional approach, they gave various reasons. They said that the constructivist approach:

1- Teaches research skills inside and outside the LRC using technologies such as the Internet, CD ROMs.;
2- Promotes sharing of technologies' use and knowledge among students;
3- Encourages cooperative work among group members, so even low achievers can benefit from higher achievers;
4- Encourages cognitive thinking by learners;

5- Encourages the use of a wide variety of technologies.

7.3.1.2 Pupils' role (students as active learners)

Teachers expressed their belief in the impact of the approach on students as active learners. Around 80% of teachers acknowledged the students' active roles. They described the approach as allowing students to learn through experience, teaching them searching skills, allowing for more independent learning, and promoting searching in different resources through different technologies. The use of multimedia, they thought, enhanced understanding, which promotes greater retention of facts. This gave an indication that students were actively involved in their learning. Teachers identified the pupils' role in a manner consistent with the pupils' role in a constructivist learning environment (Chapter Two section 2.4.2). The interview results are in line with the survey results in Chapter Six, section 6.5.1.2, where teachers' overall attitude was positive towards the pupils' new role. One teacher expressed the pupils' role as follows:

> In this method my role was only guiding, managing and supervising without getting directly involved in groups. I did not give the pupils the information. Rather, with their effort they explored, searched for it and evaluated it. I directed them to resources and they searched for it. This method is child centred. It is so because it makes the child the one who searches for information, gather ideas, record them and edit them to be used by others. The child also has learned new skills such as self-directed learning, cooperation, self-evaluation and other skills of using new technology such as a scanner and digital camera. (School#4)

In one school a teacher maintained that:

> It was an active role. That is, students researched for and gathered information and "treated" it, and then entered it in the PC and made the necessary corrections. (School#7)

Another teacher said that students' learning was not limited to the school, but they could carry out learning at home, especially when it was related to students' real life:

> It is possible for students to complete their work at home in such a manner that they gather information which is available at home and in their surrounding environment. At the same time, whenever the topic is related to students' life, it becomes more interesting and it is possible to find more information about it. (School#1)

Another teacher maintained that students were interactive with the learning operation: "It is a very good and fruitful method and students were actively engaged in the learning operation." Teachers saw students as taking responsibility.

Teachers not only saw students as responsible but also they claimed that they experienced a new role of the student as "expert" during lessons, helping the teacher to teach other students:

> The students' role was active. There was an exchange of roles among group members. Students were responsible for their learning. Also, sometimes, they worked as guide and teacher for group members and sometimes for other groups. (School#3)

In another school, the teacher believed that students were not only responsible for their learning but also had freedom in their learning:

> In this approach, students have different resources to search for information, so there were more opportunities to widen their scope of knowledge and to be responsible. That is because students are not given information but they have to make efforts to find it. In so doing, students can make distinctions between what is useful and what is not useful. The student has opportunities to search in books, TV, or the Internet. So there is a sort of freedom and responsibility. (School#13)

Teachers' reports of pupils' roles are in line with those roles discussed in Chapter Two, section 2.4.2 which shows pupils as active knowledge seekers. In addition, most teachers showed positive attitudes towards such a role in the survey questionnaire, especially after the training (presented in Chapter Six, section 6.5.1.2)

7.3.1.3 Teacher's role

Teachers' beliefs about their role during IT lessons indicated the advantages of being facilitators, helpers and guides. 85% of teachers had a positive attitude towards the constructivist role. Such roles gave opportunities for students to be responsible for their own learning and for teachers to offer more help to those who needed it. For example, one teacher stated:

> There is a difference between the two approaches. In this approach students are in groups and it is easy to focus on one group to provide help. However, in the traditional approach, there are 30 students and it is impossible to give attention to each student. This approach helps lower achievers to improve their achievement...... The teacher in the old approach teaches skills which are unknown by all students, rather than teaching skills for individual students, as in this approach. (School#7)

Teachers in this study remarked that their role was to provide assistance, give students hints on how to do things, guide students with work, and discuss students' enquires with them. "Our role was guiding and supervising during the implementation of the projects and not as dispensers of skills or knowledge." (School#20). Similarly, one teacher said:

> Our role was to guide and direct. We started by introducing the idea of the projects, we prepared searching for information forms (KWL forms). Then the students started to search for information, select sounds and pictures, captured video clips from CD Rom. We introduced PowerPoint to them. Students presented what they gathered with it, with our guidance and assistance. (School#12)

In another school the teacher stated that:

> Our role was to guide and direct, explain how to produce media, follow and guide students, encourage distinguished work and correct mistakes for the better. (School#11)

Another important role teachers mentioned was the prearrangement of the learning situation by, for example, making sure of the availability of resources for students' different projects and solving some minor technology problems. Teachers' constructivist roles coincide with teachers' constructivist roles reported in Chapter Two, section 2.4.3. Further, teachers in this study were observed practising these roles (see sections 7.2.1 and 7.2.3), and the post-training survey results show they developed a more positive attitude towards these roles, as can be seen in Chapter Six, section 6.5.1.3.

7.3.1.4 Collaboration among students

All the interviewed teachers believed that the new approach offers significant advantages in terms of providing opportunities for cooperation and collaboration among students. They reported that there had been a great deal of cooperation and collaboration among students to achieve their common goals. Cooperation and collaboration were described in phrases such as: "sharing of information and skills" and "weak students learn from others". This is consistent with what was observed taking place in the LRC (section 7.2.3.4) and with the findings of Turner and Vito (1997), Nath and Ross (1996) and Newell (1996). Teachers reported that "Heterogeneous groups work better". This is supported by studies such as Bennett and Dunne (1994); Kagan S. (1992, cited in Johnson, 1996, p.89); and Means and Olsen (1993) who maintained that heterogeneous groups are effective for learning in a cooperative environment. Teachers in the present study also said that "Students strive to do better" and "students can finish tasks faster." Generally, teachers' beliefs coincide with what Nath and Ross (1996) found in their study, that teachers (with only a few exceptions) believed that the cooperative learning experiences had a positive impact on students.

Teachers believed that students shared and discussed information and ideas among themselves in both on-computer and off-computer tasks.

> During their projects, students shared information with each other about how to use technology in addition to exchanging (subject) information among themselves. It also happened class wide. (School#1)

Teachers believed that cooperative learning among students would lead to better learning: "The discussion among students encouraged them to produce excellent work" (School#8). Other teachers commented on how cooperative learning and cooperation was extended to other groups.

> Students were working in small groups. There was a type of competition among students, for example, when one group explored

> a new IT skill, the other groups strove to learn from that group. Also when one group found a piece of information that was needed by another, they went and told that group about it. (School#14)

Teachers also thought cooperation could greatly benefit low achievers and helped them to be active learners. For example one teacher maintained that "Working in groups, there is a possibility for lower achievers to learn from higher achievers and improve their standard." (School#18). Another teacher commented, "The good students helped and assisted weak students to overcome difficulties." (School#6). Teachers believed that students learned more from their peers than from their teacher. "A student might learn more from his peers than from his teacher." (School#13). Further, one teacher stated that:

> Because of working in groups, there is cooperation in thoughts. This helps low performers to take the characteristics of higher performers in issues such as leadership, freedom in speech, how to gather information, enter them into the computer... (School#19)

On another occasion, one teacher gave a good example of how lower achievers benefited from higher achievers, stating that

> We have poor readers in some groups, and while students recorded their voices for PowerPoint presentation, they competed with each other to record their voices. The good readers helped the poor readers to read and correct their mistakes. (School#16)

Teachers also saw the potential of heterogeneous grouping. In one school, teachers argued that "Putting mixed ability students in group leads to students benefiting from each other." (School#18). Another argued that:

> There are some shy and introverted children and with the presence of the teacher they cannot break their shyness. However when they are in groups they are more confident. (School#17).

Another teacher added, "Boy and girl groups work better than boys only or girls only groups." (School#13). In another school, teachers saw heterogeneous grouping (boys and girls) as promoting students' learning:

> Mixing both sexes (boys and girls) gives more effectiveness for learning. That is so because students are more active and

> competitive and this is not so in homogeneous groups (boys only or girls only). (School#4)

The researcher's interpretation of such an active involvement is that boys are motivated to work harder in the presence of girls, as they do not wish to appear weak or inferior by achieving less than girls; meanwhile, girls are aware of this attitude and are motivated to increase their own accomplishment. The potential benefits of heterogeneous grouping are reported in the literature (such as Bennett and Cass, 1988; Means and Olson, 1995a; Simsek and Hooper, 1992; Slavin, 1991; Thurston and Secaras, 1997).

Interestingly other teachers believed that cooperation helps students to compete with other groups: "Cooperation among group members encouraged students to produce better work to compete with other groups" (School#3). Also, 10% of teachers believed that having heterogeneous groups in terms of ability would hold back higher achievers. This belief supports the view of Robinson (1990) who argued that explaining material to low achievers holds back higher achievers from making progress in their learning. One teacher maintained that "Good students will be very confined by the group." (School#14). Another teacher expressed the same view, stating that "It slows down the good pupils from making more progress." (School#4).

7.3.1.5 IT as content

IT as content refers to the use of technology across all content areas, as well being a content area in its own right (Moursund, 1999). IT in this sense is not taught as isolated skills. The teachers in this study might not have been aware of this term, but they reported that they valued the IT activities that students performed, because students learned both IT skills and content. Almost 95% of the teachers reported that students not only learned IT skills such as how to use Ms Word, PowerPoint, Paint, sound recording, digital camera and scanner, but they also learned something new about topics covered in their different school subjects. Studies such as Abbott and Faris (2000); Ertmer, et al. (1999); Hooper and Rieber (1995), and Robinson (1998), similarly reported teachers' belief in the advantage of thematic activities. One teacher argued that "The activities allowed students to use the different types of technology to learn new things." (School#8). Teachers maintained that these activities were motivating, interesting, and a good way to learn both IT skills and subjects.

> The old way, students were taught IT skills and practised them with meaningless activities such as colours in English lessons. Here, students learn new IT skills with meaningful activities such as learning more about rocks in the science curriculum. (School#2)

Furthermore, in one school, a teacher stated that "Students learn fast and more than what is in the curricula" (School#15). Another teacher provided support for what she believed is a good way of learning IT skills:

> I believe this a good way to teach IT skills. Students explored more skills than what was aimed for them. That is to say they are not confined to limited skills while learning. (School#13)

Another teacher argued that "with this approach which is more constructivist, the computer becomes an integral part of activities, centre work, etc." (School#10). Another teacher expressed what students learnt:

> They learned about the different rocks and minerals and what they do with them and they also learnt how to save pictures onto a PC and how to record their voices. (School#19)

Teachers maintained that IT activities were interesting because they are related to students' real life:

> The activities differ according to the curriculum. Some of them tie directly to students' environment, especially if students select a topic such as "*****"[16] so students meet the people and collect pictures...etc. This makes students happy. (School#4)

[16] The missing word is the name of the teacher's region; it has been deleted in order to preserve the anonymity of the teacher concerned.

Another teacher maintained that "the projects are related to students' life and environment and students learn information" (School#3). Another teacher gave a reason why IT activities should relate to students' real life:

> If the activities are tied to students' life, they provide an opportunity for students to be in touch with each other, to exchange information and to promote cooperation among them. (School#2).

One reason offered for the importance of the IT activities being related to student real life, was that it leads to more interaction:

> When the project is related to students' real life, there is more and wider interaction in students' learning because, whatever information they find, they transfer it to the environment and to their homes to teach it to them (family members). (School#1)

In the interviews with the participants, they reported IT activities covering a wide range of topics from different content areas such Social Science, English, Maths, Islamic Studies and Arabic (Appendix 7 summarizes some of these topics). Teachers believed that through such topics, students gained both subject knowledge and IT skills.

Teachers also asserted that IT skills were motivating because they covered topics from outside subjects areas such as designing presentations for the "Clean-up Campaign" competition, Environment Day, festival (Eid) days, "Good and Bad behaviours", "Do and Don't."

However, one teacher expressed her concern about teachers' limited knowledge of different subject areas. These type of activities required teachers to be knowledgeable in different subject areas, when they in fact specialize in a specific subject:

> Such activities require the teacher to be aware of and acquainted with all subject areas (English, Arabic, Geography, Maths and Science) and students assume that teachers know more that they do regardless of the teachers' specialty; we do not feel that acquainted with all subject areas. (School#13)

Blumenfeld, et al. (1991) considered teachers' lack of content knowledge as a constraint on implementing the constructivist approach.

7.3.1.6 Alternative assessment

Eighty percent of the teachers saw the value of using alternative assessment in many ways. They saw it as a relief for them, as it took some of the burden off their shoulders; a delightful way of showing what students knew and had learned; an opportunity for an audience to participate by being invited to a presentation section, and a way of encouraging competition among groups. In fact, teachers' perception of the importance of such assessment was due to the fact that students had an audience for their work. Ehrich, et al. (1998a) reported similar opinions about multimedia presentation. Liu and Rutledge (1997) found students were motivated and encouraged because they had an audience to evaluate their work. One teacher maintained that "It was a wonderful time, when students finished their presentations; it happened that some parents were visiting the school. We invited them to see students' work. They were very pleased." (School#1). Teachers saw that presentation of students' work benefited not only the class concerned, but also other classes: "Students work to collect data and present them. The benefit would not be only at class level but for all classes in the school." (School#1). This is in line with what is proposed by Grabinger (1996) and Guzdial (1998) that students should produce designs (artefacts) that can be evaluated and used by other learners (see Chapter Two, section 2.4.6). Teachers saw it as important to have peer or group evaluation, which they thought lent itself to feedback from others, consistent with the assertion of Carver, et al. (1992) of the importance of the audience's viewpoint in evaluating students' designs. "One advantage of such assessment is it gives a chance for students to show their cooperative work, discuss it and have it evaluated by groups" (School#2).

Another teacher suggested that "this type of assessment takes off some of the exam preparation and marking" Another teacher contended that:

> Self evaluation pleases the student because in this assessment the student takes the role of the teacher. This type of evaluation takes off part the teacher's job and eases the way students are assessed. (School#19)

However, 20% teachers made criticisms about this type of assessment. One teacher questioned the validity of this assessment maintaining that "We need more time to be sure of its validity." (School#13). Another teacher wondered how to be sure the learning of each individual student is measured: "It is not possible to make sure all students have learnt." (School#14). This attitude is consistent with what Bennett and Dunne (1994) maintain that individual accountability is low and it is difficult for the teacher to know what each child has contributed. Another teacher favoured retaining some traditional assessment "This is good, but I wish there were some tests to evaluate students' performance." (School#9).

7.3.1.7 IT use

Teachers' beliefs about knowledge construction reflect their use of computers. That is, if they believe in objectivism, they use software that supports this approach, whereby they believe they are still involved in selecting instructional material and controlling the activities (Hannafin and Freeman, 1995; Hannafin and Savenye, 1993). However, in the interviews LRC teachers did not express such a belief.

Teachers thought that the use of technology should go beyond traditional use and students should use available technology or resources inside and outside the Learning Resource Centre; this is what should be encouraged these days. A similar attitude was reported by Ehrich, et al. (1998a). In their study teachers believed that students' IT use should go beyond preparing them for future jobs. In this study, LRC teachers expressed their beliefs as follows:

> The nature of student learning has changed dramatically in the past decade. Within the wide availability of information sources in these days, students should be encouraged to use them in their learning. (School#19)

In one school a teacher maintained that:

> Nowadays, students are quite different from those 10 years ago. Students grow up in a world that is super hi-tech. They are raised in a world in which they are "turned on" to a very rich technology life from their earlier childhood. I am motivated by the desire to make my classes as interesting and relevant to my students as possible. This approach meets this demand. (School#8)

Teachers perceived that students used technologies to search for information, identified different media for their projects and used sources from the LRC and outside environment.

> Different sources helped students to find relevant information. They learned about different technologies and how to use them in searching for and organizing information. (School#6)

In another school the teacher commented on the use of most resources and sources in students' projects:

> Students use all that is available in the LRC – scanner, computers, digital camera, books, audio cassettes and video tapes, CD Rom and the Internet to search for information. (School#2)

Teachers also believed that using different media helps students' retention because of the involvement of more than one sense. One teacher stated that "Multimedia appeals to a variety of senses, thus enhancing learning." (School#5). Another teacher claimed that:

> The use of Project-based learning is a good way to teach IT as content because it allows an opportunity for using different media and practical implementation. This in turns helps to "infix" information in their minds. (School#3)

Another comment about the importance of multimedia was made as follows:

> I believe the use of still pictures, students own' voices and sound and video clips can greatly enhance understanding and possibly promote greater retention of facts since it appeals to more senses. (School#8)

In another school, one teacher concluded

> Learning with multimedia improves students' retention. For example, if students take information about animals from TV, the Internet, or books, this helps to foster their understanding. As we have seen in the previous projects, students well understood what they had learnt and they were confident about what they had learnt, for example the rocks and animals. (School#19)

Teachers expressed their belief about the advantage of the new approach in terms of how it was used and the amount of technology used. They maintained that technology in this approach had been used differently and effectively. In addition to its use as a source of information, teachers saw it as a forum of teaching and learning. Here, the computer is a tool, which reflects Vygotsky's idea of a social mediator for human interaction (Wertsch, 1991, cited in Warschauer, 1997, p.90). LRC teachers used phrases to describe this use, saying that "students corrected their mistakes", "edited their work", "were involved in discussion about their topics", "presented their work with it", "drew picture and graphics for their presentation", "searched for information, images and clips", "were encouraged to help other students" and "evaluated each other's work". For example, one teacher stated that:

> Usually before students designed their presentation; they typed in the text in MS Word and checked spelling. If there were many suggestions for work correction, students discussed among themselves the right choice. (School#11).

In another school, a teacher maintained that "Students used MS Paint to edit and add text to the photos before incorporating it in HyperStudio" (School#15). Another comment was made that students used computers to practise reading skills: "Students read for each other before recording their voices. Then they played it. If they realized they had made mistakes, they started over again." (School#19). In another school, the teacher saw students' argument on selecting video clips as constructive: "Students discussed for some time from where they should start capturing the video clip for their presentation. Finally they decided on something related to their topic." (School#6). Another teacher added: "One project was about traffic. After collecting data on a trip to the main road, students used Excel to draw graphics for their presentation." (School#3). Teachers also believed that the use of multimedia presentation software had helped students to learn:

> In fact, students benefited from this program (PowerPoint) and enjoyed it. The process of using and incorporating different media into it, fixed information in students' minds. (School#18)

Teachers thought the new approach had increased and activated different types of technologies. In the previous approach, teachers reported the use of a few technologies such as the computer with CAI, TV and books. With this approach, teachers reported the use of more technologies in a meaningful way. For example, teachers described frequent use of scanner, digital camera, sound recording, paint program, video and presentation software in addition to books and magazine. One teacher commented that

> Yes, in the old method students used one type of technology, while with this method students had the opportunity to decide the subject and tools that they are going to use for their projects. In this manner, they activated the equipment available in the LRC such computer, digital camera, scanner, video recorder and books. Some of these had never been used before. (School#18)

7.3.2 Barriers

In contrast to the previous section which focused on teachers' positive beliefs and experience in a constructivist learning environment, about their role, pupils' role, cooperation and collaboration and technology use in such an environment, this section identifies major obstacles which teachers believed had a major influence on their teaching. Teachers raised concerns about what they perceived as some drawbacks of Project-based learning and what they perceived as necessary for this type of learning. These barriers were classified into four subcategories: (1) issues related to training, support and vision; (2) issues related to the time of the project (time of teaching); (3) challenges related to students' problematic behaviour and (4) the lack of various equipment.

7.3.2.1 Training and technical support

Although teachers had expressed positive attitudes towards the new learning environment and had taught some successful projects, they felt that they needed more training on how to deal with technical problems and technical support for different resources. They expressed their concern that the wide range of technologies used during project implementation would certainly result in many technical problems, which they saw as an obstacle in such an environment. Eighty percent of teachers in this study indicated that were very willing to use the technology, recognized its potential, but needed more training in the technical aspects of using technologies. Similarly, in studies such as Chin and Hortin (1993) and Jaber and Moore (1999) teachers expressed a clear need for continuous training in methods for integrating new technologies into the curriculum, because most of them rated themselves as being of limited proficiency or unskilled. Further, Barnes (1998) listed seven steps for success in technology integration and one of those is continuous professional development. Those teachers who did not report such problems and needs can be considered committed teachers. Ertmer, et al. (1999) found that many teachers did not see such issues as barriers for integrating technology because of their strong vision of classroom technology use.

Teachers reported the need for "trouble shooting hints", "help desk", "regular technician visits", "training programs on technical issues", and "support for the region". Having insufficient experience of how to use technologies was one of the teachers' concerns in using the approach. Similarly, teachers in the U.S. Office of Technology Assessment (1995), expressed that insufficient technical support contributed to their use of technology in the classroom and the teachers asked for exposure to innovative uses of technology, flexible "just-in time" training, and ongoing technical support. In this study teachers expressed such needs as follows:

One teacher stated "Our concern is that we do not have enough experience with the use of modern technologies." (School#1). Insufficient knowledge of handling equipment had prevented some teachers from continuing with teaching: "We waited helpless for a technician when we encountered technical problems." Another teacher listed three technical problems that she had encountered. "The inconsistency of the network, regular computer crashes and difficulties in sending files over the network." (School#4). Similar difficulties were reported by Sandholtz, et al.'s (1992) study. Another teacher emphasized the importance of technical training:

> By all means, the teacher should be given enough information on how to deal with the equipment, and the use of modern technologies... so she can overcome some simple problems occurring during her work. (School#5)

This is in line with what Turville (1999) reported, that teachers should be also technology literate to help model the integration of technology in all subjects.

Teachers also were embarrassed in front of the students because they did not know how to solve these problems. In one school, the teacher reported, "I felt out of my mind because I could not handle such problems". Another teacher concurred: "I had an impression that I was useless in front of my students; my students expected me to know everything". Teachers' lack of knowledge and feelings of embarrassment also were reported by U.S. Office of Technology Assessment (1995, p.134) as factors influencing teachers' integration of technology into the classroom.

In addition to the above mentioned needs, teachers also showed the need to be up-to date with new technology such as the internet and how to integrate technology in their teaching. "For more effective use of this approach, teachers should be acquainted with all modern technology" (School#7). "Teachers need more training courses to understand and master the new technologies." (School#3).

7.3.2.2 Time for the new approach

Another concern which teachers raised about teaching in such an environment was the time constraint. Teachers believed that lack of time was one of the problems they faced while implementing project-based learning. The participants shared the same perception about the time-demanding nature of this approach. They used phrases such as "it is time consuming", “not sufficient time", "requires a lot of time to prepare for", "needs extra time", and "more lessons needed". This is consistent with what Bernauer (1995) and Marx, et al. (1997) noted, regarding the need for longer class periods and different timetable arrangements to accommodate moves toward increased project work.

Having sufficient time to devote to the present curriculum may mean that there is insufficient time for integration of the new approach as one teacher explained: "We are restricted to a certain time; the existing IT curriculum is given most of the teaching time." (School#14). Another teacher concurred: "It is time consuming; it requires more lessons to prepare for it." (School#9).

Teachers thought that students need to be given more time to do research and to master new technology. One teacher stated: "One drawback of this approach is that students need more periods to enable them to search." (School#13).

7.3.2.3 Students' problematic behaviours

Students' problematic behaviours were another major problem that teachers perceived as a more influential factor during implementation of the new approach. Teachers' beliefs about the problematic behaviours of some students can be classified into two categories: (1) concerning classroom control and (2) working in groups. The participants in the study described students' problematic behaviours in the first category as "students move from one group to another", "the classroom was in chaos", "it created unsettlement in classroom", "playing around" and "shut down computers". Teachers' comments were supported by the observation results in section 7.2.2.2, where such problems are reported.

For example, one teacher maintained that "students did not follow instructions in the LRC during lessons." (School#2). Another teacher concurred that "the shortcoming of this approach is that it creates unsettlement in the LRC." (School#4). As one teacher observed, "Some students did not know their roles and they were confused walking round the LRC." (School#20). Table 7.3 shows that such student behaviour was observed during some IT lessons.

Also, teachers believed that the behaviours of a few students within each group had caused problems affecting their participation and their group members' participation as well. Teachers described as problematic some students' who were "unwilling to learn", "non-cooperative", "dominant", "dependent on others", "not affiliated to their group" and "introvert". These issues are to some extent related to individual students' personalities and learning styles, which might be problematic in any learning context; however, the teachers thought that the greater freedom and looser structure provided in the new teaching approach allowed more scope for such problematic behaviours. A similar point was made by Sandholtz, et al. (1993); they reported an increase of student distractibility; as one teacher in that study claimed "... a child who is off task with pencil and paper is off task on the computer and may be more so because of the many distractions going on around him with technology."

For example, one teacher acknowledged that "One problem in some groups, was that the head of the group was in control of the PC all the time. He did not give his friends a chance to use the PC." (School#8). A similar comment was made by another teacher who concluded that "Some of them have leadership charisma so they control everything during lessons." (School#12). This problem was reported during the observations (see section 7.2.2.2).

In addition, teachers believed that characteristics of some students such as being "not willing to work", "not loyal to his group", or "dependent on his friends" caused the failure of cooperative work in some groups.

In one school the teachers maintained that "One of reasons for the breakdown of group work was that some group members were not cooperative; they relied heavily on the leader of the group." (School#8). Another teacher attributed the failure of cooperative group work to the homogeneity among group members." She added, "It is difficult for the students to work in groups" (School#6). A similar finding was reported by Achilles and Hoover (1996), that cooperative learning failed due to students' failure to work together, especially in small groups.

Teachers perceived students' loyalty to their groups as an important factor for a successful group work: "Some of my students did not feel that they belonged to their group, so did not contribute anything to their group. They walked around from place to place." (School#17).

These students' attitude of not being a part of the group process might reflect their negative attitude toward working in groups. One teacher expressed her belief about the reasons for students' attitude: "I admit that not all students like to work in groups because either they are lazy or are allocated to a group they do not like." (School#9). Another teacher argued that, "Those of such behaviours have, in general, a negative attitude towards school." (School#5). Another teacher ascribed these problems to perplexity about working in such an environment: "I think some students did not understand the basic tenets of working in a group, so they were confused." (School#20).

7.3.2.4 Lack of equipment

Ertmer (1999) and Ertmer, et al. (1999) discuss two types of barriers that hinder the integration and the use of technology in classroom: the first barrier is equipment and second barrier teachers' beliefs. The teachers in this study confirmed that one of their obstacles to using technology in this approach in the LRC was lack of equipment or lack of sufficient equipment.

LRC teachers confessed that lack of sufficient technologies and sources had prevented students from searching widely for information and limited them to what was available. Lack of or inadequate equipment and resources have been shown previously to be factors influencing teachers' integration (for example, Leask and Williams, 1999; Russek and Weinberg, 1991; Topp et al., 1995; U.S. Office of Technology Assessment, 1995). One teacher argued that, "if there had been a resource like the Internet, students could have enhanced their presentation with different types of information." (School#9).

In another school, a teacher contended that "there were not enough resources for students to search for information, such as video tapes and the Internet." (School#1). Other teachers argued that "lack of resources might increase time spent on projects and might result in ineffective implementation." (School#7). Teachers' comments are consistent with Hill and Hannafin's (2001) warning that one of the concerns in project-based learning is the lack of sufficient resources.

Teachers believed that the availability of different equipment would have resulted in better student learning and faster project accomplishment, and solved some students' problematic behaviours.

> The insufficiency of equipment and technology for each group to work on, caused delay in finishing the projects and also caused behaviour problems because students were waiting for their turn and did not have anything to do for the time being. (School#3)

Another teacher saw lack of equipment as one of the drawbacks of the new approach: "One problem with this way of teaching is that there was not enough equipment and support tools for students' projects." (School#2). This is consistent with what Edelson, et al. (1999) reported in their study: one of the challenges of resource based learning is the access to resources needed for students' projects. One teacher suggested that the lack of some equipment such headphones and microphones had increased the burden on the teachers:

> Some of these computers are old and they do not have headphones and microphones; therefore the teacher is obliged from time to time to take these headphones from one PC to another. (School#17)

The teachers suggested that for better implementation and better technology use, more equipment such as scanner, digital camera, and TV card should be provided. They also listed some technologies that are necessary for project-based learning using multimedia such as the Internet service, video camera and video projectors. Robinson (1998) argues that teachers expressed a willingness to change their role, but they cited the need for additional computers in the classroom in order for them to facilitate cooperative learning groups using technology.

However, in this study, 25% of the teachers did not mention that such issues were bothering them during implementation of the approach. Similarly, teachers in the study by Ertmer, et al. (1999) appeared not to be frustrated by barriers such as training, equipment and time.

7.3.3 Summary

Ninety percent of interviewed LRC teachers expressed their positive experience of using the new approach in LRCs. They saw the approach as a good way for students to learn "with and from" technology and to learn new subject content. They claimed that students were highly engaged and motivated in their learning.

Teachers expressed that their role changed to that of monitor, facilitator, helper and co-learner, while pupils' role was as information seekers rather than information recipients.

LRC teachers had a positive attitude towards cooperative and collaborative learning, as they saw it as an effective means by which students can share, exchange, learn and gain both knowledge and IT skills.

IT as content met with a more positive reaction from those teachers. Rather than seeing IT taught as isolated discrete skills, LRC teachers favoured the way it was taught during project-based learning.

The majority of LRC teachers expressed positive attitudes towards multimedia presentation and group/pair assessment. Twenty percent of teachers had reservations about this type of assessment such as the time involved and insufficient measurement of students' learning.

The teachers had a positive attitude towards the potential of technology as a tool and source of information in students' learning. Technologies had helped students in searching, assembling and analysing information, and had also promoted cooperative learning.

LRC teachers came up with some common concerns such as insufficient equipment time and technical support, and students' problematic behaviours. They saw these concerns as barriers influencing their practice.

7.4 Conclusion

Teachers' observed practice and interviews comments reflect teachers' beliefs about the constructivist learning approach. During the project learning in the Learning

Resource Centre, students' learning was self-directed learning, whereby students searched for and explored knowledge using a range of different technologies and media available in the LRC. The students were given the opportunity to process information, to ask questions, to solve problems and to make decisions. In these technology-rich environments, students engaged in both cognitive and metacognitive skills, as well as social skills and high-order thinking, similar to what was proposed by Lehrer (1993) and Bagley and Hunter (1992), and observed by Penuel and Means (1999). That is to say they were actively engaged in their learning. Similar observations were made by Dwyer (1994); Dwyer, et al. (1991); Means and Olsen (1995a), and Penuel and Means (1999). Each observed student during lessons was supposed to work within his/her group and the work was divided among them (Nath and Ross, 1996). There was also an exchange of roles while using different technologies. Some students became technology experts for the class; they sometimes played the role of providing technological assistance to their group members and other groups as well. This idea was proposed by Bennett and Dunne (1994) and Mergendoller and Thomas (2001) to save teachers' time and ensure that the skills were learned. In their studies, Ringstaff and Yocam (1995) and Lundeberg, et al. (1997) observed that teachers often took the role of facilitator, while some students were frequently called upon to play the role of expert.

Those "experts" were involved in activities such as helping their classmates to scan images, sound recording, and inserting files in PowerPoint presentations. This gave high self esteem to student experts and freed teachers to work with others. Students were also observed carrying out such a role during IT lessons (section 7.2.2). Similar findings emerged from studies such as Dwyer et al. (1991); Herman, et al. (1992); Hewitt and Scardamatia (1998); Hruskocy, Ertmer, Johnson and Cennamo, (1997), and Turner and Vito (1997). To put it briefly, pupils' role was as active, independent information seekers (Means and Olson, 1995a).

The teacher's role changed from being a knowledge dispenser to being a guide, a monitor, a mediator and facilitator for students' learning. Thus, this situation can be described as a student-centred environment. The Cognition and Technology Group at Vanderbilt (1992, p.73) found there was a shift in the teacher's role "from authoritarian provider of knowledge to a resource who at times is consulted by students and at other times can become the student whom others teach." Becker and Ravitz (1999) observed that teachers were more willing to cede their authority to students. The teacher encouraged students' active exploration in PowerPoint and other software. In a similar environment, Turner and Vito (1997) found that teachers encouraged students' exploration of new technology, and described the teacher's involvement as "teaching on a need-to-know basis". LRC teachers frequently and explicitly encouraged students to consult and discuss with classmates, help each other, and walk around to see what others were doing. They worked as facilitators (Peneul and Means, 1999; Turner and Vito, 1997).

During the implementation, LCR teachers were observed helping students with selecting and locating resources and some of them planned field trips to collect information from the local environment. These observations are in line with Lai (2000), Mergendoller and Thomas (2001) and Rice and Wilson (1999), who observed the teacher being a planner and manager. Also, LRC teachers allowed plenty of freedom for students to learn by themselves. A similar observation was made by Stein, McRobbie and Ginns, (1999) who observed three teachers in a similar technology rich learning environment.

LRC teachers frequently interacted with students in their groups and provided scaffolding, which highlights the Vygotskian theory of social constructivism. This interaction is supported by studies such as David (1992); Means and Olson (1995a); Sandholtz, et al. (1992); Stein, et al. (1999); and Swan and Mitrani (1993). Collins

(1991); David (1992) and Means and Olson (1995a) found that in a technology rich environment, teachers talked more with individuals or small groups rather than to the class as a whole. Teachers had more opportunity to interact with low achievers and pay more attention to them (Collins, 1991).

LRC teachers, conducting lessons in this way, were demonstrating the match between their beliefs about teaching and learning in general and their beliefs about teaching and learning in a hi-tech constructivist learning environment (Stein et al., 1999).

Collaborative and cooperative learning was clearly observed among students in each group; students were observed asking their partners for assistance and help before asking others. Järvinen (1998) found that students were not able to proceed independently and had to be supported. This support could come from peers or from the teacher. Most students were eager and willing to help each other. Similar observations were reported in studies such as David (1992); Dwyer (1994); Dwyer, et al. (1991); Means and Olsen (1995a); Hudson (1995); Knight and Knight (1995); Nath and Ross (1996); Penuel and Means (1999); Rice and Wilson (1999); Turner and Vito (1997), and Underwood (1994).

Students exchanged skills and knowledge (Turner and Vito, 1997). In this study, teachers believed that there had been many advantages of gains from students' cooperation and collaboration. Students learned from one another (Järvinen, 1998). For example, lower achievers could benefit from those who were more advanced (Allan, 1991; Simsek and Hooper, 1992). This coincides with what Nath and Ross (1996) found in their study, that teachers (with only a few exceptions) believed that the cooperative learning experiences had a positive impact on students. Higher achievers can share knowledge and skills that might contribute to low achievers' zone of proximal development (ZPD). According to Piaget, the differing points of view that emerge as people discuss a collaborative task pushes cognitive development by causing disequilibrium, which leads learners to rethink their ideas. This is consistent with previous research (for example, Allan, 1991; Singhanayok and Hooper, 1998; Slavin, 1996). This supports the claim proposed by Vygotsky (1978) that collaborative activity among children promotes growth if children of similar ages have developmental differences. Another theoretical explanation can be seen in Bandura's social learning theory which, maintains that learners can learn by modelling one another's behaviour. Mevarech (1999) maintains that lower achieving students can model the study skills and work habits of more proficient students. Just as low achievers can benefit from such a setting, higher achievers can again when they give elaborated explanations to low achievers; typically they learn more than those who receive them (Mevarech, 1999; Nath and Ross, 1996; Newell, 1996; Webb, 1992, cited in Slavin, 1996, p.45).

However, a few interviewed LRC teachers held the belief that grouping higher ability students with low ability students would hold back the former. In the interviews some teachers expressed their concern in this regard. This belief supports Robinson's (1990) claim that explaining material to low achievers holds back higher achievers from making a progress in their learning. LRC teachers mentioned some problems that they had encountered while students were working in groups, such as unwillingness of some members to cooperate with their groups. The same concern was brought up by the teachers in Nath and Ross' (1996) study. Teachers in that study reported students' unwillingness to cooperative as one negative aspect of cooperative learning.

Cooperation and collaboration among students in LRCs were observed during off-computer activities and on-computer activities. However, they more frequently occurred during on-computer activities. This might give an indication that the computer was a tool which increased the amount of cooperation, because students discussed among themselves what they had found, what information was appropriate to use and how present it, and also they corrected each others' mistakes. Similar findings were reported by Gayle and Thompson (1995) and Honey and Henríquez (1996) who found cooperative and collaborative activities were more common in such learning environments. McLoughlin and Oliver (1998) found that working on tasks around computers increased students' collaboration and group interaction. Such student engagement fosters cognitive change. This reflects Vygotsky's idea of the necessity of using tools to promote students' learning. The term 'tool' encompasses wide range of resources, whether material, as computers, or symbolic such as language (Jonassen, 1996; Warschauer, 1997).

Teachers were observed facing problems with students' behaviour during the implementation and they also reported these problems in the interviews. Similar problematic behaviours were reported in studies such as Bennett and Dunne (1994); Cohen (1997); Nath and Ross (1996), and Sandholtz, et al. (1991).

Technical problems were also observed during implementation and reported by the teachers in the interviews, such as computer crashes, sudden computer shut down and malfunctioning of sound systems, printers and scanners. Similar problems were reported in studies such as Lundeberg, et al. (1997) and Sandholtz, et al. (1991) where teachers struggled to solve these problems.

The struggle to solve these problems reflects teachers' lack of knowledge, techniques and means. This was clearly stated by the interviewed teachers, who expressed their concerns about these problems and remained helpless to find solutions for them. Some suggestions to address such difficulties are made in the next chapter, which concludes this thesis.

CHAPTER EIGHT

CONCLUSIONS, RECOMMENDATIONS, LIMITATIONS AND FURTHER RESEARCH ARISING FROM THE STUDY

8.1 Introduction

In 1998, the Ministry of Education in Oman took the initiative to inaugurate reformed schools in various regions in the country. One basic feature of these schools which distinguishes them from other schools is the existence of Learning Resource Centres. From 25,000 to 30,000 Omani Rials, equivalent to 40,000 were spent on equipping each of these centres (Ministry of Education, 1997b). They contain computers, computer accessories and applications, CD ROM and traditional learning media. However, teachers lacked knowledge of how to integrate these technologies into various subjects.

This was evident in the observations of the TFBES team (see page 6), of which the researcher was a member, which conducted inspectoral visits to Basic Education schools for the Ministry of Education in 1999, and was confirmed by the comments made to the researcher by teachers during those visits.

The study was grounded on the premise that optimum realisation of the potential of educational technology, as indicated by Mergendoller (2000) needs an effective pedagogy. The U.S. Office of Technology Assessment (1988) and several authors (Ehrich et al., 1998b and Strommen and Lincoln, 1992) have suggested that the constructivist approach to teaching is the one most conducive to effective integration of technology in teaching, and this is the approach favoured by Oman educational policy. However, as noted by Collins (1991) this involves a change in the teacher's role which does not come easily. The willingness to embrace such a change is, according to Kagan D (1992) and Pajares (1992) crucially influenced by teachers' attitudes and beliefs which serve as "implicit theories and cognitive maps for experiencing and responding to reality" (Pajares 1992, p. 324). From these theories may be inferred the importance, in attempts to indicate educational reform, of investigating whether or to what extent teachers' beliefs systems are compatible with the intended change, and how their beliefs may be influenced in the desired direction.

The study investigated teachers' attitudes towards integrating technology into curriculum subjects in Learning Resources Centres and factors influencing their attitudes and practice. Attitudes were investigated by means of a questionnaire focusing on seven dimensions of the new approach: advantages of the constructivist approach, pupils' role, teacher's role, cooperative/collaborative learning, IT as content, assessment and IT goals. Those dimensions were, as explained in Chapter Five, based on studies which identified these elements as components of effective teaching and use of technology (Jones et al., 1994, 1995; Means and Olson, 1995). The questionnaires were administered before and after an intervention involving training and practice in the new approach. The training was intended to introduce the LRC teachers to an effective way of integrating technology into subject areas. This integration was a merger of effective technology (a tool) and an effective approach to learning (the constructivist approach) through project-based learning.

This chapter is devoted to summarizing the study and to highlighting its findings and implications for integrating technology into the curriculum in Omani reformed (Basic Education) schools. The chapter begins by presenting the main findings of this research. This is followed by recommendations for practice. Finally, the chapter evaluates the limitations of this study and presents guidance for future research.

8.2 Summary of Main Findings and Conclusion

The questions presented in Chapter One provide the foundation for collecting information about teachers' attitudes towards integration and factors influencing such integration. The main question was: what are teachers' attitudes towards project-based learning (constructivist learning approach), before and after the training? The subsidiary questions were:

- Do teachers' years of teaching experience have an influence on their attitudes towards project-based learning, before and after the training?
- Do teachers' areas of residence (urban and rural) have an influence on their attitudes towards project-based learning, before and after the training?
- Does teachers' previous training in ICT have an influence on their attitudes towards project-based learning, before and after the training?
- What other factors influence or hinder teachers' practice during implementation of the project-based learning approach?

These questions, as explained in detail in Chapter One, were informed by extensive reading of the literature. Theoretical writings and previous empirical findings have suggested these factors as likely influences on teachers' willingness and ability to implement educational change in general, and in particular to adopt a constructivist teaching approach and to integrate technology into their teaching.

(a) Training as a factor

The survey questionnaires showed that there was a significant difference in teachers' attitudes before the training and after the training and practice, except on one scale, IT goals. It seems that teachers had developed a significantly more positive attitude toward the other six elements of a technology-rich learning environment. It can be argued that the training teachers received on how to integrate IT into their teaching provided them with knowledge and experience which enabled them to implement the new project-based approach effectively, with favourable outcomes. This in turn overcame some of their reservations about the new approach and helped to integrate constructivist ideas and practices into their existing schemata.

Before the training, data show that teachers were divided into three categories: those who agreed with, those who were uncertain about, and those who disagreed with the elements of the constructivist approach. The first group can be characterized as enthusiastic teachers. A number of previous researchers (Bracey, 1993; Ertmer, 1999; Schofield and Verban, 1988) similarly found teachers to be very willing to change their practice and adopt a more constructivist teaching style. At the other end of the spectrum were teachers who had negative attitudes about some aspects of the approach, were unaware of the use of technology supported by the constructivist theory (effective integration) or were influenced by other factors such as their beliefs about teaching and learning. This finding was consistent with the views expressed by Prawat (1992) who points out that much of what teachers believe about their role and the nature of the teaching/learning process is inconsistent with constructivism and that such beliefs need to be overcome in order to implement educational reform successfully. Brooks and Brooks (1993) similarly observed resistance to change among teachers and attributed it to their perception that their current approaches were effective and so no change was necessary. A third group was made up of those teachers who were uncertain. They might be enthusiastic about the constructivist approach, but their enthusiasm was diffused by their underlying beliefs. Shifter (1996) comments on the tendency for tacit attitudes to undermine efforts to establish constructivist learning environments, even among those who express enthusiasm for constructivist and other reform-based approaches. Alternatively, they may have had a positive view, but were uncertain about using technology, because of lack of equipment, the way lessons are scheduled or for genuine pedagogical reasons. The observations and informal interviews carried out by the researcher, as part of the TFBES team, for example, revealed difficulties arising out of the insufficient number of computers, such that only half the class could use them at a given time. Similar problems were cited by Honey and Moeller (1990) as a reason why some teachers who had favourable attitudes towards constructivism nevertheless remained what the authors called "low tech teachers." Dawes (2001) in addition to inadequacies of equipment, found teachers' uncertainty as to whether there was a genuine pedagogical purpose for computers as a reason for wariness with ICT.

However, after the training, the teachers' general attitude towards the constructivist learning environment was greatly enhanced. There was a significant shift in attitude from disagreement towards agreement; most of the teachers who had initially been uncertain in the seven themes had developed a positive attitude.

As Table 6.44 showed, the composite mean scores before training, for six of the seven scales were higher than 3.0 with teachers favouring the new approach, but only to a very modest degree. In contrast, after training, the mean scores in five scales were higher than 4.0, suggesting that their attitudes were between "Agree" and "Strongly Agree." There were two exceptions to this pattern: Assessment, for which the post-training mean score still did not reach 4.0, suggesting that teachers did not move wholeheartedly away from traditional assessment in favour of alternative assessment; and IT goals, where the mean score was lower than 3.0 (reflecting attitudes somewhere between uncertainly and disagreement about constructivist IT goals). These scales will be discussed later in this chapter. Gilmore's (1998) study showed that training, as a factor, had an impact on changing and reinforcing teachers' attitude towards technology integration into teaching;

teachers after training had developed positive attitudes towards technology integration in their teaching.

Data derived from observation and interviews support teachers' positive attitude towards the new approach; i.e. teachers' practice reflected the constructivist role. As stated in Chapter Five, a detailed observation checklist was compiled, drawing on the literature and on analysis of a randomly selected sample of videotapes. The categories included descriptions of the behaviours of teachers and pupils, which in turn reflected teachers' and pupils' adoption of either traditional or constructivist approaches. Observed behaviours were cross-referenced with items in the teacher's role and pupils' role scales in the questionnaire. Thus, it was possible to see whether constructivist behaviours purportedly favoured by teachers, according to their questionnaire responses, were implemented in practice. The observations revealed that teachers established a constructivist learning environment (as described in Chapter Two) in which they acted as monitors, facilitators, and helpers; students had an active role as information seekers, and technology was used as resources of information and tools for searching, analysing and organising information (as described in Chapters Two and Three). Teachers experienced the use of multimedia presentations as a means to evaluate students' presentation; though some of the time they preferred a mixed mode of traditional and alternative assessments. The learning environment permitted different types of interaction between students and teachers and between students. In the interviews, teachers expressed their satisfaction with the new approach. This indicates that training had influenced teachers' attitude towards the innovation.

The researcher argues that adopting a project-based approach, using multimedia/IT, as an instructional model of integrating technology into subject areas, was the key to changing both teachers' attitudes towards and use of technology in this type of learning environment. As Selinger (2001) points out, the constructivist learning environment is very different from the traditional one, both physically (in the availability of new technologies) and in the new roles and responsibilities placed on teachers. In such an environment, teachers often face uncertainties; for example Jager and Lokman (1999) report that teachers may be unsure how to manage projects. The lack of opportunity to learn about and practise educational reform has been identified by Smerdon, et al. (2000) and Summers (1990) as a common reason for teachers having negative attitudes towards technology integration. This is why O'Neil (1995) argues that it is a mistake, when introducing educational reform, to focus on the students rather than the teachers, as successful implementation depends on teachers' knowledge about, and positive attitude towards, the reforms. The training in this study, in line with O'Neil's recommendation, modelled the new approach to teachers before they used it with students, thereby overcoming their uncertainties. The findings of this study support the reports by previous researchers (Abbott and Faris, 2000; Christensen, 1998; Gilmore, 1998) that teachers had more positive attitudes towards integration of technology following training. Abbott and Faris (2000) in particular attributed the success of training in encouraging more positive attitudes to technology integration, to the instructional approach, to meaningful tasks using technology, and to support from teaching staff. Similarly, in this study, the training given to teachers and their subsequent practice placed the use of technology in meaningful pedagogical contexts, and the researcher provided support and "trouble-shooting" assistance. Consequently, teachers were enabled to see the relevance of the new approach, to understand how it could be implemented in practice, and to experience personal success in implementing the skills modelled to them.

However, the data also show that the change in teachers' beliefs about assessment was small because, although they took a more positive stance towards alternative assessment after the training, they did not necessarily reject traditional assessment. It was, on the whole, more experienced teachers who continued to favour traditional assessment, which may at first glance seem to support the claims by researchers such as Scott and Hannafin (2000) that more experienced (and therefore, usually, older) teachers are more resistant to change. They argue that more experienced teachers are more inclined to adhere to a traditional perspective, which they suggest is likely to be entrenched in the school culture. However, the issue may not be solely one of resistance, contrary to Tyack and Tobin's (1994) claim that teachers often resist non-grade assessment. The findings in this study showed a high level of support for alternative assessment, and teachers expressed appreciation of the role of peer evaluation (section 7.3.1.6). As suggested in Chapter Six, the statistics imply that teachers who continued to favour traditional assessment favoured it as well as, rather than instead of alterative assessment. Alternative assessment caused concerns for some teachers. As elicited from interviews, for example, difficulty in conducting alternative assessments was one reason given for wishing to retain some elements of traditional assessment. In interviews, for example, teachers raised the problem of how to assess an individual's contribution in group work. Bennett and Dunne (1994) similarly noted that individual accountability is low and it is difficult to know what each child has contributed. Teachers also expressed uncertainty as to the validity of the new forms of assessment. Similarly, Dana and Davis (1993, cited in Holloway, 1999, p. 86) and Hyerle (1996, cited in Sandra, 1997, p. 15) draw attention to the difficulty of ensuring that assessment measures students' constructed knowledge. Therefore teachers' concern to keep both types of assessment is in line with what Holloway (1999, p. 86) proposed: "traditional classroom assessment is not sufficient; as a result, teachers must use other strategies to measure what students know". Such problems have not been satisfactorily overcome by advocates of constructivist cooperative learning. Bennett and Dunne (1994) attempt to provide practical suggestions for the evaluation of learning in a cooperative setting; for example, they suggest post-task interviews. These, however, would be very time-consuming to conduct on an individual basis. One of their other suggestions, whole-class discussion, does not solve the problem of individual accountability.

From a pedagogical perspective, there is also the point that students engage in a variety of types of learning, which may be assessed in different ways. Alternative assessment has been promoted to evaluate, for example, students' creative problem-solving strategies and collaborative abilities (Dwyer, 1994), but these are not the only kinds of knowledge teachers may wish to assess. Traditional assessment has been linked to an emphasis on "factual and procedural knowledge at the expense of deeper levels of understanding" (Prawat, 1992) with a clear implication that such a focus is a 'bad' thing. But this does not mean teachers can afford to neglect factual and procedural knowledge, which is part of, and a prerequisite, for understanding. As Reigeluth (1992) points out, there are times when learners require specific understanding and skill and strive for correct answers. This implies the need for some sort of objective measurement which the suggestions of advocates of alternative assessment do not provide. Neither alternative nor traditional assessment is always appropriate; what is needed is for teachers and other test-constructors to have a clear idea what it is they wish to assess, and to take care that the mode of assessment is valid for that particular purpose.

A third point that is relevant in considering teachers' reluctance to abandon traditional assessment altogether is that, in late school years, in particular, the education system, in Oman, needs comparative statistics, for example, for allocating students to colleges and universities. Moreover, parents and students are accustomed to receiving feedback in terms of objective scores. Thus, teachers' attitudes towards traditional assessment, as reflected both in the questionnaire responses and in the interviews, is consistent with prevailing attitudes and expectations in Omani society. This implies that teachers still see the potential of using traditional assessment during project-based learning.

One dimension on which teachers' attitude remained unchanged was IT goals. Data show there was no significant difference in teachers' attitude towards IT goals before and after the training. One reason for this may be the teachers' difficulty in distinguishing between the constructive IT goals and traditional IT goals. Such difficulty is evident in the literature. According to Lundeberg, et al. (1997) teachers in their study could not differentiate between the constructivist and traditional IT goals; they valued both uses during the implementation of a project-based approach. Another possibility, however, is that teachers think that traditional IT goals are still important and should be retained alongside constructivist IT goals. For example, they may think it is important for young pupils such as those in this study to acquire basic technical and procedural knowledge about using computers. Observation data (section 7.2) showed teachers were teaching some IT skills to students in their groups, and with the help of experts, during IT lessons. This is necessary in order to use the LRC resources in the construction of knowledge.

One of the interesting issues that the study investigated was attitudes towards mixed gender grouping during cooperative learning in IT activities. In Basic Education schools, co-education is one of their distinguishing features in contrast to schools in the traditional general education system, where gender mixing is rare and confined to remote areas where the number of students may be too small to support separate schools. Despite some experience of working with mixed-sex classes, the Basic Education teachers surveyed were not aware of some of the educational and social advantages of mixing sexes with small groups. Means and Olsen (1995a) argue for the importance of heterogeneous grouping, including a mixture of sexes, to provide a richer variety of perspectives which enhances the quality of project work. Before the training, teachers had a mixed attitude towards this issue, as was discussed in Chapter Six. After the training, and after considering a variety of aspects of group formation, most teachers were in favour of mixed gender grouping. This change of attitude can be confirmed by the survey questionnaire, teachers' practice and interviews and is consistent with studies carried out in Western societies (Means and Olsen, 1995a). However, in Western societies mixed gender is accepted and observed in all education stages. In contrast, the result of this study, can not be generalised to other education stages, since it was carried out only in phase one of Basic Education schools. It is unlikely, because of religious and culture considerations which do not permit the mixing of the sexes among older children and adults, that such groupings would be acceptable.

(b) Effect of teaching experience

Before training, the more experienced teachers had more negative attitudes towards the constructivist approach than less experienced teachers. However, after the training, the gap in attitudes between the experience groups, reflected in their mean scores, was reduced. This suggests that the influence of teaching experience, which had originally tended to entrench more objectionable attitudes to constructivist teaching and learning, had been modified by counter-influence of the current study. The findings were consistent with previous claims that more experienced teachers are more confined by their traditional approach to teaching (McCoy and Haggard, 1989; Scott and Hannafin, 2000). Teaching experience, moreover, tends to be correlated with age, as proved to be the case in this study (see Chapter Six) and research shows that older teachers are more traditional in their attitudes and practice (Bennett et al., 1976; Eiken, 1974, cited in, Scott and Hannafin, 2000, p. 3). Some of the implications of this include a more teacher-centred and content focused pedagogy (Norton et al., 2000) and more negative attitudes towards the use of technology in teaching (Howie and Wen, 1997).

Low experience teachers showed no significant change in their attitude, since those teachers started with positive attitudes. One reason for this is that, as pointed out by Smerdon, et al. (2000, p. 115), recently qualified teachers are more likely than their more experienced colleagues to have been exposed to technology integration in college and graduate work. Another factor, however, is the role of experience in entrenching attitudes. The project-based, constructivist approach implies a major shift in the teachers' role, and new demands, requiring considerable adaptation. However, as Pajares (1992) points out, the longer a belief has been incorporated into structures, the more difficult it is to alter; those with recently acquired beliefs are more susceptible to change. This may explain, why although the training had influenced experienced teachers who developed more positive attitudes towards the new approach, they did not, however, acquire the same level of enthusiasm as less experienced teachers. This indicates that training had influenced experienced teachers, but did not fully overcome their entrenched views.

In particular, as noted Chapter Six, more experienced teachers were more inclined than less experienced ones to cling to a wish for traditional modes of assessment, which may reflect a degree of resistance to this aspect of the new approach.

Since the difference in attitude between experienced and less experienced teachers is consistent with the theory of Pajares (1992), the implication is that time and experience will be needed to reinforce the effect of the training and allow the new attitudes and practice to become embedded in teachers' schema. Thus, as noted by Dwyer, et al. (1991) the introduction of educational innovation requires a process of gradually changing teachers' beliefs to become more relevant and shaped by experience. If, as Pajares (1992) claims, and as the findings of this study suggest, more recently acquired beliefs are more susceptible to change than ones that have been reinforced by experience, trainers need to be aware that the effects of training in the new approach could easily be undone unless reinforced by continuous implementation and follow up. Effective establishment of educational change, therefore, will require not simply a "once-and-for-all" introductory training, but an ongoing programme of training, advisory visits and technical support. Similarly the U.S. Office of Technology Assessment (1995) showed such elements are important for introducing technology to educational reform.

(c) Urban vs. rural residence

The investigation of a possible difference in urban and rural teachers' attitudes towards the constructivist approach generally and the use of technology in particular, was of interest in this study, in light of concerns about rural backwardness, on the one hand, and the concerted efforts by the government to reduce disparities between urban and rural areas, on the other.

As recently as the mid- to late 1990s, it was being suggested that traditional cultural norms lingered more strongly in rural than urban areas (AlNabhani, 1996) and that rural areas were still lagging behind the urban areas in terms of educational and social development (Ministry of Education, 1999). In such a situation, it might perhaps have been expected that teachers in rural areas would be less supportive of the new approach than their urban counterparts. It was interesting, therefore, to find that even before the training conducted as part of this study, there was no significant difference between teachers in the two residence categories, on five of the seven attitude scales. These findings can be seen as a reflection of the success of the government in disseminating education through Oman general, and of its particular efforts in some aspects of teacher training in relation to the education reform policy. It was noted in Chapter One that education has spread very rapidly in Oman. In little more than 30 years, the number of schools has increased from 3 to 1013. Education would bring new occupational and social opportunities and expose participants to new ideas and values, contributing in a general process of social change. Of particular salience to this study, however, is the effort made by the government to prepare teachers to implement new educational policies. Training in ICT was given to teachers recruited to the new Basic Education schools. Moreover, senior and head teachers, inspectors and regional officials were targeted with an intensive training programme to understand the constructivist approach to education, with the intention that they would in turn transfer this approach to their colleagues (AlBelushi and Alkitani, 1997). Although such training had not met all teachers' needs in relation to educational reform, as evidenced by concerns reported in Chapter One, it seemed to have been successful in placing urban and rural teachers on an equal footing in their understanding of the new approach and their introduction to the technology being provided to accompany it.

There were two scales (teacher's role and pupils' role) on which there were significant differences between teachers before training. Contrary to expectation, it was the rural teachers whose scores on these scales reflected more positive attitudes towards the new approach.

The finding that in a modernizing society, there may be no difference in adoption of new technology in teaching is supported by Morale's (1999) Mexican study, and also in line with Collins and Dewees (2001) who explicitly link the closing of the technology gap to education and training. Collins and Dewees' assumption was that it was rural groups that would need training to overcome possible backwardness in the acceptance and implementation of change. Interestingly, however, in this study, it was urban teachers who appeared to benefit, in the sense that the attitude gap between urban and rural teachers, on the teachers' role and pupils' role, in favour of rural teachers, was closed after the training provided by the researcher. Since the urban group originally had more negative attitudes on these two scales, they had more room for change. After the training, there was no significant difference between the two residence groups on any of the seven scales.

(d) Effect of previous ICT courses

The study showed that the amount and relevance of training to teachers' daily practice can have a positive impact on teachers' attitude. Teachers in this study (as discussed in Chapter Five) received a training that reflected their needs as ICT teachers. The training included using technology supported by a constructivist approach and the use of a variety of programs that could be applied in their teaching. Studies (such as Murray, 1995; Swan et al., 2000; U.S. Office of Technology Assessment, 1995) suggest that effective training can have a positive impact on teachers' attitude and practice. The post-training results are supported by the finding from the pre-training results which showed that teachers who had previously attended advanced courses (such as those in cooperative learning and the child-centred approach) had a more positive attitude than those who had attended fewer courses. This result is in line with Christensen's (1998) study, which showed that teachers who had received training on using technology in teaching had significantly more positive attitudes towards such an approach than teachers who did not have such training. This can indicate that the more teachers get in-service training, the more open they become to the acceptance of new pedagogical ideas. Therefore, teachers' awareness of the value of some pedagogical technologies integration is important in adopting these technologies. Lillard (1985) found that knowledge has a positive impact on teacher attitudes toward technology.

(e) Effect of other factors:

The suggested project-based approach to technology integration into various subject areas was not without problems. Although teachers had a more positive attitude towards the innovation after the training, results (from observation and interviews) showed that there were several factors influencing teachers' practice of a project-based approach which might in turn affect teachers' attitude towards integration as discussed in Chapter Four. These factors are: technical problems, lack of time for projects, students' behaviour problems and lack of sufficient equipment. Studies such as those of Byrom (1998), Dwyer (1994) and Parr (1999) similarly showed that these factors had a negative influence on teachers' practice.

Interestingly, teachers who participated in the studies of Ringstaff and Yocam (1995), Sandholtz, et al. (1992) and U.S. Office of Technology Assessment (1995) identified these problems, though those teachers were not necessarily ICT trained teachers, unlike the teachers in this study, who at least had some experience with technology prior to the study. This gives an indication that such problems are general features of such a learning environment.

The researcher's observation during teachers' implementation of project-based learning indicates that teachers encountered various technical problems with both software and hardware. Since the observed teachers did not have the knowledge and skills to troubleshoot these problems, they were frustrated and worried. In the interviews, teachers identified these problems as major concerns in their practice. Such feelings had an impact on their attitude towards the new approach. Such an effect is consistent with the findings of Dawes (2001) that unreliability of equipment and lack of technical support were among the reasons for teachers' wariness of ICT.

Managing project-based learning also requires sufficient time. Teachers in the study reported that one of factors influencing the implementation of the new approach was lack of time to complete students' projects. All the interviewed participants shared the same perception about the time-demanding nature of this approach; the need for longer lesson periods and different timetable arrangements was clearly expressed by those teachers. This is expected for such an approach and supported by the research of Becker and Ravitz (1999) in which the teachers felt the need for longer class periods and reported that students spending more time on their own outside of class on constructivist-oriented projects. This indicates that IT lessons involve students carrying out "real work", which requires them to collect information from various resources.

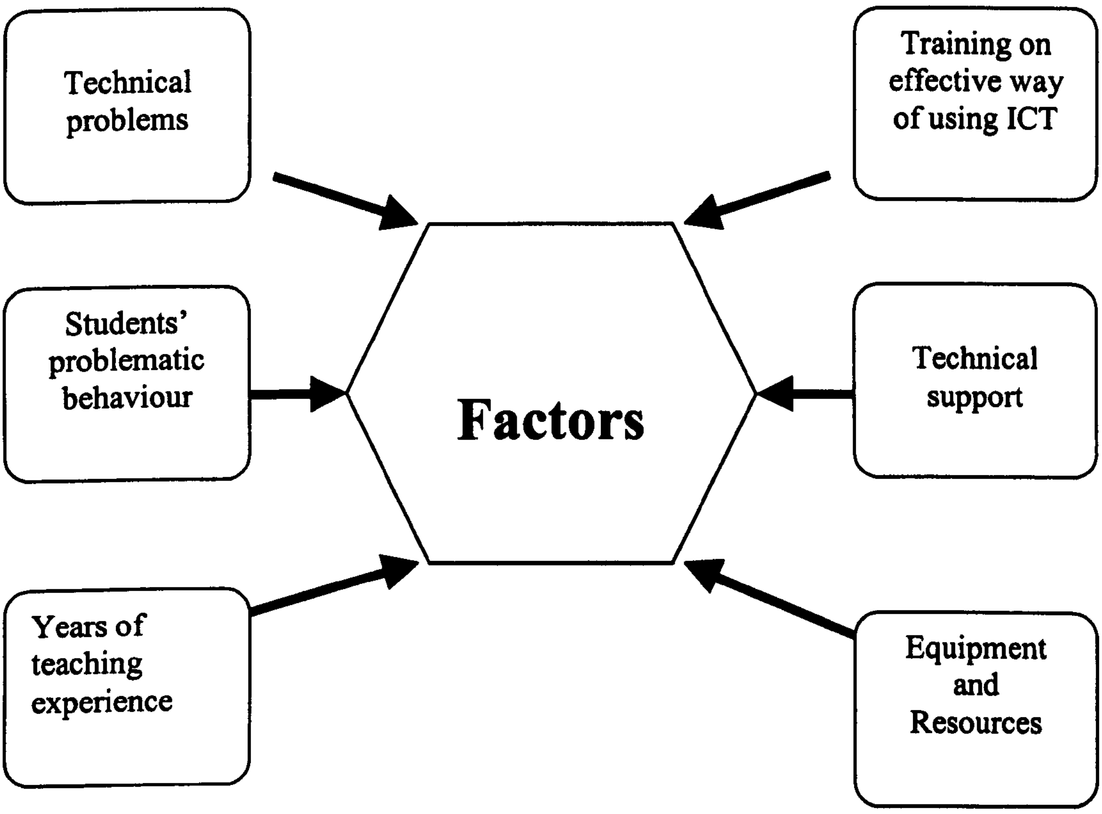
Although students were highly motivated during all observed IT lessons in the Learning Resource Centres, to the extent that in some LRCs they refused to leave after lessons, the observations, showed that there was some problematic behaviour caused by some students. In the interviews, teachers identified these problems and expressed their concerns towards them. The behavioural problems can be classified into two types: problems related to working in groups and problems related to working with technologies. Group-related problems were manifested in students' unwillingness and resistance to work in groups. Students were observed quarrelling with each other, working alone, depending on other members and playing around aimlessly in the LRCs. Similar problems have been reported in previous research. For example, Nath and Ross (1996) reported instances of bickering, and of students who did not contribute to their groups' activities. Bennett and Dunne (1994), however, shed further light on the subject of non-contributing members as they identify a variety of reasons for disagreement. While some group members may be 'free riders', relying on others to do the work, others may be isolated due to rejection by other members of the group. There are also cases where students begin by contributing actively but become disengaged when they feel others are taking advantage of them, leaving them to shoulder an unfair share of the task. Technology-related problems were evident in students' over engagement in technology activities; students were observed persisting on computer tasks when they should have been working on non-computer activities, paying no attention to the teachers. Ehrich, et al. (1998b) reported similar problems. Previous research suggests that such problems are related to insufficient motivation of students (Ehrich et al., 1998b), excessive group size (Yiping et al., 2001) and teachers' lack of skills in using classroom management techniques to keep students on-task. The implication is that explicit consideration should be given to such issues in teacher training and professional development associated with introduction of the new approach. These types of problems had not been anticipated by the teachers; they were frustrated and had a difficult time managing such problems.

Observation and interview data showed that there was a lack of equipment and resources during the implementation of the new approach. As can be seen from Appendix One, this resulted from either insufficient quantity of existing technology and resources such as scanners, digital cameras and televisions, or the absence of some needed equipment and resources such as the Internet, video projectors and electronic encyclopaedias. Teachers in the study appeared to be frustrated by these barriers.

Teachers' concerns over technical problems, lack of time for projects, behavioural problems and lack of sufficient equipment can indicate that project-based learning is not easy to manage, although teachers sounded enthusiastic about the new approach in the survey questionnaire. If the teachers lack skills and interest in this type of learning, according to Nath and Ross (1996), it might have a negative impact on successful implementation; the authors stated that "many teachers are likely to abandon the model because of its newness and challenge for them. They will gravitate back to traditional methods or to low-quality cooperative structures" (Nath and Ross, p.125). Figure 8.1

summarises the factors influencing LRC teachers' implementation of project-based learning.

Figure 8.1: Factors Influencing Teachers' Integration of Project-based Learning.



(f) Emergent issues

Observation and interview data showed interactions during all observed IT lessons. These interactions can be classified into two types: teacher-student interaction and student-student interaction. In the former, teachers had time to spend with each group and with individual students, providing different types of help, assistance and clarification; also students frequently sought the teacher's help on various issues, such as with finding relevant resources and using appropriate technologies for their projects. As regards student-student interaction, students helped each other in various ways such as in using technology within their groups; on most occasions, after each individual had done his/her part; s/he shared his/her findings with the group. Outside-group interaction was also evident; the idea of 'expert' students was observed whereby advanced, skilled students served as 'teachers' in providing technical help for their colleagues.

8.3 Recommendations

Although the Ministry of Education in Oman adopted the constructivist approach in the Basic Education schools as a full package, by providing necessary training, technologies and resources, still there is a question which poses itself, "Is the provision of training, technologies and resources appropriate and adequate?" Some writers, such as Allan (1992) and Wilson (1995) warn of possible risks in adopting the constructivist model in education. Such risks are: more costly instruction, greater need for instructional resources and information management, less coverage of material, less demonstration of specific skill mastery and chaos and confusion if poorly implemented.

The study showed that there are some factors that contributed to the effective use of technology, through the implementation of project-based learning, in the Learning Resource Centres. If it is desired to continue with the effective integration of technology into subject areas, these factors should be addressed in a proper manner. Figure 8.1, presents these factors, as they are drawn from the three research tools, namely survey questionnaire, observations and interviews, used in this study.

8.3.1 Recommendation One: Training teachers

To enable teachers to take advantage of the full potential of technology in their teaching and in the students' learning, they need to be taught or instructed in different ways of integrating technology into various subjects. This study addresses one approach to effective technology integration, which is a project-based learning approach.

Further training is needed to move those teachers to the innovation stage where teachers, according to Dwyer, et al.'s (1991) study, are ready to implement more fundamental changes in teaching and learning. They are ready to invent interdisciplinary learning activities that engage students in gathering information, analysing and synthesizing it, and ultimately building new knowledge on top of what they already know. This can be achieved through addressing the following problems which emerged from the study:

1- Based on the results of the study, teachers need further training on how to assess individual students' performance based on group work. Techniques discussed in Chapter Two such as portfolios, journals, interviews, and attitude inventories can be introduced to teachers as supplementary methods of assessing individual student performance.

2- Data show the teachers in the study were not aware of the difference between types of technology use in education. Further training should cover this issue to improve teachers' awareness of the uses of various technologies.

8.3.2 Recommendation Two: Technical problems and support

The issue of technical support was of concern to LRC teachers in this study during the implementation of the new approach. Solutions for addressing various technical problems should be considered when implementing technology in schools, in general and the classroom, in specific. There are many possible solutions to this problem. In addition to the technicians available in each region, the following recommendations could be implemented:

- Teachers should be provided with further training courses on trouble shooting and how to overcome some technical problems. This recommendation is based on teachers' demands which were elicited during the interviews, since teachers believed technical difficulties were a barrier to students' learning and their teaching;

- A hot-line help desk could be set-up in each region to respond to teachers' inquiries and solve minor software problems;
- A web site could be designed to keep teachers updated with some solutions to technical problems;
- For technical problems that cannot be resolved from remote help line access, on-site technology mentors could be trained. These would be knowledgeable, enthusiastic teachers who would be given time to coach other teachers to solve technical problems (Mergendoller, 2000). An more cost-effective alternative to taking up the valuable time of the teachers themselves would be to employ ICT technicians.

8.3.3 Recommendation three: Students' problematic behaviours

The literature reveals that there are two possible factors that might result in students' misbehaviours and lack of engagement in cooperative setting. These factors are lack of motivation and lack of social skills needed to operate in cooperative settings. Students' motivation could be elevated by establishing clear task objectives, providing a variety of tasks relevant to students, and providing choice about what to do and/or how work can be done (Blumenfeld et al., 1991; Yamzon, 1999).

Furthermore, some writers (such as Johnson and Johnson, 1990; Sharan and Sharan, 1990) emphasise that, for effective cooperative tasks, students need to gain social skills on how to work in a cooperative learning environment, even before starting cooperative tasks (Steiner et al., 1999). For example, students must get to know one another, build trust, learn to listen actively, communicate accurately and unambiguously, accept and support one another, and be able to resolve conflicts constructively.

The researcher, therefore, recommends that, in an attempt to reduce students' misbehaviours observed in LRCs during IT lessons, teachers should be made aware of these factors and be given training on how to motivate students and develop their social skills. For example, teachers need to be trained on the types of techniques advocated in the literature for grouping students, such as Jigsaw and Group Investigation. The idea behind these types of grouping is to hold each group member responsible and keep them motivated.

Furthermore, the researcher's observations showed that there were more behaviour problems when students worked in larger groups; more than four in each group. During the training for this study, teachers' attention was drawn to the importance of limiting group size to three members, but it seemed some observed teachers did not take this into consideration when forming groups. A meta-analysis study by Yiping, et al. (2001, p. 477) found that the effects of small group learning were significantly enhanced when group size was small (i.e., two members). Therefore it is recommended and emphasised that each group should not exceed three students.

Further, during training sessions, teachers should be introduced to some techniques (such as calling a problematic pupil by his/her name and using equipment as a reward) which can be used to stop some of the student misbehaviours. Some of these techniques were used by some teachers in this study (see Chapter Seven, section 7.2.3). Similar techniques were also used by teachers in Sandholtz, et al.'s (1992) study.

During the project-based learning, the researcher and teachers noticed that some students, rather than analyse, evaluate and synthesise information, copied it from its source and pasted it into their presentation. Therefore, rather than treat students' projects as final work, teachers should be trained to involve students in producing drafts of projects or asking students how they plan to use feedback to improve their projects (Lundeberg et al., 1997, p. 78). Also, students can use feedback they get from their audience on their artefacts during the presentation stage to improve their work.

8.3.4 Recommendation four: Equipment and resources

The availability of hardware and resources to carry out project-based learning was viewed as an important issue and deficiencies in this respect were seen as a barrier to integration. The study reveals that more equipment and resources were needed for a successful implementation. In addition to resources and technologies available in each LRC, as listed in Appendix One, therefore, the researcher suggests that the Internet service should be provided in each Learning Resource Centre, so students can access information available on the World Wide Web. The following equipment is also essential and each Learning Resource Centre should be supplied with (at least two items in each LRC): scanners, TV tuner/video cards, digital cameras and video cameras.

8.3.5 Recommendation five: Attention to the effect of teaching experience

This study shows that more years of teaching experience contributed, to some extent, to teachers' attitude and practice towards the innovation, even after the training. Although the sample study of teachers who had longer years of teaching experience was small in this study, the result is supported by other studies (discussed in Chapter Four) which indicated such an effect. Teachers with more years of teaching experience, although they showed gains in attitude in most scales of the study, did not reach the level of positive attitude shown by teachers with fewer years of teaching experience. The implication that can be drawn from the result of the influence of years of teaching experience, is that there is more potential for those teachers with more years of experience to change their attitude, if they are engaged in regular, continuous in-service training. The teachers in this group who held more traditional classroom practices feared that technology might "alter their relationship of control and authority with their students" and they also believed they did not have the time for any additional activities (Honey and Moeller, 1990, p.3). Therefore, the authors maintain that in order to bring about such change, different layers of the educational system would have to be affected, ranging from changing how assessment is done to helping teachers rethink how students learn and develop.

Therefore, further training on the constructivist approach might help to see the advantages in adopting constructivist perspectives. In addition, as stated earlier, there is also a need for continuous advisory visits and technical support.

8.4 Limitations of the Study

In any field of research, there is no perfect study. Each study has its limitations according to its nature. Specific aspects of the context and methodology of the present study may reduce its validity and its generalizability to other settings.

The limitations of this study resulted from various factors: a new questionnaire was designed due to the fact that there was a lack of instruments in the field and the researcher was not aware of an instrument that would measure the aspects of concern in this study.

Another possible criticism may be raised with regard to the use of a volunteer sample for the observation and interviews, rather than a random sample, as it could be argued that teachers who would volunteer would be likely to be those committed to the new approach. This could have resulted in them exaggerating their enthusiasm for using the new approach, and according to Gay (1980) the use of volunteers is likely to provide biased information. However, this was the only feasible approach for data collection methods that rely on personal contact, given the sensitivity of association between the sexes in an Islamic contest and bearing in mind the issues of ethics and the willingness or unwillingness of participants to provide data. As indicated in Chapter Five, Omani society is less rigid in this respect than some; a degree of "public" mixing of the sexes for legitimate professional purposes, and subject to certain formalities, has come to be accepted. Since almost all Basic Education teachers are female, and most inspectors and ministry officials are male, a degree of contact between the sexes in a professional contest is inevitable. Moreover, there were no concealed meetings, but instead they were formally arranged with the knowledge and approval of the education authorities and head-teachers and accompanied by appropriate letters of introduction and authorisation. Nevertheless, depending on family and community background, previous experience and individual sensibility, it is likely that some teachers would be more conventional in attitude and less comfortable having discussions with a male researcher than others. Had teachers been randomly selected, it is likely that some would have refused to participate, or would have done so in a constrained atmosphere which would not be conducive to open communication. It must be acknowledge that this would constitute a limitation on the representativeness of the sample. However, every attempt was made to maximize the representativeness of the sample by the stratification process, whereby teachers were selected from each region, with more teachers selected from regions which have a greater number of Basic Education schools. The validity of teachers' responses is supported by the fact that they were in line with the responses to the questionnaire survey, drawn from the entire target population by cross-referencing themes of the study. Moreover, some negatives attitudes and behaviours are reported in Chapter Seven, suggesting that it was not only especially committed constructivists who volunteered.

The sample of the study was limited to Basic Education teachers from Phase One (grades 1 to 4; see Chapter One for details of these schools). No other teachers were involved. This limits the generalisability of the study to other populations, such as teachers of more senior classes or from other types of schools.

Finally, a possible validity threat to this research study can be posed by the researcher's association with the project and personal theoretical bias. It was possible that participants responded to the survey and in the interviews in ways that they believed that the researcher, as IT director and hence an "authority figure" would want them to respond. However, the researcher took steps to avoid this, by refraining from discussion of his personal pedagogical belief and its relation to technology use; also he did not advocate a constructivist approach to teaching, even if it was implicit in the new approach. Moreover, although the researcher could in some ways be viewed as an authority figure, this does not necessarily mean that relationships with respondents were coercive. As indicated in Chapter Five, the Omani government has opened up a number of avenues for public debate, even when the ideas expressed are critical of the government. The Ministry of Education in particular actively encourages constructive contributions to the goal of improving education. The willingness of teaches openly to voice problems and concerns was demonstrated in the meetings reported in Chapter One which provided part of the impetus for this study. If they were willing to do so on those occasions when the researcher was visiting as a member of an inspectoral team, it is still more likely that they would feel able to do so when it was made clear to them that the visit was not inspectoral in intention and the researcher worked alongside them to help them overcome problems with technology.

8.5 Further Study

This study explored teachers' attitudes towards project-based learning and factors related to their attitude. It did not look at the effect of such an approach on students' learning; therefore, a comparative study is needed to compare students' performance using this approach and the traditional approach in schools in Oman.

This study implemented project-based learning with Multimedia, as one of a number of possible approaches to technology integration. Further research could be carried out to apply and test other instructional models to see the effect of technology as a tool in constructivist settings. For example, integrating some computer software, such as Excel (spreadsheet), Semantic Networks, wordprocessors and databases into different subject areas. Moreover, for example, using database software, in social studies lessons to build databases about, for example different aspects of a country's history, location and famous places. These types of activities require that learners organize information by identifying the underlying dimensions of the content. The use of Excel to do mathematical calculations, instead of paper and pencil calculations, in mathematics lessons would help to reduce the cognitive load on students.

Cross-cultural comparison would also be of interest. For example, it would be interesting to compare the approach taken by Oman in reforming the education system, with the situation in other Gulf States, to evaluate teachers' attitudes in, for example United Arab Emirates, and determine whether teachers' attitudes differ in these countries. Also illuminating would be a comparison of teachers' attitudes and practice between Oman and a Western country, such as the U.K.

This study involved training teachers on how to integrate technology into their teaching using project-based learning. It did not explore teachers' attitudes towards the training model itself, since the training was based on effective training literature.

Therefore it is recommended that a future study investigates teachers' attitudes towards the training model. For example, it would be useful to ascertain teachers' views on the effectiveness of the training in terms of equipping them to integrate technology into their teaching. Such a study may result in the training model being adapted and improved in order to make it more effective.

It has been argued in this study that a technology-rich environment promotes higher order thinking skills more than a traditional learning classroom does. The study did not examine this claim but suggest that during project-based learning using multimedia, students had developed such skills. However, Hopson's (1998) study showed that the creation of a technology enriched classroom environment had a minimal but positive impact on student acquisition of higher order thinking skills. Therefore, a comparative study is needed to look at whether students might develop better higher-order thinking skills in a constructivist learning environment rather than in a traditional learning environment. Post-tests could be used to measure the impact of these environments on students' thinking.

The study suggests that during project-based lessons, there were teacher-student interaction and students-students interactions. Since this study did not investigate these types of interaction before the implementation of the new approach, the claim that these interactions are features of this environment and that they were either absent or less likely in LRCs during the traditional teaching environment, cannot be proved. Further study in Oman is needed to compare such interactions in LRCs and other settings (both other types of classes in Basic Education schools, and classes in the traditional schools), in order to see whether claims that such interactions are more frequent in technology-rich learning environments are in fact true. Studies such as David (1992), Means and Olsen

(1995a) and Sandholtz, et al. (1992) found that such interactions occurred more frequently in such technology-rich learning environments.

In conclusion, conducting this study has been a very positive experience both for the researcher and education in Oman because it indicates that there are many potential benefits to be gained by adopting a multimedia project-based approach in an ICT-rich environment. Education in Oman has seen much development over the last thirty years and if this rapid rate of progress is to be maintained during the 21st century then innovations such as the one investigated in this study will need to be given careful consideration by the Omani government.

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Appendix 1

Technologies in LRC

Media and Technologies in each LRC	No.
Video Camera	1
Digital Camera	1
CD Players	15
Drawing Tablet	1
Keyboard	15
Microphone	15
Modem	1
Monitor	15
Server	1
Pointing Devices (Mouse, Touch Pad, Trackball, etc)	15
Presentation Devices (video Projector)	1
Printer	1
Scanner	1
Sensors	1
Speakers/Headphones	15
Storage Devices (Zip driver)	1
Storage Media (e.g. Floppy Disks)	16
Synthesizer and/or Sampler	1
System Unit	15
Video Capture	1
Video Disk	1
Photocopier	1
TV	1
Cassettes players	6
Video recorder (player)	1
Books	Approx. 1500
Cassettes	Approx. 50
Videotapes	Approx. 20
CD ROMs containing various learning material	Approx. 100

Appendix 2

LRC Teachers' Attitude toward Technologies Use

Dear LRC Teachers,

Please, take some time to complete this attitude questionnaire. The questionnaire is about your attitude toward the way educational technology is used in learning resource centres (LRC). Your point of view might help to improve the effectiveness of technology use in LRC in Basic Education Schools in future.

I. Demographic data:

1. Sex: Female ___ Male ___
2. Age: < 22 ___ 23-27 ___ 28-32 ___ 33-37 ___ > 38 ___
3. Place of Residence: rural ___ urban ____
4. Years of experience in teaching: 1-5 ___ 6-10__ 11-15__ 16-20__

5- Training Courses: Windows ______ MS Word ______ Internet _______ Excel _____

PowerPoint ______ Multimedia ________

Other IT Training Courses____________________________________

II: The following two paragraphs describe observations of two LRC teachers, Ms. Amira and Ms. Habeeba. Please **read** each paragraph carefully and then **select** from the table below the appropriate answers that represent your opinion.

Ms. Amira wanted to teach her class 4 some IT skills through designing Multimedia presentations. She spent a few minutes introducing the topic and explaining the aims and some important commands for example, how to open the MS Word program, how to open and save a new file. Then she divided her class into 6 groups of 4 and gave each group as task to work on. Ms. Habeeba told her pupils that she would be available to offer assistance. The pupils started working on their project in small groups. In each group, pupils spent sometime time thinking of what to write, and what possible resources to use. After collecting some information, each group typed their draft. Some groups included pictures of a fish market and fish; other included pictures of people in the fish market. They incorporated sounds. They got images from books by scanning them or got them from the LRC. At the end, the headmistress was invited; Ms. Habeeba allowed each group to show their work to the class using PowerPoint.	Ms. Habeeba wanted to teach class four some skill in using MS Word. Using LCD, she started explaining to them how to open a file, type some words, how to check spelling... and print and save a file. She asked several students to come to the front of the class and demonstrate these skills to the other students. After that she gave each pupil a paragraph to type in MS word. Each pupil sat in front of a computer and started typing. They practised their skills for 3 lessons. They printed and saved their work.

	Advantages of the approach	Certainly Amira's teaching method	Tend toward Amira's teaching method	Not sure	Tend toward Habeeba's teaching method	Certainly Habeeba's teaching method
1	Which type of teaching method are you more comfortable using?					
2	From which type of methods do you think pupils learn more and gain more knowledge?					
3	From which type of methods do you think pupils gain more IT skills?					
4	Which type of methods would most pupils prefer?					
5	Which type of methods do you think will motivate pupils to learn?					

III	Pupils' Roles items	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1	I believe student should be passive recipient of information transmitted to them from their teacher.					
2	I believe student can be actively interacting in thinking about information.					
3	I believe students should choose resources and sources of information when doing project/ activities assignment.					
4	I believe each student should work alone (independently) in his/her group.					
5	I believe when in group, student should rely on other members to do his/her part on their task.					
6	I believe in their groups, some students should take the role of the teacher transferring skills and information on certain topics.					
7	I believe a student should not be responsible for his/her learning process.					
8	I believe student should analyze, evaluate, and synthesize information.					

IV	Teacher's Role items	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1	Provide students with guidance when they need it.					
2	Provide students with resources and sources of information to do their tasks.					
3	Facilitate the cooperation among students in their groups.					
4	Walk around to check students' work.					
5	Suggest resources inside and outside LRC for the students.					
6	Observe students working with computer application and other technologies.					
7	Discuss with students their choices of material.					
8	Assign roles to each member and give a chance for everyone to take turn in IT lessons.					
9	Give grades to individual group member based on the performance of the entire group.					
10	Give clues and hints when students ask questions, but not direct answers.					

V	Cooperative and Collaborative Learning	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1	Members perform different tasks (e.g. some work on computer, others look for resource or write draft).					
2	Each group should be composed of mixed gender (boy and girls).					
3	Each group should consist of mixed abilities.					
4	Group members should cooperate to accomplish joint tasks.					
5	Group members should interact with each other in their group, asking and questioning.					
6	Group members perform different tasks towards one goal.					
7	Group members should contact other group members to seek help.					
8	Group members should present their work as group work, not as individual work.					
9	Group members should subdivide a complex task among themselves.					
10	Group members should share information.					
11	Group members should help each other to achieve their goals.					
12	Groups should see and evaluate each other's projects.					
13	Students will take more initiative to learn when they feel free to move around in the LRC during IT lessons.					

VI	**IT as Content items**	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1	IT activities should be integrated across subjects (should contain at least one subject).					
2	IT activities should be related to students' real life.					
3	IT activities should involve the use of more that one type of technology applications.					
4	IT activities should require the use of wide range of material available in LRC.					
5	IT lessons should be related to students' personal interest.					
6	IT activities contain skill and ideas transferred from previous activities (background knowledge).					

	Assessment	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1	Multimedia presentation of their final work (i.e., PowerPoint, KidPix, and HyperStudio.					
2	Written reports on their projects.					
3	Self-assessment.					
4	Electronic portfolio (collection of different types of files).					
5	True and false test items.					
6	Short-answer and multiple-choice tests.					
7	Extended answer items.					

VIII	**Goals of IT Use**	Not important	Not Sure	Important
1	To prepare students for future jobs.			
2	To promote active learning strategies.			
3	To improve students' achievement scores.			
4	To deepen students understanding.			
5	To support instructional reform.			

Thank you, for your cooperation and help

The researcher
Dawood Al-Hamdani

Appendix 3

Interview Questions أسئلة المقابلة

س 1 : ما هو رأيكن في اسلوب استخدام المشاريع باستخدام وسائط التعلم لتدريس مادة تقنية المعلومات؟
ما هي ميزات هذا الأسلوب

Q1: What is your attitude towards the new learning approach? What are its advantages and the disadvantages? Please comment:

س 2: ماذا كان دور التلاميذ أثناء القيام بالمشاريع؟

Q2: What was the pupils' role?

س 3: ما هو دوركن أثناء تنفيذ هذه المشاريع؟

Q3: What was your role?

س 4: ما هي الصعوبات التى واجهتكن قبل و اثناء تنفيذ المشاريع

Q4: What were the difficulties you faced before and during implementing the approach?

س5: كيف استخدمت التقنيات و كم منها استخدم

Q5: How technology was use and how many been used

Follow-up questions:

1- What types of technologies were used?

2- What made students motivated?

3- How far project related to students' real life?

4- Which aspect/s of this method do find least interesting?

5- Which aspect/s of this method do find most interesting?

Appendix 4

Observation Checklist for Teachers' Behaviours

	Teacher's Behaviours	Not at all very little	A little	Moderate amount	A lot
1	Teacher moves around to check students' work and progress.				
2	Teacher offers helps and assistance for each group.				
3	Teacher makes sure that each student is actively involved in her/his group.				
4	Teacher observes class control.				
5	Teacher talks to groups.				
6	Teacher checks background knowledge about the project topic.				
7	Teacher guides students through resources.				
8	Teacher questions students about their prior skills of using computer program applications- e.g. MS Paint.				
9	Teacher intervenes to solve some technical problems.				
10	Teacher teaches IT skills to the class.				
11	Teacher gives directions to all the class.				
12	Teacher talks to the class as whole.				
13	Teacher lectures.				
14	Teacher teaches subject content to the class.				

Coding Guide:

1= These practices are rarely seen (e.g., not at all or very little-less than 25% of the time)
2= These practices are not seen very much (e.g., a little-from 25%-50% of the time)
3= These practices are sometimes seen (e.g., moderate amount-from 50%-75% of the time)
4= These practices are prominent (e.g., a lot- from 75%-100% of the time)

Appendix 5

Observation Checklist for Students' Behaviours

	Students' Behaviours	Not at all or very little	A little	Moderate amount	A lot
1	Students are willing to work together.				
2	Students discuss, analyse ideas and finding with each other.				
3	Students share ideas and work with each other.				
4	Students tutor and help each other.				
5	Students take turns in their work.				
6	Students are willing to listen to each other.				
7	Students seek each others help.				
8	Students talk to each other.				
9	Students seek teacher's help and assistance.				
10	Students encourage and motivate each other.				
11	Students disagree with each other.				
12	Some group members work alone, not with the other members.				
13	Students play around in LRC aimlessly.				
14	Students play with technologies.				

Coding Guide:

1= These practices are rarely seen (e.g., not at all or very little-less than 25% of the time)
2= These practices are not seen very much (e.g., a little-from 25%-50% of the time)
3= These practices are sometimes seen (e.g., moderate amount-from 50%-75% of the time)
4= These practices are prominent (e.g., a lot- from 75%-100% of the time)

Appendix 6

KWL Forms

جـــــــــــدول المعلومـــــــــــات

ملاحظات		ما نعرفه What we **K**now
		ما نريد ان نعرفه What we **W**ant to know
		ما تعلمناه What we **L**earnt

Appendix 7

Examples of some topics

امثلة لبعض المواضيع المنفذة

1) الخريف في صلالة

1- The Autumn in Salalah

2) القلاع والحصون

2- Forts

3) الألعاب الشعبية أو الرقصات الشعبية

3- Folklore dance

4) الأزياء العمانية

4-Omani costume

5) مراحل النمو

5-Human development

6) الأكلات الشعبية

6-Public food

7) أزياء الوطن العربي

7-Arabic costume

8) الأعلام

8-Flags

9) أركان الصلاة

9-Prayer pillars

10) النظافة المعنوية-المادية

10-Cleanliness

11) الحروف الأبجدية

11-Alphabet

12) أدوات الإتصال

12-Communication tools

13) السياحة في بلادي

13-Tourism in Oman

14) علماء العرب

14-Arab scientists

15) شخصيات بارزة من بلادي

15- Famous people in Oman

16) الصخور وأنواعها

16- Rocks and Minerals

17) الوزارات

17-Ministries and Duties

18) فصول السنة

18-The seasons

Appendix 8
A Letter from Ministry of Higher Education

بسم الله الرحمن الرحيم

سلطنة عُمان
وزارة التعليم العالي

الرقم: د.د.ع/١٥٧
التاريخ: .... هـ الموافق ٢٧/١/٢٠٠١م

شهادة لمن يهمه الأمر

تشهد دائرة الدراسات العليا بوزارة التعليم العالي بأن الفاضل/ داود بن سالم بن عبدالله الحمداني مبتعث من قبل وزارة التربية والتعليم لمواصلة دراسته العليا للحصول على درجة الدكتوراه في مجال إدارة مراكز ومصادر التعلم بجامعة هل بالمملكة المتحدة وذلك على نفقة وزارة التعليم العالي ويقوم حالياً باعداد بحث بعنوان TECHNOLOGY USE IN LEARNING RESOURCE CENTER IN BASIC EDUCATION SCHOOL CONSTRUCTIVISM APPROACH وهو متواجد حالياً بالسلطنة لجمع المعلومات اللازمة لبحثه .

نرجو التكرم مساعدة المذكور في الحصول على المعلومات والبيانات قدر الإمكان.

شاكرين ومقدرين كل جهد ومساعدة تقدم للمذكور لتسهيل مهمته.

سعيده بنت عبدالله الصبحي
مدير الدراسات العليا

Appendix 9
Group Evaluation Form

سلطنة عمان
وزارة التربية والتعليم
المديرية العامة للتربية والتعليم لمنطقة الظاهرة/جنوب
مدرسة الدريز للتعليم الأساسي

علوان المشروع الحياة الطبيعية في سلطنة عمان

اعضاء المجموعة * .... * ....
* .... * .... * ....

م	مجالات التقييم	ما تم استخدامه	المستوى أ	المستوى ب	المستوى ج	ملاحظات
١	تلوع المصادر:					
	- كتاب		✓			
	- قرص مدمج			✓		
	- حويفظة سمعية			✓		
	- حويفظة مرئية		✓			
	- إنترنت				✓	
	- أخرى .. اذكرها					
٢	التقنيات المستخدمة:					
	- الماسحة الضوئية			✓		
	- الكاميرا الرقمية				✓	
	- كاميرا فيديو				✓	
	- أخرى .. اذكرها					
٣	طريقة العرض:					
	- عرض الشرائح تلقائيا		✓			
	- بدون استخدام الفارة					
	- تنسيق الشرائح باستخدام المؤثرات الصوتية والحركية وضبطها			✓		
٤	مدى ارتباط المشروع بالبيئة المحلية للتلميذ			✓		
٥	مدى استفادة المجموعات من المشروع			✓		

Appendix 10

A letter to General Director in Region

To: General Director of ....

Dear Mr. ....

I am a graduate student at Hull University on my Ph. D. in Information Communication Technology (ICT). I am conducting a survey of teacher in your region.

As a Ph. D. candidate in the process of doing my thesis research, I am interested in the factors which influence teachers' attitude towards a new way of integrating technology into various subject areas. The new approach is called project based learning using multimedia/IT. With increasing commitments in technology, it is important for professional staff developers and teacher educators to know what factors influence their attitudes towards the innovation. Therefore the purpose of this study is to assess what factors are influential in teachers' practice of the new approach and provide direction for interested parties to improve access, training and planning for the integration of technology in curriculum.

I have a permission from Ministry of Higher Education to conduct this survey in the country as whole. Some LRC teachers from your region have been selected to participate in this survey. This study is confidential. No individual responses will be revealed. I need you help in conducting this survey. Could you encourage your LRC teachers which have been selected to participate in this survey to promptly complete the survey questionnaires and return it directly to me? I would greatly appreciate your help in this area.

Thank you for your cooperation and help.
Sincerely,

Dawood Al-Hamdani

Appendix 11
A Letter to LRC Teachers

Dear LRC teachers,

I know that time is very important to as a LRC teacher and there are many demands being placed in your daily working schedule. Almost three months ago you filled in a survey on teachers attitudes towards constructivist approach before training. I am sending to you the questionnaire. This time I am interesting in your attitude after training and practice.

As I stated in the first request this study is confidential. No individual response will be revealed.

Thank you, for your help and cooperation.

Dawood Alhamdani

Appendix 12
Videotaping Permission

Dear LRC teacher,

Thank you for inviting me to attend your IT lessons in your school. In accordance with research regulations, it is important to get your signature to confirm that you agree to be videotaped. Please sign below this form.

I appreciate your cooperation.

Teacher's name:

Signature

Appendix 13

Kruskal-Wallis Test

13-A: Kruskal-Wallis Test for Teachers' Years of Experience before Training

Scale	Teachers' years of experience and Mean Ranks						Chi-Square	d.f	S.level
	Less than 11		**16-20**		**16-20**				
	N	MR	N	MR	N	MR			
1	101	141.70	83	57.73	16	62.28	104.15	2	.000
2	101	142.27	83	63.42	16	29.19	111.41	2	.000
3	101	148.62	83	49.42	16	61.72	142.16	2	.000
6	101	138.32	83	57.47	16	84.97	90.76	2	.000

13-B: Kruskal-Wallis Test for Attitude before the Training, Related to Teachers' Training Courses for Previous Training Subcategories

Scale	Teachers' years of experience and Mean Ranks						Chi-Square	d.f	S.level
	Basic		Intermediate		Advance				
	N	MR	N	MR	N	MR			
3	52	98.95	125	94.06	23	139.00	11.805	2	.003
4	52	97.54	125	92.56	23	150.37	19.62	2	.000

Appendix 14

استبيان باللغة العربية

بسم الله الرحمن الرحيم

اتجاهات معلي ومعلمات مركز مصادر التعلم نحو تدريس مادة تقنية المعلومات

الافاضل معلمي ومعلمات مراكز مصادر التعلم   المحترمين.

السلام عليكم ورحمة الله وبركاته .....وبعد،،،

بين أيديكم استبيان يستئف اتجاهاتكم وراءكم حول طريقة تدريس مادة تقنية المعلومات للصف الرابع تعليم اساسي. ان الطريقة التي اود ان استطلع رأءكم حولها تعتمد على تعلم التلاميذ في مجموعات صغيرة تقوم بتنفيذ انشطة ومشاريع جماعية. فقد أثبتت الدراسات في هذا المجال جدوى العمل في مجموعات في تدريس مادة تقنية المعلومات. ان وجهة نظركم قد تساعد في تقييم فاعلية تدريس المادة بمركز مصادر التعليم الاساسي.

الرجاء التكرم بقراءة الاستبيان بدقة ثم تعبئته.

أ: معلومات شخصية:

1- الجنس: ذكر______   أنثي ______

2- العمر دون 22___ 23-27___ 28-32____ 33-37____ فوق 38___

3- مكان السكن : المدينة ______   القرية ______

4- سنوات الخبرة في التعليم   1-5 ___ 6-10 ___ 11-15 ___ 16-20___

5- المؤهل الدراسي : ماجستير____ بكالوريوس ____ دبلوم ____ الثانوية____ مؤهلات اخرى____

6- الدورات التدريبية في مجال تقنية المعلومات : Windows____ Ms Word____Internet____ Excel____Power Point ____Multimedia____

7- دوات اخرى في هذا المجال

____

_______________________________.

ب: تصف الفقرات التالية طريقة كل من المعلمة أميرة و المعلمة حبيبة في تدريس مادة تقنية المعلومات. ارجو قراءة كل من فقرة بتمعن ثم اختر افضل الاجابات التي تمثل رايك في الجدول ادناه.

ارادت المعلمة أميرة (معلمة تقنية المعلومات) ان تعلم تلاميذ الصف الرابع بعض مهارات برنامج الطباعة (MS Word) قضت دقائق قليلة تشرح فيها بعض الاوامر المهمة مثل كيفية فتح البرنامج ، كيفية فتح ملف جديد. ثم بعد ذلك قسمت فصلها الى 6 مجموعات من 4 تلاميذ واعطت كل مجموعة نشاطا او مهمة للعمل. كانت المهمة هي كتابة رسالة مقنعة الى مديرة المدرسة للذهاب في رحلة الى سوق السمك..... ثم اخبرت المعلمة تلاميذها انها ستكون موجودة لتقديم المساعدة. بدأ تلاميذ الصف الرابع العمل في مشروعهم في مجموعات صغيرة. في كل مجموعة ، قضى التلاميذ بعض الوقت في التفكير بماذا يكتبون ، وما الموارد الممكن استعمالها. فيما بعد، بدات كل مجموعة، طباعة مسودتهم على الحاسوب، ضمنت بعض المجموعات في رسائلها صورة لسوق السمك وبعض السمك، كما ضمت بعض المجموعات الصور للناس في سوق السمك. قاموا بمس هذه الصور عن طريق الماسحة الضوئية من كتب متوفرة في مركز مصادر التعلم.. بعد انتهاء التلاميذ من عملهم طلب المعلمة من كل مجموعة عرض عملها على الصف. ثم اختار الجميع احسن رسالة، ثم تم ارسالها الى المديرة.	ارادت المعلمة حبيب(معلمة تقنية المعلومات) ان تعلم تلاميذ الصف الرابع بعض مهارات برنامج الطباعة (Ms Word). بدات تشرح لهم كيفية فتح ملف، وطباعة بعض الكلمات، كيفية تدقيق الاخطاء الاملائية .... وطباعة الملف وحفظه. بعد ذلك طلبت المعلمة من بعض التلاميذ ان يأتوا امام الفصل للتدريب على هذه المهارات. بعد ذلك اعت كل تلميذ و تلميذة فقرة لطباعتها باستعمال البرامج. جلس التلاميذ امام كومبيوتر وبدءوا في الطباعة. بعد ثلاثة دروس تمكنوا من انجاز العمل وحفظ عملهم في ملف خاص.

البند	بالتاكيد طريقة تدريس المعلمة اميرة	اميل اكثر الى طريق تدريس المعلمة اميرة	غير متأكيد	اميل اكثر الى طريقة تدريس المعلمة حبيبة	بالتاكيد طريقة تدريس المعلمة حبيبة
1-أي من طريقتي التدريس تثير ارتياحك للاستخدام؟					
2- من أي طريقة تعتقد ان التلاميذ يتعلمون اكثر ويكتسبون معرفة أكثر ؟					
3- من أي طريقة تعتقد ان التلاميذ يكسبون مهارات تقنية المعلومات؟					
4- أي طريقة تعتقد سيفضل التلاميذ؟					
5- أي طريقة تعتقد سوف تحفز التلاميذ على التعلم؟					

ج: دور التلاميذ في التعلم.

م	البند	أوافق بشدة	أوافق	محايد	أعارض	أعارض بشدة
1	أرى ان يكون التلاميذ سلبيين (غير نشطين) في تلقي المعلومات.					
2	أرى ان يندمج التلاميذ بنشاط عند التعامل مع المعلومات.					
3	أرى ان يقوم التلاميذ باختيار مصادر المعلومات عند قيامهم بمهام وواجبات الانشطة / المشاريع.					
4	أرى ان يعمل كل تلميذ مستقلا عن بقية التلاميذ.					
5	عندما يعمل كل في مجموعته، أرى ضرورة ان يعتمد كل عضو على الاعضاء الاخرين في تنفيذ المهام الملقاه عليهم.					
6	أري ان يقوم التلاميذ بدور المعلم في بعض الموضوعات والدروس.					
7	اري أن لايكون التلاميذ مسئولين عن عملية تعلمهم.					
8	اري ان يقوم التلاميذ بتحليل وتقييم وتركيب المعلومات.					

د: دور المعلم في التعليم.

أرى من خلال الدور الذي اقوم به في هذه المدرسة العمل على:

م	البند	أوافق بشدة	أوافق	محايد	أعارض	أعاض بشدة
1	تقديم المساعدة للتلاميذ متى احتاجوا لذلك.					
2	تزويد التلاميذ بالمصادر التي تساعدهم على تنفيذ المهام او تدريبات الدروس.					
3	تسهيل التعاون بين التلاميذ في مجموعاتهم.					
4	التجول لمراجعة متابعة اعمال التلاميذ.					
5	اقتراح مصادر معلومات داخل وخارج مركز مصادر التعلم للتلاميذ.					
6	ملاحظة التلاميذ وهم يقومون بتنفيذ تطبيقات الكمبيوتر.					
7	مناقشة التلاميذ حول اختياراتهم للمواضيع.					
8	بعد تقسيم التلاميذ الى مجموعات، أحدد دور كل تلميذ في مجموعته.					
9	منح درجات لكل فرد أو عضو مجموعة بناءا على أداء عمل المجموعة ككل.					
10	عدم الاجابة المباشرة لاسئلة التلاميذ وانما اعطاء تلميح او مساعدة للاجابات.					

هـ:التعلم التعاوني:

م	البند	أوافق بشدة	أوافق	محايد	أعارض	أعارض بشدة
1	في كل مجموعة يقوم الاعضاء بأداء مهام مختلفة (مثلا يعمل البعض على الكمبيوتر ويعمل البعض الاخر بحثا عن الموارد وكتابة مسودة التقارير).					
2	يجب ان تتكون كل مجموعة من الجنسين (ذكر واناث).					
3	يجب ان تتكون كل مجموعة من تلاميذ ذوى قدرات متفاوته.					
4	يجب تعاون اعضاء المجموعة لانجاز مهام متفاوته.					
5	يجب أن يتفاعل أعضاء المجموعة وذلك بسؤال واجابة بعضهم البعض.					
6	يؤدي أعضاء المجموعة مهام مختلفة للوصول الى الهدف الواحد.					
7	يحب ان يتصل أعضاء المجموعة بأعضاء المجموعة الاخرى طلبا للمساعدة.					
8	يجب ان يقدم اعضاء المجموعة عملهم كعمل جماعي وليس كعمل فردي.					
9	يمكن لأعضاء المجموعة تقسيم أي مهمة عمل عصبة فيما بينهم.					
10	يجب ان يقوم اعضاء المجموعة على تبادل الملومات فيما بينهم.					
11	يجب ان يقوم اعضاء المجموعة بمساعدة بعضهم البعض للوصول الى اهدافهم					
12	تقوم المجموعة بمساعدة وتقييم مشروعات بعضهم البعض.					
13	تكون قابلية تعلم التلاميذ أكبر اذا اتيحت لهم فرصة التجول داخل مركز مصادر التعلم.					

و: محتوى مادة تقنية المعلومات.

م	البند	أوافق بشدة	أوافق	محايد	أعارض	أعراض بشدة
1	يجب ان تدمج أنشطة تقنية المعلومات مع المواد الاخرى (يجب ان تتضمن انشطة تقنية المعلومات مادة دراسية واحدة على الاقل).					
2	يجب ان تكون أنشطة تقنية المعلومات مرتبطة مع الحياة الواقعية للتلاميذ.					
3	يجب أن تتضمن أنشطة تقنية المعلومات أستخدام اكثر من نوعية واحدة من تطبيقات التقنية مثلا برامج الرسم والطباعة.					
4	يجب ان تتطلب أنشطة تقنية المعلومات استخدام تشكيلة واسعة من المواد داخل مركز مصادر التعلم.					
5	يجب ان ترتبط دروس تقنية المعلومات بالرغبات الشخصية للتلاميذ.					
6	يجب ان تكون انشطة تقنية المعلومات مبنية على مهارات وأفكار الدروس السابقة.					

ز: تقييم عمل التلامبيذ

ما هو رأيك بشأن تقييم عمل التلاميذ في مادة تقنية المعلومات. أرى يجب تقيم التلاميذ اعتمادا على:

م	البند	أوافق بشدة	أوافق	محايد	أعارض	أعارض بشدة
1	تقديم عروض الوسائط المتعددة لأعمالهم الختامية (عن طريق PowerPoint أو KidPix).					
2	اعداد تقارير مكتوبة حول مشاريعم.					
3	استخدام التقييم الذاتي.					
4	الملفات الإلكترونية (تجميع مختلف أنواع الملفات لاعمال التلاميذ.					
5	اختبارات الصح و الخطأ.					
6	اختبارات ذات أجابات قصيرة أو ذات خيارات متعددة.					
7	من خلال الاختبارات المطولة.					

ك: ما مدى اهمية الاهداف التالية الخاصة باستخدام تقنية المعلومات في مركز مصادر التعلم:

م	البند	مهم	غيرمتأكد	غير مهم
1	إعداد التلاميذ للمستقبل العملي.			
2	تنمية استخدام التعلم الفاعل.			
3	تحسين مستوى تحصيل التلاميذ.			
4	تعميق مستوى الفهم لدى التلاميذ.			
5	دعم مناهج تطوير التعليم بهذه المدارس.			

Appendix15

رسالة الى مدراء العموم بالمناطق

بسم الله الرحمن الرحيم

الفاضل/ مدير عام التربية والتعليم بمنطقة .... المحترم

تحية طيبة وبعد

أود التفضل بالإفادة بأنني أنا الطالب المذكور أسمه أدناه أحضر الأطروحة الدكتوراه في مجال تقنية المعلومات بالمملكة المتحدة هذا وقد تم اختيار منطقتكم التعليمية من قبلي لتكون ضمن المناطق التي يتم فيها تطبيق هذه الدراسة

عليه ارجو التكرم بالإيعاز نحو تسهيل هذه المهمة وإخطار المعلمات المعنية "معلمات مراكز مصادر التعلم بالمدارس المختارة كعينة للدراسة" بتعبئة الاستمارات الخاصة بذات الموضوع

اشكر لكم صادق تعاونكم معي

وتفضلوا بقبول فائق الاحترام

الباحث/ داود بن سالم الحمداني

Appendix16

رسالة عدم ممانعة بتوثيق دروس مادة تقنية المعلومات

بسم الله الرحمن الرحيم

الفاضله/ معلمه مركز مصادر التعلم بمدرسة .... المحترمه

تحيه طيبه وبعد

أود الإفاده بأنه في ضوء موافقتكم الشخصيه المسبقه على اجراء مشاهده عمليه للدروس وما يتبع ذلك من تسجيل وثائقي لها وذلك لأغراض البحث العلمي الخاص بأطروحه الدكتوراه التي احضرها في المملكه المتحده في مجال تقنيه المعلومات.

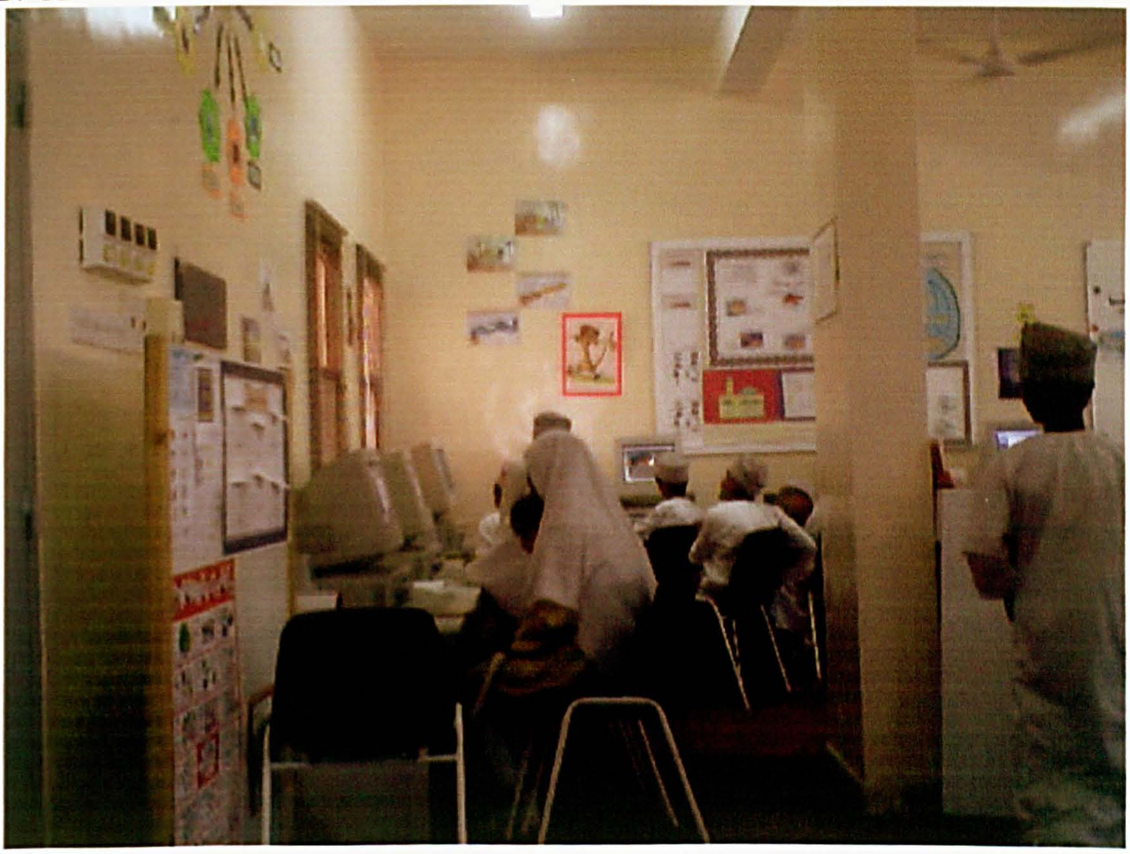
عليه أرجو التكرم بالتوقيع بعدم الممانعه من إجراء ذلك على هذه الاستماره.

وتفضلوا بقبول فائق الاحترام

الباحث/ داود بن سالم الحمداني

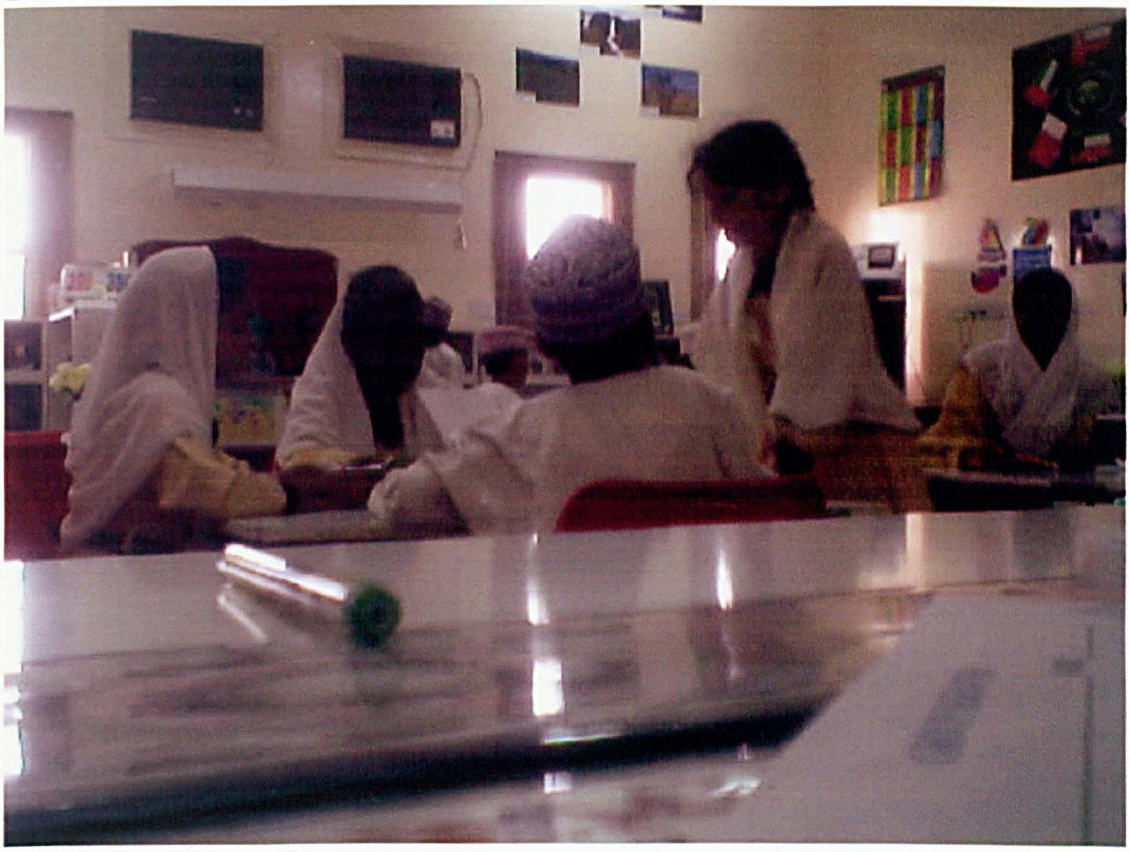
Appendix 17
Interaction in the LRCs

17-A



17-B

17-C



17-D

17-E

17-F

17-G

Appendix 18

Pupils' Role	Mean	S.D.
1- Student should be passive recipient of information.*	4.03	1.07
2- Student should think about information while learning.	4.19	0.97
3- Student should choose resources and sources.	4.14	0.97
4- Each student should work alone.*	4.12	0.95
5- Student should rely on other members do his/her part.*	3.74	1.42
6- The use of groups' "experts".	4.07	1.04
7- Student should not be responsible for his/her learning.*	4.08	0.90
8- Student should analyse, evaluate, and synthesize information.	4.14	1.01

*Reversed during statistical analysis (see Chapter Six, section 6.4)

Teacher's Role	Mean	S.D.
1- Provide students with guidance when they need it.	4.47	0.71
2- Provide students with resources and sources of information to do their tasks.	4.33	0.67
3- Facilitate the cooperation among students in their groups.	4.38	0.69
4- Walk around to check students' work.	4.42	0.66
5- Suggest resources inside and outside LRC for the students.	4.36	0.71
6- Observe students working with computer application and other technologies.	4.47	0.66
7- Discuss with students their choices of material.	4.36	0.74
8- Assign roles to each member and give a chance for everyone to take turn in IT lessons.	4.09	0.88
9- Give grades to individual group member based on the performance of the entire group.	3.97	1.06
10- Give clues and hints when students ask questions, but not direct answers.	4.34	0.70

Cooperative and Collaborative learning	Mean	S.D
1-Members perform different tasks (e.g. some work on computer, others look for resource or write draft).	4.12	0.93
2- Each group should be composed of mixed gender (boy and girls).	3.98	0.93
3- Each group should consist of mixed abilities.	4.28	0.85
4- Group members should cooperate to accomplish joint tasks.	4.28	0.85
5- Group members should interact with each other in their group, asking and questioning.	4.23	0.82
6-Group members perform different tasks towards one goal.	4.23	0.84
7-Group members should contact other group members to seek help.	4.02	0.90
8- Group members should present their work as group work, not as individual work.	4.33	0.83
9- Group members should subdivide a complex task among themselves.	4.17	0.86
10- Group members share information.	4.29	0.82
11-Group members should help each other to achieve their goals.	4.13	0.92
12- Groups should see and evaluate each other's projects.	4.13	0.88
13- Students will take more initiative to learn when they feel free to move around in the LRC during IT lessons.	4.26	0.91

IT as Content	Mean	S.D.
1- IT activities should be integrated across subjects (should contain at least one subject).	4.10	1.02
2- IT activities should be related to students' real life.	4.14	0.86
3- IT activities should involve the use of more that one type of technology applications.	4.12	0.91
4- IT activities should require the use of wide range of material available in LRC.	4.09	0.88
5- IT lessons should be related to students' personal interest.	4.02	0.92
6- IT activities contain skill and ideas transferred from previous activities.	4.02	0.87