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The relationship between facilitation, computer software and the learner in teaching a computer-integrated lesson: an experimental design

by

Anthony Marlon Williams
Student number: 23387239

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Supervisors: Prof. J.C. Cronjé, Dr P.A. Miller

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Abstract

The aim of the research was to investigate the relationship between facilitation, computer software and the learner in teaching a computer-integrated lesson.

South Africa has recently changed their education system from that of content-based to that of outcomes-based. With these changes came the introduction of e-Education. The Government e-Education goal is that every South African learner in the general and further education and training bands will be ICT (Information and Communication Technology) capable by 2013.

Educators are expected to facilitate these classes without having being trained as facilitators in a computer environment. Most educators' follow an instructivist mode of teaching and the researcher decided to do a case study at a school in the Western Cape to investigate the role of an educator in a computer environment. The researcher also wrote the computer-mediated software for the educator to use in his lesson. The software was written for a lesson on Physical Science which was not the field of study of the educator. The educator, however, is a computer technician.

These issues raised questions as to what the methodology of teaching of this educator would be, how would the learners interact with the facilitator and the content and to what degree learning would take place with regards to transfer of skills and knowledge.

From the literature survey the researcher compiled a checklist of what the role of an educator in a computer environment should be whereby the educator was assessed. A questionnaire was compiled whereby the learners evaluated the software that was used for this computer integrated lesson. The learners had to write a pre- and post-test to determine whether content was transferred in this lesson and they were asked to perform a practical experiment to determine their skills.

This dissertation shows how good facilitation, coupled with pedagogically well-designed software and good learner participation leads to a successful learning community.

List of Key Words

Computer-learning environment

Computer-mediated software

Computer-integrated lesson

Constructivism

Cooperative learning

Epistemology

Information and Communication Technology (ICT)

Instructivism

Learning community

Objectivism

Pedagogical dimensions

Pedagogical philosophy

Pedagogically well-designed software

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~ Ephesians 5:20

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Chapter 1

Introduction

1. Introduction

Any successful computer-learning environment requires a facilitator, learners and software in order to function optimally (Newhouse, Trinidad and Clarkson, 2002). After thirteen years of educational research in Information and Communications Technologies (ICT), the Apple Classrooms of Tomorrow (ACOT) labelled the above mentioned entities as indispensable components to what they call a “learning community” in a computer environment (Newhouse, Trinidad and Clarkson, 2002). The diagram below illustrates how ACOT (Newhouse, Trinidad and Clarkson, 2002) represents the educator, the learner and the application software as well as the relationship amongst them.

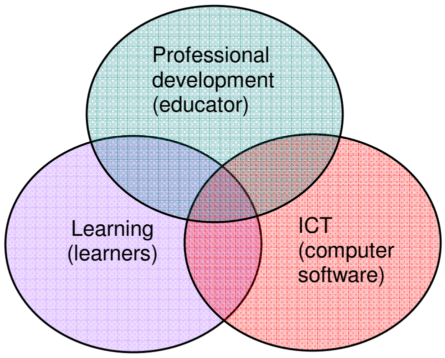

Figure 1 Relationship between educator, learners and computer software (adapted from Newhouse, Trinidad and Clarkson, 2002)

I describe the figure above as an adaptation as I have added the words, “educator”, “learner” and “computer software” to the picture. In the diagram the professional development circle is represented by the educator, the learning circle represents learners, and the ICT circle represents computer software. These overlapped circles illustrate the interaction between educator and learner, between educator and computer software, and between learner and computer software, as well as the zone in which they all interact simultaneously. All three of these entities are necessary components of the learning environment.

Educators are the facilitators of a learning environment. It is their responsibility to ensure that a proper balance is maintained between the interacting components of a learning environment. It is the role of an educator in a computer-learning environment to act as a visible but unobtrusive observer and facilitator who remains present but who never intervenes in the learning process unless his or her assistance is specifically requested by learners. It is also the duty of the educator in the computer classroom to set the scene: to ensure that all the elements of a computer-based classroom are assembled in a coherent and rational manner and that conditions are as conducive to learning as possible. While traditional teaching and learning places the teacher squarely at centre-stage and firmly in the spotlight in front of the classroom as the sole "authorised" and authoritative dispenser of information and received opinion, the computer-mediated education paradigm completely reconceptualises the role of a teacher.

In a computer-learning classroom, it is the learner and the learners' needs that are central to the educative process. Although there is no "centre stage" in a computer-learning classroom, the most important feature of such a class is the learner and the computer which replaces the teacher and possibly even the textbook as the dispenser of necessary knowledge, information and inspiration. In a radically behaviourist version of the traditional classroom, there is only one right or wrong answer to any question, and information received from the teacher (or other "authoritative" sources) needs to be memorised and reproduced as accurately as possible in tests, examinations and in response to questions. In the computer-learning classroom, learners engage in the construction of their own knowledge as they grapple (alone or in groups) with authentic tasks that have been devised by the educator to suit their level of attainment. While educators in computer-learning classrooms thus refrain from traditional methods of lecturing, talking and directing, they are neither quiet nor invisible like spectators of a drama or observers of some kind of solemn spectacle (ETE, 2004). An efficient educator should be friendly and approachable at all times and have a finely developed sense of when to intervene and when to stand back (ETE, 2004). They also need to have a clear idea of the processes that learners use to learn, and they should know exactly when and how to interact with learners in order to stimulate the learning process.

It is also the responsibility of the educator to select software that is likely to produce the desired learning outcome. The facilitator must also be capable of guiding and tutoring learners in the use of the software. A Becta seminar participant put it in the following way: "It is often the way that teachers use software, rather than the software itself, that determines its effectiveness as a teaching tool" (Becta, 2001: 4). It is vital for the educator to arrange, structure and organise the learning environment that learners will be able to make optimal use of the software.

I conducted an investigation into the roles of these three entities and their interaction by investigating a specific learning situation in a selected school. I used computer software that enabled me to design a science experiment that learners would interact with. The learners in the sample were assessed for any prior knowledge they might have about the subject content and skills implied by the ammonia fountain experiment which I used as the basis for this research. After implementing the computer-integrated lesson under research conditions, I tested the learners again in order to determine exactly how much knowledge and what kind of skills might have been transferred in the experimental situation.

2. Rationale

The Western Cape Education Department (WCED) is facing the dilemma that they are losing Science educators to a more lucrative public sector. This concern is also shared by the Khanya project. The Khanya project is providing computer technology in schools to use technology as a teaching aid, hence to improve curriculum delivery. They state that, "both the continuous decrease in the number of adequately qualified educators (particularly in the learning areas of Mathematics and Science) and the reduction in the number of entrants to the education profession, require the WCED to harness technology in order to support and strengthen a system which is at risk. A need therefore exists, not to replace teachers with technology, but rather to assist them to increase their capacity through the use of technology" (Khanya, 2008).

While educational software is becoming more and more widely used and accepted in schools and educational institutions (Wheeler, 2000), most educators have not been trained to teach in a computer-enriched environment and many are not even computer literate. The Government Gazette (2004) states that many educators have grown up in environments with limited electronic technology, and thus find the adaptation of working with ICTs (Information and Communication Technologies) more difficult than their learners do. It is becoming more and more evident that educators who hope to survive and keep pace with new methods and technologies will have to adapt themselves to the computer centric technology that is becoming indispensable in all walks of life and in education in particular (Wheeler, 2000).

The e-Education policy goal for South Africa is that “every South African learner in the general and further education and training bands will be ICT capable (that is, use ICT confidently and creatively to help develop the skills and knowledge they need to achieve personal goals and to be full participants in the global community) by 2013” (Government Gazette, 2004: 17). The South African government’s vision is to enrich the learning environment through the use of ICT by learning about ICTs, learning with ICTs and learning through the use of ICTs (Government Gazette, 2004).

A major concern for schools is the fact that most educators are not trained to be facilitators in a computer-rich classroom environment. The few textbooks that are available focus on what the educator needs to teach the learners according to the NCS, but little is said on how to facilitate such an environment.

Another concern is the selection of software, Carlson and Silverman (1986:107) argues that a facilitator “must understand how available software matches, or fails to match, learning needs as each student progresses through learning activities”.

These concerns led me to the point where I want investigate what the role of a facilitator in computer-rich environment should be, how to select appropriate software and what the interactions will be amongst the facilitator, the software and the learners.

3. Statement of purpose

The purpose of this study was to investigate what the role of a facilitator in a computer-rich environment should be, how to design effective computer software and what the interaction will be amongst the facilitator, the computer software and the learners. In order to do this I have developed a computer-mediated program for the ammonia fountain experiment and asked the computer literacy facilitator at Gordon High to implement the experimental lesson with a particular grade 11 class.

I visited the school, Gordon High, to interview the computer literacy facilitator whom I planned to use in the experimental design. This computer literacy facilitator is not a Science educator. The software that I designed is on a Physical Science topic called the ammonia fountain. I selected the facilitator for his computer skills and wrote the software program to convey Physical Science content and skills. The purpose of this interview with the facilitator was to establish what his perspective on teaching was and to learn more of his teaching methodology.

Before designing the program, I conducted research into available literature in order to understand as much as I could about computer-mediated software. The learners engaged with the software and evaluated it afterwards. During the computer-mediated lesson, I observed the learners closely as to report on their interactions with the facilitator and the software. I also wanted to measure the success rate of this experimental design by assessing the learners with a pre- and post-test as well as practically performing the experiment before and after the lesson.

4. Critical questions

In order to investigate the interactions between the three entities engaged in a computer-integrated lesson, I devised the following research questions:

a. What was the role of the facilitator in the computer-integrated learning environment at Gordon High?
b. Was the software for the lesson pedagogically well designed?
c. How did the learners react to information in a computer environment at the school?
d. How much learning took place in the computer-integrated lesson at the school?

I want to revert back to my first sentence in the introduction that any successful computer-learning environment requires a facilitator, learners and software in order to function optimally (Newhouse, Trinidad and Clarkson, 2002: 12). My reasoning is that if the role of the facilitator is well-defined, the software is well-designed and the learners participate optimally, then that learning environment would be highly successful.

5. The research plan

5.1 Research methodology and design

In my approach to this research, I made use of both qualitative as well as quantitative research methods. Cohen et al (2002: 45) justifies this methodology in stating that "scientists have abandoned the spurious choice between qualitative and quantitative data: they are concerned rather with that combination of both which makes use of the most valuable features of each". In the first three research questions my approach is mainly qualitative whereas in the last research question it is highly quantitative. I focused my investigation on whether the interactions between facilitator, a software program and learners could produce an effective learning experience in the context of a lesson designed to teach the ammonia fountain experiment. My intention was to search the literature firstly for information on the role of a facilitator in a computer environment and to compile a list of good facilitation strategies whereby one can measure the actions of other facilitators. Secondly, I investigated pedagogically well-designed software and designed an interactive computer mediated lesson in Macromedia Authorware to be used in my field work. I observed the whole process focussing on the interaction amongst the three entities and made use of a video recording to assist me afterwards in my conclusions. Lastly, I wanted to determine the extent of the knowledge and skills of the ammonia fountain experiment that was transferred to the learners. Figure 2 sets out the research procedure.

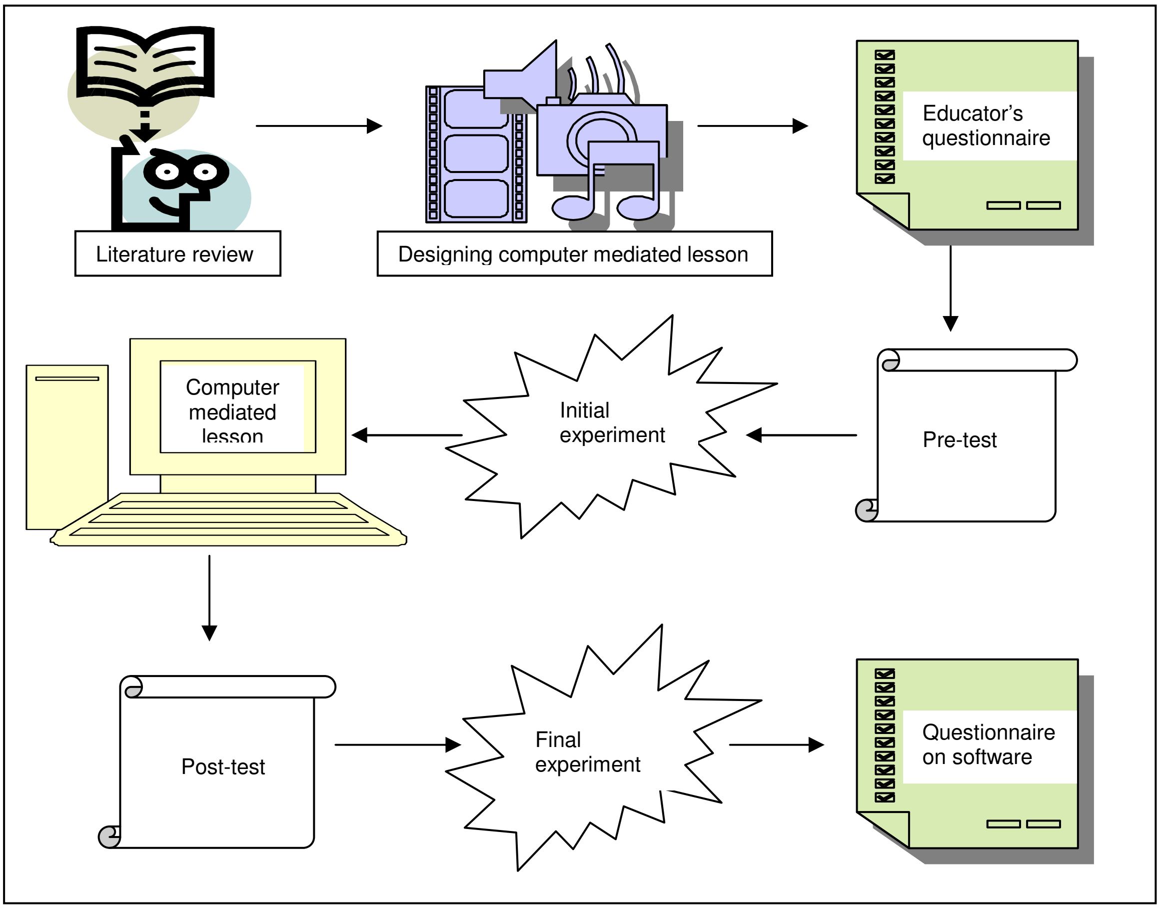

Figure 2 Visual presentation of the sequence of the research process

After compiling a list of characteristics describing the facilitator's role and reviewing software design methods, I started authoring an applications program in Macromedia

Authorware on the topic of the ammonia fountain reaction. I administered a questionnaire to the facilitator (see Appendix A), which would establish his profile with regard to educational philosophy, beliefs and assumptions (Reeves, 1997). I wanted to know in advance what learning strategies he would be likely to employ in the presentation of the lesson. I issued the questionnaire when I started to write the software program and again the same questionnaire a few months later just before the actual classroom intervention. When I gave him the questionnaire the first time, he had just started teaching at Gordon High, with a total of two month's teaching experience. When I gave him the questionnaire the second time, he had a total of ten months of teaching experience.

A week after he completed the questionnaire the second time, I administered a pre-test to the learners in order to determine whether they had any prior knowledge about the content of the proposed lesson. It was important to me to know in advance whether or not they would be learning about the ammonia fountain from scratch or whether some of them already possessed information about it. I only selected learners who had no prior knowledge of the subject so that I could assess whether knowledge was transferred through this mediation only. The results of the pre-test were also used to draw a comparison with their results in the post-test to get an indication of knowledge that was gained in the process.

I then introduced them to the apparatus, briefed them and asked them to undertake the ammonia fountain experiment so that I could assess the kind of practical skills they possessed. This step can be labelled as the initial experiment.

Immediately after this initial experiment, they were introduced to the computer-integrated lesson which was facilitated by the educator that I selected as my focus of analysis in answering my first critical question.

Immediately after the lesson, I asked the learners to write a post-test. They were not allowed to converse with each other during the changing of classrooms for I did not want any knowledge transfer other than what they learned in the computer mediated lesson. The post-test was then used to measure if any knowledge was transferred compared to the pre-test.

They were then asked to perform the ammonia experiment again after having watched the video that was included in the software program. This step was included in the process to assess whether any skills were transferred compared to the initial experiment.

It was important that the learners should not have any contact with any resources once the process had begun between the time of the pre-test and the final experiment. If any such contact was made, it would have been impossible to claim with any accuracy that most of the learning had in fact taken place only in the classroom under the conditions created by the educator, the software and presence of the other learners.

5.2 Stages of the research

I undertook this research study in five stages. In the first stage, I searched the literature to review prior studies on this topic. In the second stage, I wrote a software program with the help of Macromedia Authorware for the ammonia fountain experiment. It took me seven months to learn Macromedia from a text book and to finally publish the program. The third stage entailed the completion of the questionnaire by the educator that would elicit information about his teaching methodology and educational philosophical assumptions. I gave him the same questionnaire a second time about eight months later. The fourth stage entailed administering the pre-test, the initial experiment, the computer-integrated lesson, the post-test and the final experiment. This whole process was implemented sequentially and learners were allowed to move onto a subsequent activity without waiting for the rest of the class. In the last and fifth stage, the learners completed a questionnaire on the quality of the software program. I was then in a position to analyse the findings.

The table (Table 1) below summarises the stages of my research.

Table 1 Stages of the research

Stage	Description of Stage	Activity
1	Searching the literature	• Reviewing prior studies that were done on the three entities that I am investigating.
2	Writing the software program	• I learned how to use Macromedia Authorware and then wrote a program on the ammonia fountain experiment.

3	Eight months and one week prior to my intervention	• The facilitator had to complete a questionnaire twice a few months apart (Appendix A). I gave him the questionnaire the first time when I started learning Macromedia Authorware.
4	Computer-integrated lesson	• The learners wrote a pre-test about the ammonia fountain (Appendix B).
		• The learners were asked to complete an initial experiment in connection with the ammonia fountain (Appendix D).
		• The learners took part in the computer-integrated lesson.
		• The learners wrote a post-test about the ammonia fountain (Appendix C).
		• The learners conducted their final experiment in the laboratory (Appendix D).
5	Immediately after the final experiment	• The learners completed a questionnaire that allowed them to evaluate the software program. • I analysed the data and produced the outcomes.

5.3 Participants of this study

In answering the first research question the unit of analysis is the Computer Literacy facilitator. I asked him to facilitate a lesson from the Physical Science syllabus on the ammonia fountain experiment.

In answering the second research question, the unit of analysis changed to the computer software and the interaction of the facilitator and the learners with it.

In answering the third and the fourth research questions, the unit of analysis shifts towards the learners. My participating sample consisted of fourteen grade 11 learners of equal gender from the Physical Science class of Gordon High School. Before this research took place, I established that these learners possessed no prior knowledge about the ammonia fountain experiment although they had all worked with chemical indicators in grades 9 and 10. Since all of them were enrolled for computer literacy at school, it was possible to assume that they all possessed at least a basic level of computer skills. I excluded from the selection all learners who were repeating their grade 11 year of study.

I then divided the learners into pairs so that each pair could be accommodated at one computer. These pairs were composed of different genders in order to eliminate extraneous variables that might significantly influence the results. Lorri Neilsen (Findings of CAL Research, online) reports that boys and girls behave very differently in front of a computer. All the participants were 16 years of age and came from roughly similar ethnic, cultural and social backgrounds.

5.4 Data collection methods

Table 2 shows a data collection matrix that tabulates the six different data collection methods I used to answer particular research questions:

- Literature review: The literature review covered whatever relevant journal articles, books and electronic documents were available on the Internet on the selected topics.
- Event log: I kept notes about all the activities of the facilitator and learners while they were interacting with the computer. I used this log in answering the checklist that I compiled with regards to the role of the facilitator as well as to describe the learners' interactions.
- Questionnaires: I designed a profile questionnaire (Appendix A) on the basis of information supplied by Reeves (1997) to gather necessary information about the facilitator. I included another questionnaire in order to evaluate the quality of the software program (Appendix F).
- Pre-test/Post-test: I developed a pre-test to assess whether or not the learners had any prior knowledge about the subject of the experiment. I also developed a post-test to measure whether the computer integrated lesson had in fact allowed them to construct knowledge about the physical science subject content. If they had any prior knowledge on the subject, then I would not be able to assess whether new content knowledge was constructed by that particular learner.
- Initial experiment/final experiment: I designed an initial experiment and a final experiment to measure the level of skill that was transferred to the learners after their exposure to the software (the computerized lesson).

- Observation: Apart from my own personal observations, I used a video camera to capture the facilitator and learners' interactions. The information provided by the video also helped me to triangulate my findings.

Table 2 Data collection plan

Research Questions \ Instruments	Literature	Observation	Pre/post-test	Video	Experiments	Profile Questionnaire	Software Questionnaire	Event log
What was the role of the facilitator in the computer-integrated learning environment at Gordon High?	√	√		√		√		√
Was the software for the lesson well designed from a pedagogical point of view?	√	√					√	
How did the learners react to the information in a computer environment at the school?	√	√		√				√
How much learning took place in the computer-integrated lesson at the school?		√	√	√	√			

6. Overview

6.1 Description of the process

I designed a computer-mediated lesson in Macromedia Authorware on the topic of the ammonia fountain for a selected group of the grade 11 learners for the Physical Science curriculum. I asked the educator to complete a questionnaire and his responses gave me a good idea about his personal philosophy and assumptions about teaching and learning. The learners then wrote a pre-test and did an initial (prior) experiment that enabled me to determine their level of prior knowledge about the ammonia fountain and their skills. They were then immediately exposed to the ammonia fountain lesson in a computer-integrated classroom environment. After the lesson had been completed, they were asked to write a similar (but not identical) post-test and also to carry out the experiment again. A video camera captured all these activities for the sake of analysis at a later stage. Although I discussed the issue of the Hawthorne effect with the educator and the learners beforehand, I endeavoured not to influence the course or outcomes of the lesson. The Hawthorne effect (Cohen, Manion and Morrison, 2000:156) indicates that the presence of the researcher affects the research as participants may wish to avoid, impress and direct the researcher or deny his or her influence. I therefore endeavoured to become the proverbial "fly on the wall" and focused on capturing the teaching methodology of the facilitator and the reactions of the learners by directing the video camera and making notes. I also kept a log of the events that occurred throughout the intervention.

The unit of analysis changed with every critical question. In answering the question of the role of the facilitator the unit of analysis is the interaction of the educator with the learners that are part of the research. On the question of what constitute good educational software the unit of analysis becomes the software and how the learners interact with it. The third and the last questions shift the unit of analysis towards the learners.

6.2 Overview of research report

This research is divided into five chapters. The aim of each of these chapters is indicated in Table 3 below.

Table 3 Overview of the dissertation

Chapter	Content
1: Introduction	• Introduction and statement of the problem
2: Literature review	• Elucidates how the role of an educator changes from that of a lecturer to that of a facilitator • Elucidates what constitutes pedagogically, well-designed software • Elucidates the contribution that learners have to make to a successful learning environment
3: Research methodology	• Description of my research methodology • Description of my software program
4: Findings	• Synthesis of my findings
5: Conclusions and recommendations	• Summary of my research • Recommendations for future research

7. Summary

In this chapter I described how this research into a computer-integrated lesson developed from the point of view of the three major role players. I visually represented the interactions with circles in order to give the reader a better understanding of the three different interactions. I explained why schools are concerned about computer-integrated lessons and formulated some research questions that I implemented in the context of an experimental lesson in a particular school in my neighbourhood. Lastly, I explained my research plan (which I describe in more detail in chapter 3).

Chapter 2

Literature Review

1. Introduction

This chapter explains what the literature says about the three entities mentioned by Newhouse et al, (2002) being the educator, the learner and the software in a computer environment as well as the interaction amongst them.

I investigated what the literature says about the role of the educator in a computer environment and what his relationship is with respect to the learners and the computer software. I compiled a list of characteristics of a good facilitator in such an environment. I used this list to answer part of my fourth research question by comparing the educator's actions to what the literature prescribes it to be.

I also searched the literature on the role that the computer and in particular the software plays in this tri-circle of Newhouse et al, (2002). I constructed a checklist of what literature classifies as pedagogically well-designed software and used it as an instrument for the learners to compare my software program with.

Lastly, I examined the role of the learners in this learning community and their interactions with the educator and the computer software.

After I have examined what the literature says about the three key factors of this research (educator, learner and the computer software) and the way in which they interact, I assembled a description of what Newhouse, Trinidad and Clarkson (2002) regard as a learning community that is able to provide rich learning experiences for those who participate in it.

2. The role of an educator in a computer environment

“Teachers can co-opt the technology, but in some instances they can also 'surrender' to it”, (Goodson and Mangan, 1995: 626). I would like to add that some educators also ignore it. Computers in the classroom were received differently by educators.

There were educators that resisted this change in education for they see it as another change from the education department in which they are only included in the implementation phase. Goodson and Mangan (1995: 626) report on their interviews with educators where some educators remark that, “it's like everything else, it's been brought on us 'from above'. Initiatives 'from above' are not always seen by teachers as well-informed, or indeed well-intentioned. They are sometimes viewed as essentially political responses to powerful pressure groups in society”. Hence by this view, it could be argued that it has been judged politically expedient to introduce computers to accommodate business and economic interests.

Other reasons for resisting this change are that educators view teaching style as an expression of a teacher's personality (Goodson and Mangan, 1995). If this is true, the implication is that a change in style would require nothing less than a change in personality, as well as a change in culture (Goodson and Mangan, 1995).

Other educators see the computer as only a tool in their classrooms, none different from the calculators and the desks and tables they use. Goodson and Mangan (2002) continue that they, “found very few examples of teachers fundamentally reworking their lesson plans and pedagogy”. Carlson and Silverman (1986) in their interviews with educators also report that most of them see the computer as ‘just another tool’ - ‘just another way of learning’.

This resistance to change might be caused by the fear that computers might be replacing the educator. Carlson and Silverman (1986) after stating that computers, coupled with appropriate software, are capable of interactively modelling, showing, explaining, and so forth, ask the question, “Will the teacher survive?” Hoffman (1982, as cited in Carlson and Silverman, 1986:1) predicted a shift in the educator’s role from that of an active dispenser of information to that of a more passive manager of instructional environments and learning materials - a shift from an educator to facilitator.

Chapanis (1988, as in Koschmann et al, 1994:2) supports the notion that an educator is essential for “spoken discourse provides many cues (e.g., tonal, gestural) that are not carried in a typed message”. This affective figure cannot be replaced by a machine. Newhouse (2002) on the other hand states that in working with a computer, the “students thinking may go beyond the teacher’s experience or capabilities”. Koschmann, et al. (1994:2) find the middle way and explain that, “experienced educators must exercise some judgment in identifying times and places in which computer-mediation can facilitate the process and those in which it might interfere”. Newhouse (2002:6) argues that, “to accommodate a significant role to the computer in the classroom there needs to be a number of changes to the role of the teacher.”

2.1 The changing role of the educator

The ETE (2004) webpage explains that educators dominate classroom conversation and that, in so doing, they consume nearly 70 percent of classroom time. Lecturing or talking is a form of one-sided communication. In the learning situation where the teacher talks all the time, the learning process is reduced to note-taking and what can be acquired on the basis of individual auditory skills. By talking an educator is in any case merely imparting content knowledge and attitudes. Very little skill is transferred in lecturing. Since some educators are less than competent themselves, learners who merely transcribe what such educators say are merely making (often) garbled notes about content that has already been garbled first by the teacher’s inadequate comprehension of it, and secondly by the teacher’s less-than-perfect delivery of the content. In some cases the understanding of the subject content by the teachers themselves is erroneous and flawed. Since all the necessary content (and much more) can be found in good textbooks and on the Internet (Wheeler, 2000), a wise educator will acknowledge that one cannot compete with the Internet when it comes to content (Jager and Lokman, 1999). This does not mean that the educator’s role is redundant: it merely means learning to accommodate a shift to new paradigm of teaching. Educators according to Wheeler (2000: 3) need to be able to:

- explain to learners how to access the information they need;
- help them to select information by the exercise of discrimination;
- encourage critical thinking about what they find;
- help learners to work cooperatively to obtain the educational goal.

An educator achieves this by moving away from being an omniscient and infallible expert and by becoming a facilitator.

The educator was always traditionally regarded as an expert and a source of authoritative knowledge. The Centre for Substance Abuse Prevention (CSAP) Training Library (2001) describes the teacher's role as leader-centred because it assumes that educators present information and provide the right answers in a teaching or lecturing format characterised by uninterruptible one-way communication. The opposite of this is when educators guide discussions, suggest the right *questions*, and promote respectful two-way communication. A learning format of this kind is group-centred. Forsyth (1996:13) notes that in such a teaching and learning situation, a learner is able to direct his or her own studies and activities while the educator acts as a guide rather than a director. Bevis and Watson (1989) agree that a teacher's job is to offer guidance, support and direction so that a learner's curiosity and spirit of inquiry are stimulated.

The transition from being a traditional "talking head" lecturer to becoming a facilitator necessitates a radical shift in reorientation in thinking and philosophy. This changing role requires the educator to move away from reliance on behavioural theories and to embrace cognitive-development theories of learning (Carey, 1993). Success, according to the facilitator's guide of the NECC (2002), should not be measured by the end product alone, but rather by the skill with which a facilitator is able to stimulate new knowledge, make inferences, reach conclusions, and share his or her learning creatively with others. Wheeler (2000) supports this statement by noting that whereas traditional methods of imparting knowledge were characterised by the strict linear progression of information, the hardwiring of the human mind is much better adapted to using non-linear strategies for problem-solving, reiteration, representation and the storage and retrieval of information.

While all this research obtained from the literature survey supports the concept of facilitation in general, my focus in this chapter is on more than just facilitation in general. There is a difference between facilitation in general and facilitation in an environment in which education is mediated by computers. I will clarify this statement in the following section.

2.2 Facilitation in a computer environment

Facilitation in an information and communication technology (ICT) environment is somewhat different from facilitation in a face-to-face workshop or seminar or a "chalk-and-talk" class. Facilitators in a computer environment sacrifice some of the eye contact that is important in general facilitation in favour of placing themselves in positions where they can see the computer screens. It sometimes happens that when learners are apparently concentrating on educational tasks, they are doing nothing more than reading their latest emails or even playing solitaire. Shepherd (2004) notes that one needs to be able to read the body language of learners accurately to understand who might be confused, lost or at sea.

An educator needs to be able to keep in mind the broad band of diverse activities that constitute an ICT environment. Such activities might be situations as simple as those in which learners are using a word processor or they might be as sophisticated as those in which learners engage in an online conference. My point of departure for the purposes of this study was a facilitator in a class of about 30 learners who were networked so that they could receive and transmit online communications. The focus of my research in these circumstances was the use of ICT as a medium of teaching and learning. In order to further this aim I used the Macromedia Authorware software to write a computerised tutorial lesson about the ammonia fountain experiment which was then taught to a select group of a grade 11 Physical Science learners in a classroom under controlled circumstances.

Wheeler (2000: 4) notes that facilitation in a computer environment has the following implications and consequences for educators:

- Because ICT products proliferate and change so rapidly, various teaching resources quickly become obsolete.
- ICT makes certain assessment methods redundant. Low-level knowledge can now be tested by means of multiple-choice questions that are embedded in software. The answers are automatically marked and the software immediately returns a progress report to the learner.

- It is no longer necessary for teachers to impart content knowledge because the Internet and high-quality print sources do this much better than any human being could ever possibly do.
- Educators should adapt their customary linear strategies of teaching and become better acquainted with non-linear modes of human thinking, teaching and problem-solving.

These implications of computer-mediated education require educators to revise their approach to teaching because traditional methods clearly do not meet the requirements of a computer-assisted educational environment. Educators need to be able to reproduce all these conditions so that effective learning can take place.

The greatest challenge for educators is that the majority of them are now expected to teach in a computer-enriched environment without having been trained in methods that are appropriate to that environment. Most of these teachers are at sea because they are uncertain about what their exact function is in such environments. Even the most recent textbooks tend to focus on subject content and say very little about methodology.

This difficulty inspired me to undertake some research into the role of an educator in a computer environment. I will now discuss what this implies.

2.3 Different roles in being a facilitator in a computer environment

Berge (1995) notes that there are four dimensions or roles that need to be taken into account in being a good facilitator in a computer environment. These are *pedagogical, social, managerial* and *technical*. I will make use of these headings to discuss and compile a list characterising good facilitation, but I will also integrate what other researches found on the topic.

Before I discuss facilitation in terms of these four headings, it is important to know that facilitation means “to make things easier” The word *facilitation* is one of a number of words built up from the Latin root ***facil***, which has a root meaning of to be or to make “easy” (Cadwell, 2004). Facilitation therefore means performing those actions that help (or make it easy for) groups and individuals to achieve specific goals. While the literature that I was able to consult says nothing about *poor* facilitation *per se*, it does offer a number of suggestions about how one should facilitate.

2.3.1 Pedagogical role

According to Berge (1995), the pedagogical role of a facilitator refers to what he calls the *intellectual* aspect of facilitation. This he defines in the following way: “The moderator uses questions and probes for student responses that focus discussions on critical concepts, principles and skills” (Berge, 1995:2).

Berge (1995) is of the opinion that a facilitator needs a clear agenda in order to achieve the outcomes of a lesson. Miller (2003) takes this a step further, not only by providing instructions but also by giving the learners options from which to select. The facilitator then needs to make sure that the learners understand the instructions properly (Miller, 2003). MILES (2004) even goes to the extreme of suggesting that the learners themselves should develop their own learning plans with corresponding outcomes and suggests that it is the role of the facilitator to help them do this. The outcomes of my particular experimental lesson were already prescribed in the Revised National Curriculum Statement (RNCS, 2004), and it was the responsibility of the facilitator to guide the learners to demonstrate these outcomes in the context of the lesson.

Berge (1995) suggests that the goals of courses should (as far as possible) be flexible so as to accommodate the individuality of the learners. It is his opinion that facilitators should encourage participation and interaction by means of small group discussions, debates, one-on-one message exchanges, and the polling of activities (Berge, 1995). Miller (2003) believes in the efficacy of collaborative teaching, especially if learners are required to work alone or from a distance.

Berge (1995:3) goes on to suggest the following guidelines:

- Avoid being the “authority figure”. Rather be a *co-learner* or collaborator.
- Don’t lecture. Rather use open-ended remarks and examples to get discussion going.
- Remain sufficiently neutral and self-effacing to stimulate *learner* initiative.
- Refrain from agreeing or disagreeing as far as possible.
- Encourage learners to reach their own conclusions.

Because this medium and methodology are new to most learners and teachers, Berge (1995) asks facilitators not to expect too much too soon. Facilitators should not set group assignments that are overcomplicated. Miller (2003) even suggests that learners be given readily accessible examples upon which to improve.

With regard to learning material, Berge (1995), MILES (2004), Miller (2003) and Wheeler (2004) all agree that it should be *relevant* to learners and that all activities should be designed with the prior knowledge and experience of the learners in mind. Facilitators must ensure that learners are able to use applications well before they are required to manipulate information (Miller, 2003). Miller (2003) counsels against the use of ready-made images because it seldom add value to the meaning of the information in the context.

It is important to provide motivation for both those learners who are academically inclined and those who are weak and who struggle (Miller, 2003). Miller's report focuses on both intrinsic and extrinsic motivation. Berge (1995), by contrast, has nothing to say about intrinsic motivation. In his opinion, it is necessary for learners to sign on a certain number of times and to contribute enough to earn marks.

These guidelines can help educators to assist learners pedagogically, and I will make use of them when I assess the pedagogical role of the educator. I will make these guidelines available to the educator once my research has been completed.

2.3.2 Social role

Berge (1995) examines the social role of a facilitator by recommending a friendly and sociable environment in which participants can work together to achieve mutual ends. Learners should be encouraged to introduce themselves individually and thus build up a sense of community (Berge, 1995). Miller (2003) suggests that learners be permitted to select their own seating positions in a computer laboratory and keep them for the duration of the class. She also suggests that facilitators might arrange the seating to create the best possible conditions for group work.

Facilitators can promote interactivity by using “introductory techniques, dyadic partnering and some assignments that facilitate informal discussion among learners” (Berge 1995:4). Berge (1995) advises facilitators to circularise a written code of acceptable online conduct or “netiquette” among the learners. He observes that it is vital to model good discussant behaviour and to reinforce it among participants. While one has to accept that there will be lurkers and latecomers, these learners should nevertheless also be acknowledged and welcomed (Berge, 1995). While some people also learn by just listening or observing, all learners should be encouraged to participate actively within their groups to the best of their ability (MILES, 2004).

What is happening in most South African schools is that learners are told to be quiet. Any form of noise is seen as a sign that educators cannot control their classes. Berge, by contrast, positively promotes informal discussion. It was interesting to observe the extent to which the educator at Gordon High allowed “informal discussion” to be part of the learning experience. I will report on this and the points above in my findings in chapter 4.

2.3.3 Managerial role

The managerial role of a facilitator refers to the organisational and administrative tasks of the educator and how he or she manages interactions (Berge, 1995).

The facilitator may decide to encourage informality by, for example, explaining to learners that perfect grammar and error-free typing are less important than making their meaning quite clear (Berge, 1995). Berge (1995) promotes the state of synchronous learning in which all learners begin together and proceed in an orderly fashion. But MILES (2004) is of the opinion that asynchronous learning is also important. Learners also learn in unstructured situations such as in discussions over coffee or discussions during breaks or in their free time. Private discussions can also be encouraged by distributing a list of all the learners’ emails so that they can communicate privately with each other.

Berge (1995:5) offers the following guidance about learner control: “If a learner seems overly outspoken, ask him/her privately to wait a few responses before contributing. Similarly, ask less outspoken learners to contribute more actively.” MILES (2004) makes the suggestion that learners be asked to facilitate discussions or certain class activities.

Such possibilities are obviously restricted and determined by the subject content and by the skill, attitudes and abilities of individual learners themselves.

Conscientious time management is crucial in a computer-learning environment. While it is necessary for facilitators to “cater both for slow and fast learners, additional enrichment activities can keep fast learners occupied and can also incidentally extend the range of their interests and activities” (Miller, 2003;250). She advises that work be broken up into easily manageable “chunks” and a time limit should be set for each chunk. This has the effect of forcing learners to manage their time effectively (Miller, 2003).

2.3.4 Technical role

It is the responsibility of the facilitator to make the learners familiar with the system and software (Berge, 1995). The technology must be transparent (Berge, 1995). What Berge means by transparent is that the technical side of the programme should not inhibit the learners from doing well in the actual computer-mediated lesson. Miller (2003) encourages the use of software that might already be familiar to learners. In the early stages, teachers who are not yet sufficiently confident or competent to facilitate a class alone might need someone on hand to provide technical advice and assistance (Berge, 1995). If it is not possible to have a technician present, then a workbook that explains content and technical assistance would be the second-best alternative (Berge, 1995).

The facilitator should provide sufficient and ample time for the learners to master what they need to achieve (Berge, 1995). Most learners will also need support as they learn to cope with the new software (Berge, 1995). Kluse (2003) suggests that learners should work in pairs: one as a “keyboard captain” and the other as the navigator. Berge (1995) agrees that this is especially important if one learner is a novice and the other is more experienced. In all the circumstances, it is important for facilitators to refrain from offering too much guidance (Berge, 1995).

I used this discussion in the paragraphs above to compile a checklist that I used in assessing the role that the educator displayed in facilitating the computer-integrated lesson. This checklist is available as Appendix E.

2.4 Pedagogical dimensions

A vital part of my research was to observe the educator while he was implementing the lesson. When I examined the literature in the hope of finding out which pedagogical approaches were more likely to produce successful learning, I discovered two broadly significant strands of thought. On the one hand, Reeves (1997) and Vrasidas (2000) describe the two major learning theories, objectivism and constructivism, as opposing theories on opposite ends of a continuum. In contrast to this, Cronje (2006) argues that it is more accurate to conceptualise these two major learning theories as complementary rather than opposing approaches. I will now briefly discuss six of Reeves's (1997) fourteen pedagogical dimensions of computer-based education before examining these two different approaches.

2.4.1 Reeves's pedagogical dimensions

Reeves (1997) describe fourteen different pedagogical dimensions of computer-based education. These I used to judge the pedagogical approach of the educator and to assess the software. The facilitator can be described in terms of the first six dimensions while the last eight can be used to assess the software. I only included the six dimensions that are relevant to my research briefly below.

2.4.1.1 Epistemology

Objectivism ⟵⟶ Constructivism

Epistemology is concerned with theories of knowing or how human beings know things. Objectivist epistemology claims that human beings are able to obtain objectively existing knowledge from a world that exists "out there" by means of our various sense organs, and that we merely make sense of a world that is already meaningfully constructed externally to ourselves. In contrast to this, constructivist epistemology claims that there is no such thing at all as *objective* knowledge. Constructivists believe that we as human beings construct our knowledge *subjectively* by giving a profoundly subjective colouration to our sense data. The constructivist might therefore say that although there might well be something objective "out there" in the world, we as human beings are in no position to make objective sense of it because our understanding of the world is so profoundly and subjectively constructed by our minds. Even our knowledge of our own bodies and psyches is subjectively constructed. One may therefore summarise these two points of view by saying that while objectivists believe in the possibility of entirely accurate knowledge of whatever there is “out there”, constructivists believe that whatever data we receive via our sense impressions is dramatically distorted by the tendency of the human mind to subjectively distort and colour all our supposedly objective knowledge.

2.4.1.2 Pedagogical philosophy

Instructivist ⟷ Constructivist

Instructivists emphasise the importance of goals and objectives, that is to say, in teaching by means of *instruction*. Constructivists on the other hand believe in creating *authentic learning situations* in which learners can *construct* their own knowledge by means of self-directed exploration, discovery and experimentation.

2.4.1.3 Underlying psychology

Behavioural ⟷ Cognitivist

While behavioural psychologists claim that the most powerful form of learning can be achieved by shaping desirable learning behaviours through the intentional disposition of stimuli, responses, feedback, reinforcements and other contingencies, cognitivist psychologists place much more emphasis on self-directed activity and subjective mental states than on responsive behaviour.

2.4.1.4 Teacher’s role

Didactic ⟷ Facilitative

In a didactic environment the educator is a provider of knowledge. Most of any lesson will therefore consist of the educator telling learners what to think and do. In a facilitative teaching environment, the educator is one among many resources that can be consulted. In such an environment an educator may also become a learner.

2.4.1.5 The value of errors

Errorless learning ⟷ Learning from experience

While some educators believe that learners learn by making mistakes and renegotiating their data, other educators maintain that it is not necessary to learn by making mistakes. and that learners can be guided not to make errors.

2.4.1.6 Learner control

Non-existent ⟷ Restricted

Learner control refers to the option of allowing learners to make their own decisions about what sections they wish to study and/or what paths they wish to follow as they navigate their way through interactive material. Learner control may therefore be either nonexistent or restricted.

2.4.2 Cronje's four quadrants of learning

Reeves's (1997) model is based on the assumption that objectivism and constructivism are polar opposites and extremes on the same descriptive continuum. In terms of Reeves's description, objectivism and constructivism are irreconcilable because they are exclusive of one another in their aims and their methods. Cronje (2000) disagrees with Reeves's assertions in this regard, and both he and Vrasidas (2000) argue that objectivism and constructivism are not opposing paradigms but that they are rather complementary.

Cronje (2000) suggests that these two educational philosophies can be better described and understood if they are plotted at right angles to one another to form an integrative matrix such as that in the figure below.

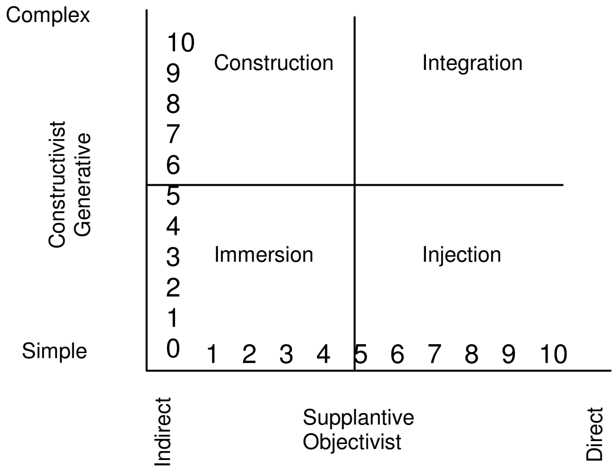

Figure 3 Four quadrants of teaching and learning as proposed by Cronje (2000)

2.2.1 Injection quadrant

This quadrant is high in objectivist elements. It emphasizes the behaviourist notion that content, skills and values need to be passed on to learners by being "injected" into them. Lectures, drill-and-practice, rote learning and memorisation are characteristics of this approach. This method is obviously suitable in those cases where learners need to memorise content and reproduce it without thinking (as, for example, in the learning of a language).

2.2.2 Construction quadrant

In this quadrant, learners construct their own meaning by building on previous knowledge and experience. This quadrant is high in constructivist elements. Here learners learn best by using their own initiative, by exploring and by finding and constructing the specific knowledge that they need.

2.2.3 Immersion quadrant

Learning by immersion is low in objectivist as well as constructivist elements. Cronje (2006) calls it this "the domain of serendipitous learning". The kind of learning that happens here is purely incidental. Learners learn through serendipitous happenings and there is no evidence of planning or design.

2.2.4 Integration quadrant

This quadrant contains a well-considered combination of carefully planned objectivist and constructivist elements. This is the domain of the instructional designer. There is clearly room for both these two approaches in the teaching of different subjects since different situations and different needs and outcomes require different kinds of practice. An educator needs to make a decision about what will be the most appropriate method for a particular situation.

Cronje (2006) demonstrates that different kinds or combinations of learning take place in each of the four quadrants. It is up to the educator to make decisions about the kind of learning that will be best suited to the outcomes that need to be achieved.

3. Pedagogically well-designed software

Pedagogically well-designed software is educational software that has been designed to make learning easy. There are numerous ways of evaluating whether or not software is educationally well designed. I will now examine the software evaluation methods of Hannafin and Peck (1988), Kirkpatrick (1998), and Mayer and Moreno (2003).

When it comes to evaluating software, Hannafin and Peck (1988) suggest the following four basic headings:

- Instructional adequacy
- Cosmetic adequacy
- Programme adequacy
- Curriculum adequacy

When Hannafin and Peck talk about *instructional adequacy,* they are referring to the *pedagogical* effectiveness of the software. This refers to the guidance that an educator gives to a child in order to move him or her from a position of *not knowing* to a position of *understanding*.

When they talk about *cosmetic adequacy,* they are referring to the use of colour, sound and motion in the program. Many programmers use special features on the screen to attract the attention of users and to make the on-screen environment more attractive. These features are probably the first things that a user notices.

When they talk about *programme adequacy,* Hannafin and Peck are referring to how well programme executes. Some programmes might run well under normal circumstances, but break down under certain conditions.

When Hannafin and Peck talk about *curriculum adequacy,* they are referring to how well lesson procedures, activities and formats conform to accepted standards. They also refer to how easily an existing lesson can be incorporated into existing curriculum activities and requirements.

Hannafin and Peck's research study evaluates the programme by posing questions about the features of the software. While they focus on software that has been developed commercially, one can also utilise the lessons that they propose when designing software.

Kirkpatrick's model (1998) focuses more on what Hannafin and Peck call "instructional adequacy". Kirkpatrick's model can be used to evaluate feedback from trainees in a class and then to conclude on the basis of that feedback whether the software was in fact equal to the task of providing an authentic learning experience. Kirkpatrick's model for evaluation proposes the following four levels: *reaction, learning, behaviour, result*. In evaluating *reaction* he uses, for example, a questionnaire which gathers feedback immediately. The evaluator collects the trainees' reactions by means of software. In order to evaluate *learning*, Kirkpatrick focuses on knowledge, skills and attitude. He suggests that one might do this by administering a pre-test and a post-test in order to determine whether learning has taken place. But he also suggests that one might use methods such as interviews, observations, surveys (or combinations of these) to find out whether learning has taken place. Kirkpatrick suggests that one evaluates *behaviour* by measuring the achievement of performance objectives. Because these are not always immediately apparent, one should allow enough time to make the necessary observations. When one evaluates *result*, Kirkpatrick suggests that one looks at "the bottom line". He suggests that one asks whether it is worth buying – or whether it is simply a "nice-to-have". One should also look at whether there is proof of claims or consider whether one should be satisfied with soft evidence. Kirkpatrick also adds a fifth level. This inquires into whether or not there is a *return on investment*. (This level was not included in the original statement of the model.)

Mayer and Moreno (2002) analyse educational software by dividing it into two categories: *pictures* and *words*. On the basis of their assumption that human beings possess separate systems for processing pictorial and verbal information, they argue that one should be careful not to overload these two cognitive channels inordinately (Mayer and Moreno, 2003). They write: “There is only a limited amount of processing capacity available [to human mind] in the verbal and visual channels” (Mayer and Moreno, 2003: 44). They therefore recommend that software designers should discard the frills and extras that are a feature of multimedia software and stick only to what is relevant and essential. They even suggest taking out background music because it occupies the audio channel and thus limits other relevant audio information that might be coming in on that channel.

Halpern (n.d.) disagrees with this point of view and points out that the right kind of background can stimulate the brain and so enhance learning. He writes: “This music assisted over 85% of test subjects to effortlessly enter alpha and theta brainwave states and experience hemispheric synchronization” (Halpern, n.d.). He nevertheless cautions that different kinds of music work in different ways for different people.

While I support the view of Mayer and Moreno (2003) that it is probably not advisable to insert background music, I also believe that certain kinds of music or sounds (such as waves breaking) stimulate the mind and thus enable it to absorb information more efficiently. (It is, however, impossible to deny that the same music or sounds will affect different people in different kinds of ways.) It might be counterproductive to include background music in software designed for the classroom because, since learners work at different speeds, the sound of the accompanying music will produce a cacophony. If educators feel that certain kinds of music can stimulate learning, they should so arrange the music that the whole class can listen to it together from one source.

Mayer and Moreno (2002: 107) propose the following principles for designers who are designing new software:

- *The multiple representation principle*. This principle states that it is better to present an explanation by means of words and pictures than by words alone.
- *The contiguity principle*. This principle states that it is better to locate words and pictures that are related in physical proximity to one another rather than separately when using them to present a multimedia explanation.

- *The coherence principle*. This principle states that it is easier to understand multimedia explanations when they include a few rather than too many redundant words and sounds.
- *The modality principle*. This principle states that it is better to present words in audible narrative format rather than as visual on-screen text.
- *The redundancy principle*. This principle states that it is better to present animation together with narration rather than to present animation together with narration *and* on-screen text (Mayer and Moreno, 2002).

When I designed my software for the Physical Science lesson, I tried to combine the principles suggested by Hannafin and Peck, Kirkpatrick and Mayer and Moreno as judiciously as possible. I designed the software, for example, with the principles of Mayer and Moreno in mind, and administered a questionnaire to the learners so that they could evaluate the software in terms of the criteria suggested by Hannafin and Peck. I will also report on this evaluation of the software in chapter 4.

4. How learners interact with the educator and the computer software in a computer environment

Goodson and Mangan (1995) write that computers have a distinct effect on classroom interaction patterns. They studied the learner's participation in different subjects at school. In the art class for example is learner-centred and the educator plays a coaching role compared to the social study class where the learners are passive listeners featuring a more educator-centred pedagogy. With the introduction of computers, all the classes, even the art classes, became more learner-centred. The implication of this is that learners need to become more self-directing and motivating and thus take more responsibility for their own learning (Newhouse, 2002).

Learners in working in a computer environment learn to develop skills that were not so prevalent in the traditional classrooms. Newhouse (2002: 21) lists a few of the skills that are enhanced from working in a computer environment:

- Learners need to make decisions for themselves and with other learners;
- They learn the ability to follow instructions on a computer screen;
- They develop skills in determining and assessing their own learning;

- They develop increased levels of comprehension and concentration;
- They develop skills in recording;
- They learn to evaluate their findings and progress.

Newman (1990) observed that learners having computers in all their classrooms transport their work between contexts. They start a project in one class and at the end of the lesson they save their work and they can continue with it in another class. This is in contrast with the traditional way of packing away all books and taking out new ones for the next subject. Newman continues to write that boundaries between one class period and another became permeable.

Letting learners work in small groups around one computer also enhances learning opportunities. Peer interaction emerges from such an arrangement (Mehan, 1989 as in Newman, 1990). Vygotsky introduced the concept of zone of proximal development (ZPD) in 1978 in which learners, with the help from each other, can work at problems that are beyond their competence as individuals (Newman, 1990).

Miller (2003) investigated the interaction of learners with computer software. She investigated how sixteen-year-old learners interact cognitively, affectively and from a physical point of view with digital information in a computer-assisted environment.

Miller (2003:246) reports that, from a cognitive point of view, “higher-level thinking skills were evident in conceptualising and creating the webs with levels of information, frames, image maps and interactivity”. From an affective point of view, she found that learners supported each other well. The learners whom she investigated were prepared to share their ideas and skills with their fellow learners. From the physical point of view, Miller concluded that learners interacted with each other most of the time even though this was not required of them. They also shared features and information with those around them. This is one of the reasons why Kluse (2003) advises that it is more beneficial for learners to work in pairs rather than alone.

One of Miller's (2003) findings was that learners do not go to the proverbial drawing board to plan a presentation, for example, they create it while they work. Little or no preplanning was evident. She found that academically strong and experienced learners were able to communicate content in multiple formats that contained animations, words and images.

The conclusion that I make from her findings is that while academically challenged learners probably had their hands full merely in managing the software; the more accomplished learners were probably motivated by a desire to get good marks. The implications of this is that while novice learners were able to explore new features up to a point, the more experienced learners were able to push the boundaries of the program.

Miller's findings are far more extensive than what I have reported. I am only reporting in this study on what is relevant to *computer-based* lessons. Miller also noted that work performed by a group contained fewer spelling errors than work done individually. It seemed to her that learners enjoyed exploring features and sharing the excitement of doing so. She also found that learners tended to lose track of time when they became deeply focused on the work. She notes that a supportive environment will not induce feelings of anxiety in learners.

5. Summary

In this chapter I discussed guidelines for the facilitator in a computer environment. I compiled a checklist (Appendix E) of characteristics of a good facilitator whereby I will assess the role of the facilitator at Gordon High. All guidelines in such circumstances are only provisional because every classroom situation is different. Experienced teachers know that even the same class will react differently on the following day – or even on the same day if they are seen again. Just as educators are being asked to change their method of imparting knowledge and lecturing to facilitation, learners are being asked to take more personal and group responsibility for their learning. It is also therefore important to discriminate between facilitation in general and facilitation in a specifically computer-assisted environment. It will undoubtedly take some time for both educators and learners to become proficient in the use of technology-mediated instruction.

I have compiled this list of characteristics (see appendix E) on the basis of the principles enunciated by Berge (1995), MILES (2004), Miller (2003) and Wheeler (2004), that is desirable for a computer facilitator to possess. I used this list of characteristics as a checklist when I observed performance of the educator who facilitated the computer-integrated lesson on the Ammonia Fountain experiment.

I also used this chapter to examine what pedagogically well-designed software entails. I noted that Hannafin and Peck (1988) categorised good software in terms of the following four areas: *instructional adequacy, cosmetic adequacy, programme adequacy* and *curriculum adequacy*. I also noted that Kirkpatrick (1998) and Mayer and Moreno (2003) focused more on what Hannafin and Peck (1988) call “instructional adequacy”. Yet each of these contributors made valuable contributions that I took into consideration when I designed the software for my experimental lesson. I will elaborate more on the program software in chapter 3.

Miller’s (2003) research can be used as a basis for understanding how South African youths process information because the sample group also consisted of sixteen-year-old learners. It is important, however, to bear in mind that Miller worked with more privileged English-speaking learners from an urban area whereas the participants in my research were generally poor Afrikaans-speaking learners from a school in a rural area. I only draw attention to these differences because there were many cultural and ethnic differences between Miller’s group and my groups of learners. I will report on the findings of the experiment in chapter 4.

The table below highlights the main points in the literature survey.

Table 4 Summary of the literature survey

Unit of analysis	Literature mostly focused on	Actions taken
The educator	Roles of Facilitator Pedagogic Social Managerial Technical Pedagogical Dimensions	Constructed Assessment Checklist to measure the educator’s interactions.
The computer software program	Software evaluation Instructional adequacy Cosmetic adequacy Programme adequacy Curriculum adequacy	Constructed software evaluation questionnaire whereby the learners will evaluate the software program.
The learner	Learner interaction Cognitively Affectively Physically	

Chapter 3

Research Methodology

1. Introduction

This chapter discusses the sampling of the target group, the validity of the findings, issues about the reliability of the research and the appropriateness of the research instruments used to obtain data. The research instruments were an event log, a questionnaire, a pre-test and a post-test, an initial and final experiment, and observation. This chapter also describes the software program that I designed and used in this research.

2. Qualitative vs. quantitative research

My research was an experimental design. I have used what John Cresswell (2008) called and mixed-methods design. I started with a qualitative design that entails research, observation and collating learners' views and then confirming my research with a quantitative design featuring a pre- and post-test.

In answering my first three research questions I followed a qualitative approach. In assessing the role of the facilitator, the educator completed a questionnaire on his perspectives of teaching and I assessed his methodology by filling in a checklist that I compiled from the literature survey. In answering my second research question on the quality of the software, the learners expressed their views by completing a questionnaire. To report on the interaction of the learners, I was the silent observer and kept a log on what was happening in the computer laboratory. I also video recorded the classroom activities to validate my observations. The qualitative instruments that I used included an event log, questionnaires and observation. I used the data of the educator's questionnaire on his teaching perspectives and portrayed it graphically as interpreted by Reeves (1997) as well as Cronjé (2006).

In answering my last research question on whether knowledge and skills were transferred, I used a quantitative approach. The learners engaged in a pre-test and an initial practical experiment regarding the ammonia foundation which served as a baseline assessment.

They wrote a post-test and performed a final experiment immediately after engaging in a computer integrated lesson on the topic. The scores of the tests were compared and conclusions were reached. The quantitative instrument that I used was involving a pre-test and a post-test to enrich my findings. I also expressed the data on knowledge transfer graphically to highlight the difference in comparing the pre- to the post-test.

3. Investigation instrumentation

3.1 Event log

I kept a log of all of the interactions that occurred during the computer-integrated lesson. The log reports on interactions of the learners. It describes in detail the interactions between the learners and the software, and the learners and the educator.

3.2 Questionnaires

I designed two questionnaires, one for the educator and one to evaluate the software. I used the pedagogical dimensions of Reeves (1997) to create a questionnaire (Appendix A) that would create a profile of the educator in his role as facilitator. I administered the questionnaire with the facilitator well in advance and again shortly before the experimental lessons. I then used the information that I was able to gather from the questionnaire to sketch the educator's personal philosophy of teaching and teaching. I then represented this information as a graph (which is presented in the next chapter).

The second questionnaire intended for the learners, posed questions about the quality of the software they used in the lesson. I constructed the questions in the questionnaire in accordance with the criteria presented by Hannafin and Peck (1988). The learners were asked to complete this questionnaire *after* the final experiment was done. This step concluded my interaction at the school itself.

3.3 Pre-test/post-test

I designed a pre-test (Appendix B) and post-test (Appendix C) to elicit information about the learners' content knowledge of the ammonia fountain, which is prescribed in the grade 11 Physical Science syllabus. The learners wrote the pre-test before they undertook the experiment in the context of the computer-integrated lesson. The purpose of the pre-test was to establish what prior knowledge (if any) the learners might have had about the ammonia fountain experiment. Immediately after the lesson, the learners were asked to complete the post-test. It was part of the experimental protocol that little or no contact should be made between the pairs of learners (groups) once the process had started. I tried to eliminate any external opportunities where learning could take place other than the ones planned for my research. Guided by the literature (Newman, 1990; Kluse, 2003) I had the learners working in pairs at one computer. The pre-test and post-test were similar but not identical. Although I was in fact testing for the same knowledge, I had reframed the questions. These two activities were the only activities that were completed as individual work.

3.4 Initial experiment and final experiment

I also devised an initial and final experiment for the same reason that I had devised the tests. The initial experiment took place immediately after the pre-test. From the science laboratory the learners moved into the computer-integrated lesson. The final experiment then took place after the post-test and that concluded the fieldwork. The pre-test and post-test were also completed by the groups (two learners in each group).

3.5 Observation

I observed the interactions of the educator with respect to the learners and the computer program in answering the first research question. I used the checklist (Appendix E) to record the educator’s role in the computer environment.

I set up the video camera on a wide angle at the back of the class so that I could capture all the activities in the classroom. Although it was set on a wide angle, it was clear enough to distinguish the activities of the learner in their individual groups. The footage from the camera also helped me to confirm my observations and to validate my findings by means of triangulation.

4. Sampling

Sampling forms as an important role in research as methodology and the instrumentation that is used. Cohen, Manion and Morrison (2000:92) articulates this statement as follows: "(T)he quality of a piece of research not only stands or falls by the appropriateness of methodology and instrumentation but also by the suitability of the sampling strategy that has been adopted" . I decided to use a probability sample when I selected a particular group of learners (grade 11 science learners). This strategy is called *stratified sampling* (Cohen, Manion and Morrison, 2000). Stratified sampling involves dividing the population into homogenous groups, each group containing subjects with similar characteristics (Cohen, Manion and Morrison, 2000:101). All the learners were from the same cultural and socio-economic background and they were all enrolled for Computer Literacy as a subject. I used the same number of girls and boys and grouped them in pairs. The reason for selecting homogenous groups was to eliminate external factors such as gender differences, cultural and socio-economical differences that I could not account for in the research. One does have to accept though, that even in a homogenous group; every learner is different at an individual level. The target group in this case was grade 11 learners who had not been exposed to the particular topic of the ammonia fountain. There were fourteen learners in the sample: seven boys and seven girls.

5. Validity

In order to claim validity, I have addressed it under the following headings: internal validity, external validity, content validity, construct validity, ecological validity, catalytic validity, criterion-related validity and triangulation.

5.1 Internal Validity

Internal validity seeks to demonstrate that the explanation of a particular event can actually be sustained by the data (Cohen, Manion and Morrison, 2000:107). I validated my research by means of triangulation. While I was observing the role of the educator and the interactions of the learners, I had the whole class covered by video footage to triangulate my findings.

There were no dropouts from the sample and therefore no exigency that might affect the statistics and make them invalid. The pre-test and post-test were similar but not identical, and the questions were of such a nature that the learners needed to understand certain principles in order to score by returning correct answers. We were also careful to prevent the learners from mingling with one another or from making contact with any resources between the beginning and the end of our intervention.

5.2 External validity

External validity refers to the degree to which the results can be generalized to the wider population (Cohen, Manion and Morrison, 2000:109). My research is very relevant to South African schooling at the moment. Educators find themselves in a situation where text books prescribe the content that needs to be dealt with, but not the methodology of how to interact with it. I will provide a clear and detailed description of my observations so that others can decide the extent to which my findings can be generalized to their situation.

5.3 Content validity

To demonstrate this form of validity the instruments must show that they fairly and comprehensively cover the domain that they purports to cover (Cohen, Manion and Morrison, 2000:109). For my research I am focusing on the topic of the ammonia fountain experiment. The content is covered extensively in the computer program and the learners had the opportunity to perform the experiment practically.

5.4 Ecological validity

For ecological validity to be demonstrated it is important to include and address as many characteristics in a given situation as possible (Cohen, Manion and Morrison, 2000:110). A related type of validity is the emerging notion of cultural validity (Morgan, 1999). In my research I have selected participants with the same cultural and socio-economical background. All the participants are from the middle-income cape-coloured community from the Somerset West region in the Boland.

5.5 Catalytic validity

Catalytic validity simply strives to ensure that research leads to action (Cohen, Manion and Morrison, 2000:111). The agenda is to help participants understand the importance of the research, the consequences and the importance of being true to what they normally would have done. I tried to minimise the Hawthorne effect by explaining the format of the research to the learners. The Hawthorne effect (Cohen, Manion and Morrison, 2000:156) indicates that the presence of the researcher affects the research as participants may wish to avoid, impress and direct the researcher or deny his or her influence.

6. Reliability

6.1 Reliability as stability

"Reliability as stability can also be stability over a similar sample" (Cohen, Manion and Morrison, 2000:118). Cohen, et al. (2000) went on to report that if one were to administer a test or questionnaire to two groups of students who were very closely matched on significant characteristics (e.g. age, gender, ability, etc.) then similar results or responses would be obtained. In the pre-test, all the participants failed. The boys' scores ranged from 2 to 7 and the girls' scores ranged from 1 to 4 out of a maximum of 18 points. One can reliably conclude that none of the two groups had significant prior knowledge on the topic.

6.2 Reliability as equivalence

"This type of reliability might also be demonstrated if the equivalent forms of a test or other instrument yield consistent results if applied simultaneously to matched samples" (Cohen, Manion and Morrison, 2000:118). Fourteen participants wrote a pre- and post-test. All of them scored very low marks in the pre-test and all of them improved in the post-test. Seeing that no contact were made with any resources other than working in pairs in a computer mediated lesson, I want to conclude reliably that should this research be done in future under the same circumstances, one would expect an improvement as well.

7. A description of my software – *Science Alive!*

(At this point I would like you to insert the CD in your CD-Rom and double-click on the icon "Science Alive.exe". Please browse through the program – it is quite entertaining)

The creation and development of the software program formed a major and vital part of this project. Before I tackled this project I was unfamiliar with authoring software of this kind. Because there was no expert on hand to tutor me, I had to learn how to use the program from the manual. There are consequently places in the program that attest to my lack of authoring knowledge. Unfortunately my lack of skills with regards to the functionality of the application program somewhat limited my creativity.

7.1 Overview of my software program

The name of my software program is "Science Alive!". It had all the necessary features for targeting learners engaged in mastering the grade 11 Physical Science syllabi. For the purposes of the experiment on which this dissertation is based, I confined myself to the Ammonia Fountain experiment. Figure 3 shows the different topics that are covered by the Science Alive! program.

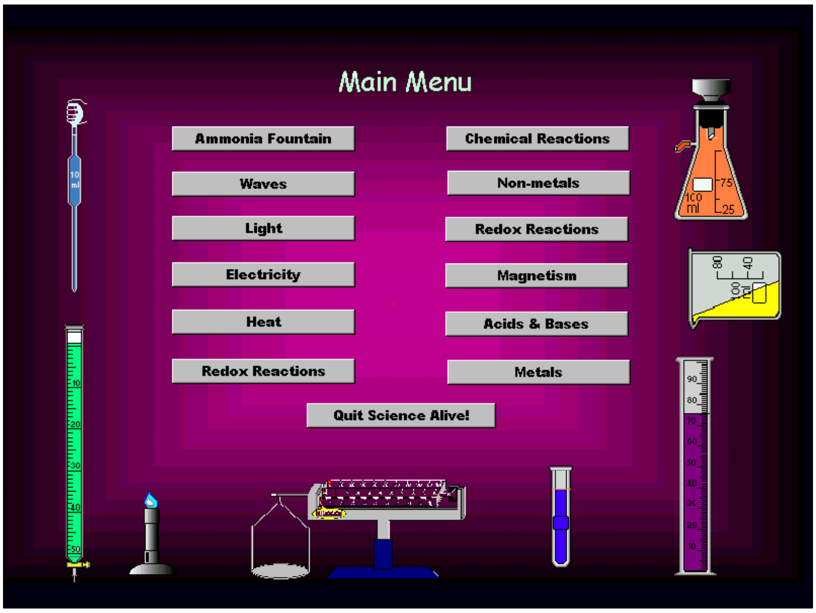

Figure 4 Menu of Science Alive!

I used the Standard Windows 3.1 buttons so that the participants would find themselves in a familiar environment. When the learners clicked on a particular button, the topic they selected appeared on the screen. For the purposes of the Ammonia Fountain experiment, I focussed on the apparatus that was needed, the safety precautions that accompany the experiment, the concept of indicators, and the procedure for undertaking the experiment. I also included a quiz by means of which the learners could test their knowledge afterwards. Figure 4 shows the menu of the Ammonia Fountain screen. When one clicks on the Ammonia Fountain button, a new window opens with a menu that shows the Ammonia Fountain experiment options. For the purposes of my research I made all the other buttons inactive so that the learners would only be able to execute the Ammonia Fountain experiment on that particular day and not be distracted by side issues.

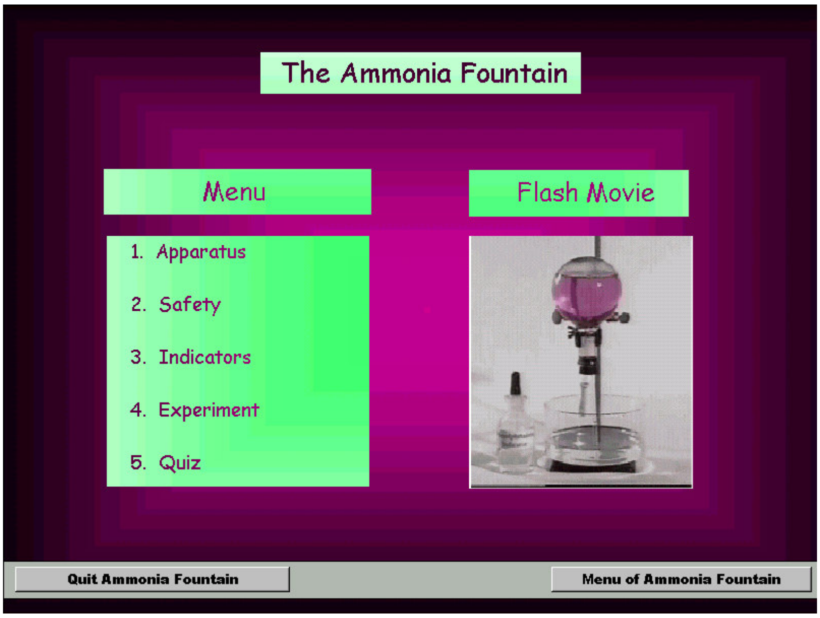

Figure 5 Menu of the Ammonia Fountain

7.2 Apparatus menu

When learners selected the Apparatus option, they found an interactive activity that forced them to label the apparatus before they could proceed to the next screen. Other activities in this exercise also required the learners to answer questions about particular pieces of apparatus. The learners, however, retained full control over the program and could exit from the program at any time. The buttons that enabled them to quit or to navigate to the Ammonia Fountain menu remained on the bottom of all the screens throughout the experiment. Figure 5 shows a screenshot of the apparatus that was needed for the experiment.

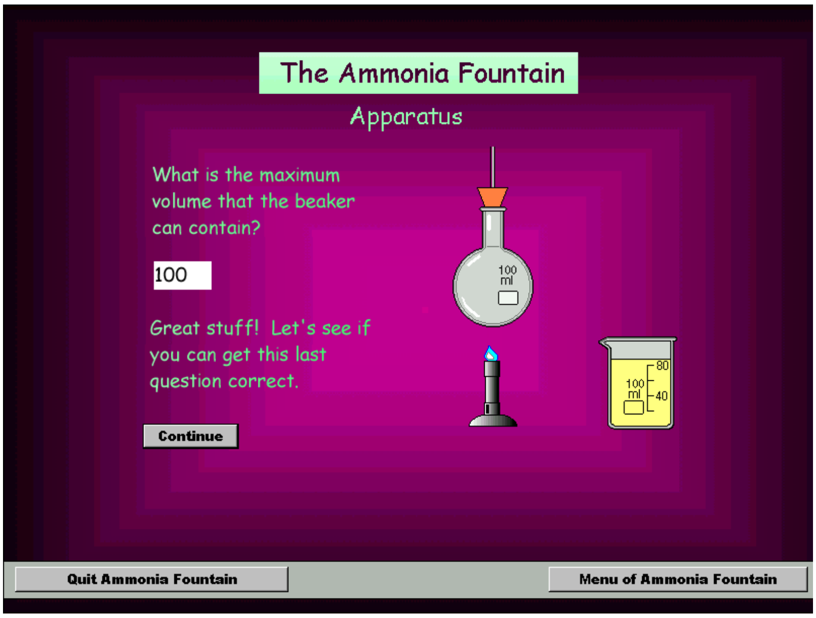

Figure 6 Example of one of the Apparatus screens

7.3 Safety menu

The safety menu includes information about the potential hazards of the experiment. Such hazards include the chemicals catching fire, inhalation of the chemicals, getting chemicals into one's eyes, chemicals making contact with human skin, and chemicals exploding. Each selected hazard opens out into further pages that list symptoms, how to prevent a particular hazard, and what first aid measures to apply once it has happened.

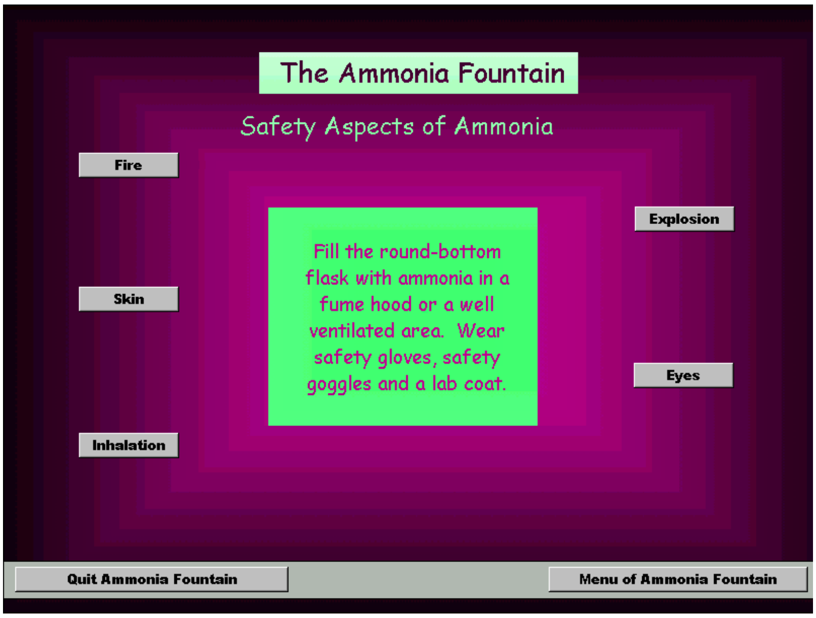

Figure 7 Example of a screen about safety precautions

7.4 Indicators menu

The screen that shows indicators includes the following indicators: Universal Indicator, Bromothymol Blue, Phenolphthalein, Methyl Red, Methylene Blue and Methyl Orange. Each of these indicators is to test both an acid and a base. As the user drops a drop of the indicator into the acid or the base, an animated drop will move towards the solution and the substance will change colour. Figure 7 shows how this happens onscreen.

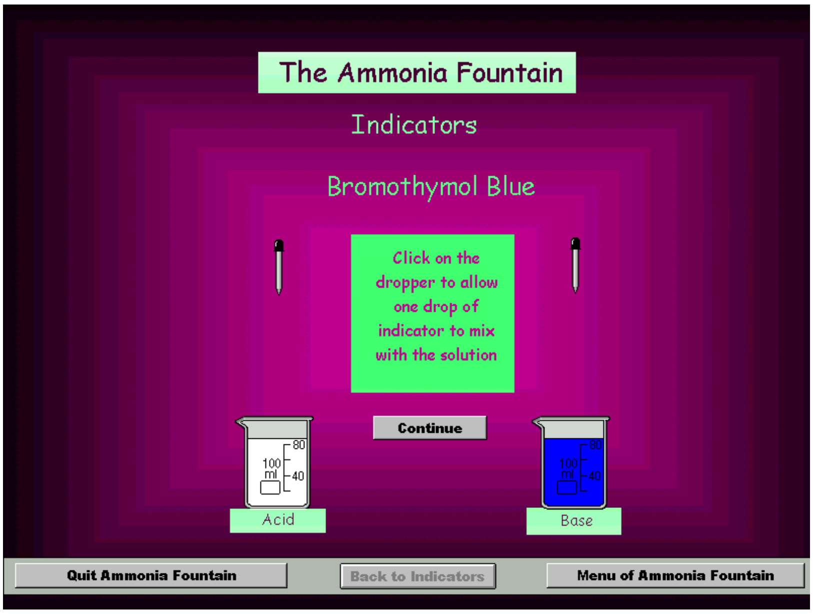

Figure 8 Example of one of the Indicator screens

7.5 Experiment menu

This screen describes the actual experiment, what materials to use and the cleaning-up procedures. Selecting an option from the Materials menu will open a video showing the different kinds of materials and how to use them. The Procedure menu will play a video about the Ammonia Fountain that is accompanied by narration. In my construction of this section, I followed the redundancy principle of Mayer and Mareno (2003), which states that video and narration is better than video, narration and online text together. The Cleaning-up menu explains to the user how to dispose of the by-products of the experiment in a safe way. Figure 8 shows an example of one of the screens from this section.

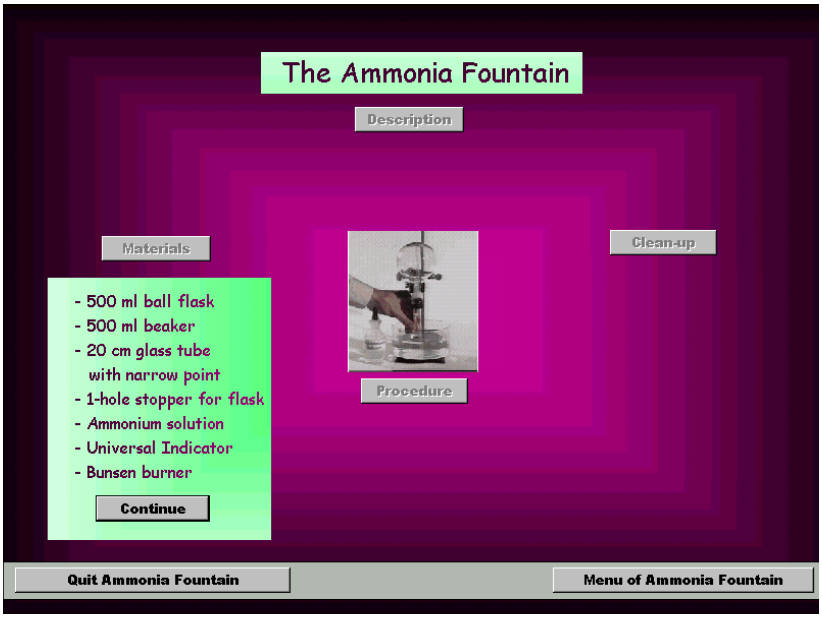

Figure 9 Example of a screen from the Cleanup part of the experiment

7.6 Quiz menu

The Quiz screen opens with a log-on menu. This allows the educator to keep track of each learner's performance. A data file records and saves the test scores every time a learner takes the quiz. When a new learner enters the quiz, the program asks them to sign in. They are then registered automatically.

The quiz takes the form of a multiple-choice questionnaire. While the format of this quiz usually allows learners to move forwards and backwards through the quiz, the version that I opted for in my research limits each learner to only one try. My motivation for doing this was to prevent learners from selecting each option until they found the right answer. The computer immediately offers feedback to the learner about whether the selected option is right or wrong, and, if wrong, what the correct answer is. At the end of the quiz the computer adds up the correct answers and gives the learner a percentage score. While learners can quit the quiz at any point, the computer will retain a score for their names up to the point where they complete the quiz. I did not utilise the scores in the quiz for experimental purposes because the program only permits one to test low-level knowledge by means of multiple-choice quizzes. Instead, I prepared a questionnaire for the learners (see Appendices B and C) which I administered as a pre-test and post-test. The figure below shows an example of one of the Quiz pages.

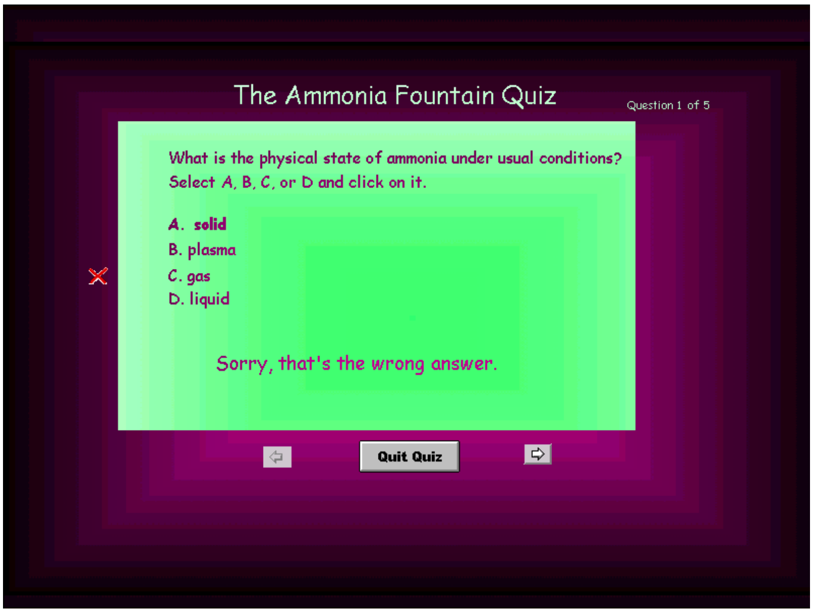

Figure 10 Example of a Quiz page

8. Summary

In this chapter, I have attempted to establish the validity of my research. I have elaborated on the instruments I used and why they were the most appropriate tools for my investigation. I also presented the reader with an overview of the software program. In order to answer my second research question (about whether the software is pedagogically well-designed), I assessed it in accordance with the guidelines presented by Hannafin and Peck (1988). I administered a questionnaire (Appendix F) to report on the four different criteria that Hannafin and Peck (1988) uses to evaluate software. I will report on this in detail in chapter 4.

Chapter 4

Findings

1. Introduction

In this chapter, I present and review the data that I collected by using the research procedures that I discussed in chapter 3.

In order to obtain meaningful answers to the research questions, I used the techniques that I deemed most suitable for collecting particular kinds of data. What follows here is a point-by-point review of some of the most important issues that arose from the experiment in general and the empirical work in particular. Detailed discussion follows later in the chapter.

- In pursuit of my research into good facilitation, I asked the educator to complete a questionnaire about his philosophy of teaching (see Appendix A), and I also observed his teaching methods as he facilitated the computer-integrated lesson. I also used the list in Appendix E that I compiled on the basis of my reading of Berge (1995), MILES (2004), Miller (2003) and Wheeler (2004), and used it as a checklist to measure the educator’s facilitation skills and deficiencies. I will elaborate more on the question of the different roles that he played in part 2 of this chapter.
- In order to assess the educational value of the software that I created for the experiment, I evaluated it by using the guidelines (Appendix F) of Hannafin and Peck (1988). I will report on the instructional, cosmetic, curriculum and programme adequacy of the software that I used in part 3 of this chapter.
- I also kept an event log which I used to find out and reflect upon how the learners reacted to the information that was presented throughout the whole process. I also made a video so that I could confirm and triangulate my findings. I present these findings in part 4 of this chapter.
- In order to find out whether learning had taken place, I also asked the learners to complete two separate tests (Appendix B & C) so that I could assess whether they had obtained the skills from the sequence of experimental events shown in the figure below. (The sequence of the process from the pre-test to the final experiment

is presented in figure 11 below.) In order to be able to claim validity for my findings from these interventions, we prevented the learners from having any kind of contact with any external resources from the beginning of the pre-test to the end of the final experiment. Discussions among the participants during the experiment were also not allowed. I took every precaution to ensure that learning could only take place through working in pairs and interacting with the software.

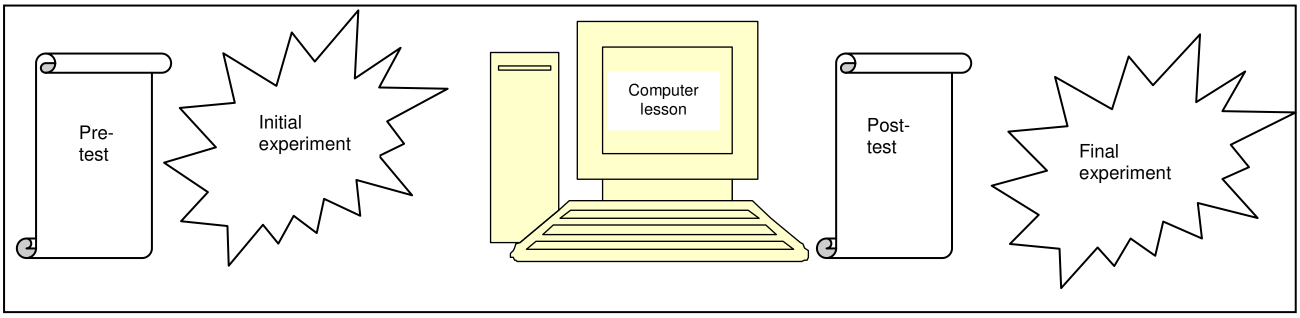

Figure 11 Sequence of events from the beginning of the pre-test to the end of the final experiment

2. What was the role of the facilitator in the computer-integrated learning environment at Gordon High School?

2.1 Pedagogical dimensions of the educator

Before I embark on reporting on the role of the facilitator, I would like to share some empirical knowledge that I deducted from the questionnaire the educator completed. I presented the facilitator with a questionnaire (Appendix A) that I based on Reeves's (1997) pedagogical dimensions in order to identify the educator's personal beliefs about pedagogy. I used the six pedagogical dimensions of Reeves's (1997) that focus on the facilitator to create a profile of the educator who facilitated the classroom component of the research. I asked the educator to complete the questionnaire in March 2005 and then again in October 2005. This particular educator had only begun to teach at the beginning of 2005. One can readily see from the data how the educator's perspective and skills changed between the first administration of the questionnaire in March 2005 (when he only had two months of teaching experience) and the second administration of the questionnaire in October 2005 (when he had nine months of teaching experience). The solid black line in Figure 12 portrays the results obtained in March 2005 whereas the perforated line shows the results of the questionnaire obtained in October 2005.

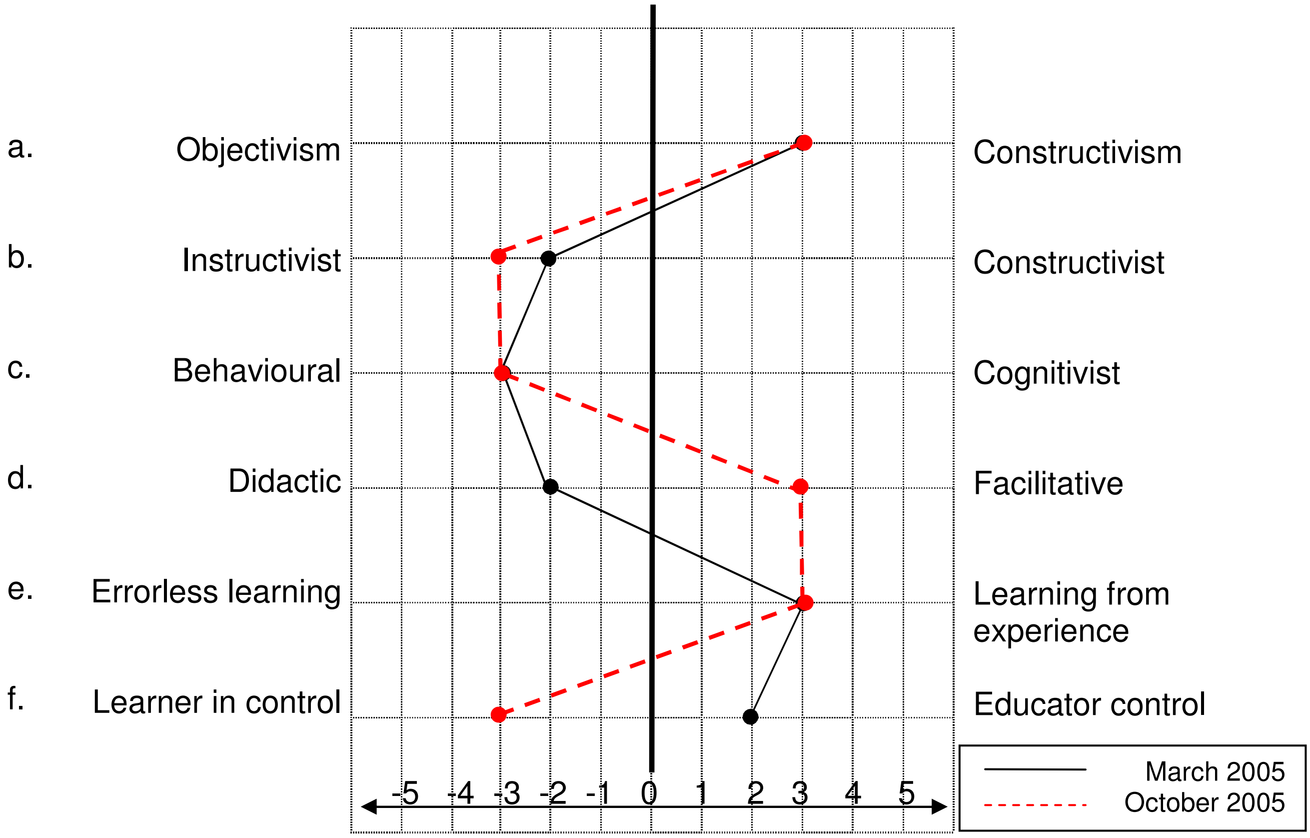

Figure 12 Results of the Reeves questionnaire (Appendix A)

From the educator's responses in (a), one can deduce that the educator is a constructivist. This means that he allowed the learners to explore and learn at their own pace, thereby constructing new knowledge on the basis of their existing knowledge and prior experience. At (b), however, the educator indicates that he teaches by instruction – which is contrary to what one would expect from a constructivist. Instruction generally means that the teacher stands in front of a class, lectures and relays instructions. He furthermore reveals in (c) that he teaches by means of classical behaviourist methods to attain his pedagogical objectives. These methods depend on sequences of stimuli and responses. This kind of behaviourist teaching is characteristic of an instructivist. Point (d) indicates that in the seven months between the first and second administration of the questionnaire, the educator had shifted from being a didactician and instructor to being more of a facilitator. In making such a shift, he moved towards a constructivist pedagogical position. The educator also believes in learning from experience – as is indicated by (e). Learning by means of experience allows learners to make mistakes and learn from their errors. In the beginning of the year the educator believed in himself being in control and giving direction, but in October he indicated that learners should be allowed to browse their way through a program and construct their own learning experiences as deducted from (f).

From Reeves's linear representation one might interpret the educator to be confused about his teaching strategy. The educator indicated that he changes periodically from being a constructivist to being a behaviourist. Reeves's (1997) present constructivism and behaviourism as the two extremes on a continuum, therefore the educator's selection seems contradictory.

However, if one plots this same graph as in figure 12 on the four-quadrant model of Cronje, one obtains a figure similar to the one below.

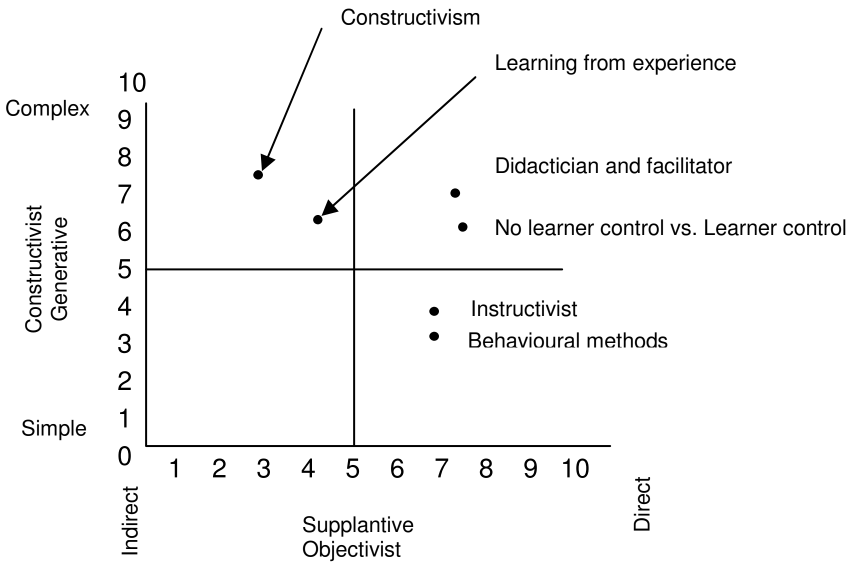

Figure 13 Data plotted on the four quadrants of teaching and learning devised by Cronje (2002)

While this diagram does not portray the data in as much detail as Reeves's scale, it nevertheless gives us a clear indication of how the different pedagogical philosophies are not necessarily exclusive of one another. Teaching can utilise either extreme constructivist or objectivist methods – or a judicious combination of both. When one looks at the educator's profile in terms of the information entered into these quadrants devised by Cronje, it does not show a contradiction as in Reeves's presentation. Cronje's quadrants also show that constructivism and objectivism need not be two opposing learning strategies, but that the two theories can actually compliment each other.

2.3 Observation

The second instrument that I used to investigate the role of the educator was direct observation. I was present when the facilitator presented the lesson and assessed the educator in terms of the guidelines for facilitation from the list that I had compiled on the basis of information from Berge (1995), MILES (2004), Miller (2003) and Wheeler (2004) (see Appendix E). This checklist consists of a lot of actions that a facilitator can be assessed with, but I adapted the checklist in Appendix E to fit the conditions of my research.

2.3.1 Pedagogical role

According to Berge (1995), "pedagogical role" refers to the intellectual task at hand. I observed the facilitator during the lesson and ticked off his actions on the checklist below. A (√) symbol means that the facilitator focused on the characteristic while a (x) indicates that he did not.

Table 5 Checklist on the pedagogical role of the facilitator

Factor	Measure	
Outcomes	The outcomes of the lesson must be clearly stated. Clear instructions with options from which to select. Make sure the learners understand the instructions properly.	X √ √
Activities	Encourage participation and interaction, small group discussion, debates, polling activities, and one-on-one message exchanges. Provide an intellectual atmosphere in which exploration is the norm.	√ √
Style	Avoid being an "authority figure". Rather be a co-learner or collaborator. Don't lecture. Instead use open-ended remarks and examples to get discussion going.	√ √
Being objective	Be neutral. Avoid agreeing or disagreeing with comments. Rather simply take cognisance of them.	√
Expectation	Don't expect too much. This medium and methodology are new to many learners.	√
Communication	Design opportunities for private conversations among two or more learners. Utilise peer interaction and support in the teaching methodology.	√ √
Assignments	Provide readily accessible examples for learners to improve upon.	X
Material/Content	Use relevant material. Develop activities related to learners' experiences.	√
Contributions	Get learners to sign on and contribute to a discussion a certain number of times.	√

During the actual lesson the educator facilitated for 90% of the time. The only time that he lectured was in the beginning when he introduced the lesson and gave instructions. He allowed the learners to make mistakes and he also allowed time for learners to make corrections. Although his profile in figure 12(f) on page 46 showed "educator control" in

March 2005, he nevertheless allowed them to engage with the interactive material in their own way.

The facilitator did not discuss the outcomes of the lesson clearly. He remained neutral with respect to the content. This might have been because the content was not part of his personal field of study – he was a computer literacy facilitator, not a Physical Science educator. The content used in the lesson was highly relevant to the learners because it forms part of the grade 11 learning programme. Because the software had been designed to be as user-friendly as possible, the learners did not ask many questions about the lesson. And since this was tutorial software, the learners were not expected to make any contribution in the form of discussion. The only contributions they made were to sign on for the quiz and interact with the software. Because this was a volunteer group, no external motivation was needed for them to complete the lesson. The educator played a facilitative role and the learners found the software easy to understand and manipulate.

2.3.2 Social role

Berge (1995) recommends a friendly, social environment in which learners can work together towards a common end. The checklist below shows how well or otherwise the facilitator created such an environment.

Table 6 Checklist on the social role of the facilitator

Factor	Measure	
Lurkers	Accept that there will be lurkers. People also learn by just listening. Both lurkers and latecomers must be acknowledged and welcomed.	√
Interactivity	Facilitate interactivity by using dyadic partnering.	√
Behaviour	Reinforce and model good discussant behaviour. Request change privately, in poor discussant behaviour.	√ √
Classroom ecology	Allow learners to select their own seating positions and let them keep their preferred seats for the duration of the project. Arrange the seating of the learners in a compact fashion so that group work can be facilitated.	√ √

Because the participating learners were all from the same class, they had already built up a sense of community. They worked in pairs (with a boy and a girl in each pair) in front of one computer for each pair. The facilitator allowed the learners to make up the pairs themselves as long as both genders were represented in each pair. He also allowed them to select their own seating. The atmosphere in general was very relaxed and the learners were only allowed to consult their partners and not anyone else. Throughout the intervention, the behaviour of the participants was exemplary.

2.3.3 Managerial role of the facilitator

The managerial role of a facilitator comprises organisational and administrative tasks and the overall management of learner interactions (Berge, 1995). The findings in the table below show the extent to which the facilitator was successful in performing the managerial role.

Table 7 Checklist on the managerial role of the facilitator

Informality	Encourage informality might, for example, letting learners know that perfect grammar and typing are less important than making their meaning clear.	X
Synchronise	Ensure that all learners begin at the same time and in an orderly fashion.	√
Time	Structure the working time in the laboratory. Plan time usage to cater for both slow and fast learners. Provide enrichment content to keep fast learners occupied. Break work up in easily manageable chunks and set a time limit for each chunk. (This teaches learners to manage their time efficiently.)	√ √ √

All the learners began at the same time and proceeded to work in an orderly fashion. The facilitator allowed the learners to work at their own tempo. He also allowed them to select their own paths and the order in which they wanted to work through the chapters. When learners completed the lesson, they moved on to the laboratory where they began the post-test. The facilitator managed to keep good control over the learners. This was evidenced by the fact that none of them communicated with one another and by their orderly and disciplined movement between the venues. It was vital for the reliability of the empirical work that no learning should take place other than by means of contact with software and by working in pairs at the same computer. This research was done after school, hence there were no other learners or educators that could influence the learning situation as the pairs moved from the computer class to the Science laboratory that was a short distance away.

2.3.4 Technical role of the facilitator

In terms of Berge's (1995) protocol, the facilitator needs to familiarise learners with the system and software that will be used. The facilitator's success in a technical role is reflected in the checklist in the table below.

Table 8 Checklist on the technical role of the facilitator

Feedback	Provide swift feedback (especially in response to technical problems).	√
Time	Provide sufficient time to learn. Learners need support as they learn how to use new software.	√
Peer learning	Encourage novice users to work with more experienced peers.	X
Direction	Do not give too much direction.	√
Software	Encourage the use of software that is already available in the school so that learners will be able to use applications that are familiar to them.	X

Although Gordon High is a school in a rural area, the computer laboratory was well equipped with all the necessary resources. As the facilitator is a computer technician, no additional technical support was necessary. The facilitator supported the learners wherever they needed support. Although they were not familiar with the new software used for the experiment, they quickly gained confidence because the program itself is very user-friendly. Because the volume of the audio tracks that accompanied the video clips in the software was too low, the learners listening through their headphone speakers were not able to distinguish what was being said. When the facilitator realised that this was happening, he immediately shared his screen with all the learners via the network and played the audio track over his own amplified speakers so every one could hear. It was only at this juncture that he asked them all to work together on the same page in the program. The facilitator was thus extremely confident in his handling and management of the technicalities of the computers and the software.

2.4 Triangulation

In order to triangulate my findings about the role of the facilitator, I kept an event log of significant occurrences and I also made a video made of the whole intervention. The lens of the video camera was set at wide angle so that the actions of all the learners would be captured.

In response to one of the questions in the questionnaire, the facilitator stated that he did not give learners much control over the software. My observations showed that he allowed the learners to explore the software without interruption. They consequently retained full control over the pages they visited and the order in which they visited them. After triangulating the results with the video footage, I came to the conclusion that the learners were allowed to have full control over the software.

3. Was the software used for the lesson pedagogically well designed?

3.1 Evaluation of the software

I used a questionnaire (see Appendix F) that I had devised on the basis of guidelines provided by Hannafin and Peck (1988) as an instrument to evaluate the software. Hannafin and Peck suggest the use of the following four basic categories for evaluation: *instructional adequacy, cosmetic adequacy, programme adequacy* and *curriculum adequacy*. This report contains a summary and condensation of the feedback that I received from the learners. They worked with the programme and completed the questionnaire on the software afterwards.

3.1.1 Instructional adequacy

By *instructional adequacy,* Hannafin and Peck (1988) mean the pedagogical aspect of education. This refers to the guidance that the educator gives the learner to move him from a position of *not knowing* to one of *understanding*. A summary and condensation of the responses to the questionnaire elicited positive feedback from the learners. The learners felt that the program instructions were easy to follow. Other features attesting to *instructional adequacy* are contained in the points below:

- The program gave the learners the freedom to navigate and to explore on their own. The Ammonia Fountain menu page offered learners five different options to navigate: an apparatus page, a page about the necessary safety precautions when performing the Ammonia Fountain experiment, a page about indicators, an experiment page, and a page devoted to the quiz on the Ammonia Fountain experiment.

- Every page required some kind of interaction from the learners.
- The program itself guided the learners through the tutorial.
- The learners could exit the program and reach the main menu from any page. From there they could select any other chapter.
- The learners were allowed to determine their own pace for working through the program.
- Every page fits fully on to one screen and so no scrolling was necessary.
- The software contains video clips that demonstrate to learners how various things need to be done.

I removed the background music from the program because Mayer and Mareno (2003) claim that background music pre-empts the auditory channels of the human brain.

Although the tutorial is generic for all the learners, it became more personalised when a learner signed on for the quiz. The program asked the users to assign to themselves a username and password. From that point on the program addressed the learner in terms of the input that he or she made. The quiz page recorded individual scores and learners could improve their scores by redoing the quiz. All learner attempts were automatically recorded and subsequently written to a batch file. While learners could redo the whole quiz, they could not browse forwards or backwards in the quiz. Once an answer had been given, a learner could not rectify it. Learners who wanted to redo the quiz had to start from the first question again. They could stop at any question and the program would work out their scores. The program provides immediate feedback of the right answers.

There was also negative feedback from the learners. I summarise their negative opinions in the points that follow.

- The outcomes of the lesson were not stated clearly enough for everyone to see.
- Although one can go to the main menu from any given page, there is no Help button.
- The amount of content offered by the program is too little. (There is no extra content that could be referred to as enrichment. The quiz only consists of five questions. Since the quiz is constructed in terms of multiple-choice questions, it will not take learners many repetitions of the quiz to obtain full marks.)
- Not all the answers to the questions in the quiz can be found in the program.

- One learner felt that it would be better if the computer were to store his marks so that when he signed on at some future point, he could continue from where he had left off the previous time.

The learners agreed unanimously that they had enjoyed working through the program and that they found it enjoyable to learn Physical Science content from a computer compared to conventional methods of just listening in class.

3.1.2 Cosmetic Adequacy

Cosmetic adequacy in Hannafin and Peck's protocol refers to the use of colour, sound and motion in the program. Many programmers use special features on the screen to catch the attention of their audiences. This feature is usually the first thing that a user notices.

- The learners judged the screen to be colourful and appealing to the eye. The text was set to contrast highly with the background so that it could be read more easily. The selected font is Arial which is generally regarded as being easily readable. I planned the layout carefully so as to avoid making it seem over-crowded. The program was written to open on a full screen so that it would look enticing. I also used a lot of animation to make the frames look alive.
- All of the learners were instantly familiar with the menus because I used Windows-style menus and retained the familiar MS Word blue and grey colour schemes. The menus are outlined with a small degree of three-dimensional elevation so that they are easy to identify. I used the same outline, colours and menus on all the frames so as to achieve a consistent appearance.
- Although the learners asked for some background music, I removed the background music so that their audio recognition channels would not become too overloaded. This was what Mayer and Moreno (2002) recommend.

3.1.3 Programme Adequacy

Programme adequacy in Hannafin and Peck's protocol refers to how well the program executes. Some programs might run quite well under normal circumstances but break down under certain conditions. One of the best features of the software is that it can run on a 486-computer with only 16 megabytes of RAM. We therefore did not require any special hardware other than what was available to execute the program. What follows below are some points and observations about programme adequacy.

- The learners indicated that the program executed quickly and ran effectively.
- The program gave immediate feedback about wrong answers.
- The learners could not change anything in the program. The program is also teacher-proof. This means that it can only be changed by the author.
- The learners needed to sign on to the quiz by creating a personal username and password. The program wrote a batch file to record the learners' marks. The educator could view the results of the quiz as well as the number of attempts that any particular learner made in order to pass the quiz. The program has an assessment function built into it so that even if the learner quits the quiz before finishing, the program will still calculate a score.
- Users cannot terminate the program by pressing a single key. When a pair of learners indicated that they wanted to end their session, they were presented with a confirmation box that asked them to confirm their decision.
- Some of the learners complained that even though their answers were correct, the computer still returned a mark for an incorrect answer. This defect occurred because the program did not allow answers to be made in different cases or with incorrectly spelled words. This is a feature that needs to be improved in my next version.

3.1.4 Curriculum Adequacy

Curriculum adequacy in Hannafin and Peck's protocol refers to the extent to which lesson procedures, activities and formats are consistent with best accepted standards. It also refers to how easily the lesson could be incorporated into the existing curriculum activities and structures. I asked the Science educator to complete this part of the questionnaire because the learners were unfamiliar with the syllabus. I have summarised the educator's responses in point form below.

- The Ammonia Fountain experiment is part of the grade 11 Physical Science syllabus.
- The information is factual and will not become obsolete so long as the curriculum remains the same.

- This format of the lesson supports the new outcomes-based syllabus that will commence in 2007 for grade 11s.
- This lesson is a necessary precursor for other lessons in inorganic chemistry later on in the syllabus.
- Although the lesson is written for a 45-minute period, it is also suitable for learning over a longer period of time.

Negative observations by the educator included his observation that the program does not allow for different teaching styles and that it cannot be modified by other educators. My response to this would be that the fact that it cannot be modified is a positive feature because some educators might introduce modifications to the software that they may not later be able to rectify.

His overall overview was that the learners enjoyed working with the software – probably because the way in which the Physical Science content was presented to them was both novel and interesting. The learners were not in a position to compare how well the computer program allowed them to do experimental work with how they usually did experimental work in class because their Science educator never allowed them to do any experimental work in class.

4. How did the learners react to the information in the computer environment at Gordon High School?

I used my personal observations as an instrument to answer this question. I also kept an event log with a timeline in which I recorded all the significant actions that occurred during the intervention. In addition to this, I made a video of all the interactions during the experiment. I use this footage to confirm my observations and to triangulate my findings.

The learners who constituted my experimental group were what Miller (2003) would classify as the ‘Children of the Chaos Generation’. The ‘Children of the Chaos Generation’ is defined by Miller (2003) as children influenced by a non-linear culture, probably since the middle 80s. Although they were all born in the late 1980s, I would not be able to classify them as the ‘Net Generation’ because of the poverty and deprivation that prevails in the region and social class from which they come. The ‘Net Generation’ is referred to as children who were born between 1977 and 1997 and have become influenced by intensive Internet usage. Although they are computer literate, they do not have the resources to use the Internet frequently or extensively. Because Miller (2003) categorises interactions with the computer under the headings of *cognitive, affective* and *physical dimensions*, I also made use of these subheadings in my report. This part of the report is presented in the section below.

4.1 Cognitive dimension when interacting with information

Miller (2003:26) defines the *cognitive dimension* as "the recall or recognition of specific facts, procedures and concepts that serve in the development of intellectual abilities and skills as the learners acquire, recall, process and present information".

The facilitator introduced the lesson by guiding the learners through the program. He then showed them how to navigate through the different pages. After his introduction, the learners were allowed to begin to explore the software. The interactive multimedia program stimulated their curiosity and lured them into browsing through the pages so that they could see what would happen next. The dyadic groups were not afraid of making mistakes because they soon found that mistakes could be quickly resolved. The learners therefore browsed through the pages very quickly in order to familiarise themselves with the territory. They only paused when they needed to watch a video or to determine what kind of input was needed from their side. They paid special attention to the video of the Ammonia Fountain experiment. They probably did this because they knew that they would be returning to it.

Learners applied cognition to the questions when they worked through the quiz for the first time. They then repeated the quiz in order to improve their marks. On the second run they remembered what they had corrected during the first run and so they were usually able to answer the questions correctly. They reiterated the quiz in this fashion until they were all able to offer all the correct answers.

4.2 Affective dimension when interacting with information

Miller (2003:26) defines the *affective dimension* as “how the learners deals with their emotions, feelings, values, appreciation, enthusiasm, motivation, attitudes and relationships”.

Those learners who volunteered to participate in the research were all computer literate to varying degrees. The only external motivation they received was food as this research was done after school hours. Intrinsic motivation was provided by the excitement that they felt because they were given the facilities to perform real science experiments on their own. What usually happens in their school is that the educators themselves perform the demonstrations because the school lacks the necessary resources and apparatus.

The atmosphere in the class was very relaxed. None of the learners suffered from computer anxiety and they were all keen to explore the program themselves. The only occasion on which I observed anxiety was when some of the learners started to complete their interactions with the software and move on to the final experiment; some of the remaining learners seemed to become visibly anxious.

The most significant phenomenon that I noticed was that all the girls chose to be Navigators while all the boys chose to be Keyboard Captains (Kluse, 2003). This meant that the boys controlled the mouse. This is in line with the research of Lorri Neilsen (Finding of CAL Research, online), director of teacher development at Mount Saint Vincent University in Halifax, Nova Scotia, who discovered “that girls often feel that if something goes wrong while they are using computer equipment, it is their fault, whereas boys are more likely to blame the machine”. Neilsen’s research also demonstrated empirically in the specific environment of the empirical work that “the girls and women [were] less confident than boys and men about their computer abilities” (Findings of CAL Research, online).

Working with their peers in groups of two created a positive, relaxed and friendly social environment. Healthy competition began to emerge when the pairs got to the quiz. The quiz is an integral part of the software programme and should not be confused with the pre- or post-test that the learners completed. When the learners worked through the interactive program they can decide to test themselves in the quiz. This quiz was explained in chapter 3 on page 42. Because every group wanted to score the highest marks in the quiz, they reiterated the quiz until they obtained full marks. A competitive atmosphere was generated as the pairs raced to be the first to achieve full marks. The program automatically creates a batch file that indicates to the educator who signed on to the quiz, how many times the quiz was redone and what the individual score was for every attempt.

Figure 14 In every case and without prompting, the boys voluntarily took control of the mouse

4.3 Physical dimension when interacting with the information

Miller (2003:26) defines *the physical dimension* as “the learners’ physical movement, coordination, use of motor skill areas, manipulative or motor skills in acquiring, recalling, processing and presenting information”. She also included in the physical dimension “the environment in which they work”.

The learners worked in pairs, with each pair being in front of only one computer. Because the classroom was large, they had ample space for bodily movement. In spite of this, they moved very little as they worked through the program. I observed that most of them sat in the same position for the duration of the session. While they only conversed with their partners next to them, they shared ideas and accepted guidance from one another. They interacted very actively with the program and worked through it at a very fast rate. It seemed to me as an observer as though most of them were only scanning the pages.

As was noted earlier, the boys alone (without any prompting) took control of the computer mouse while the girls selected for themselves the role of navigator, which required them to choose the sequences in which they would explore and work through the program. As soon as the first group had completed their computer session, they moved back to the laboratory to redo their Ammonia Fountain experiment.

5. How much learning took place in the computer-integrated lesson at the school?

I answered this question by making use of the test instruments. I administered a pre-test to the learners in order to assess prior knowledge and a post-test to determine how much they had learned from the computer-integrated lesson. When I measured *learning*, I only looked at the amount of content and skill that was transferred and did not take *attitude* into account at all. I will report firstly on the content (which includes the results of the pre-test and the post-test), and secondly on the extent of the skills that were transferred as a result of the practical work.

5.1 How much content was transferred?

Table 9 tabulates the results of the pre-test and the post-test undertaken by the learners in my research. I have altered the names of the learners for ethical reasons. Seven boys and seven girls participated in pairs and every pair consisted of one boy and one girl. Neither I nor the facilitator gave any guidance about who should do what in any of the groups.

Table 9 Results from the pre-test the and post-test separated according to gender

Boys Results			Girls Results		
Name	**Pre-test/18**	**Post-test/18**	**Name**	**Pre-test/18**	**Post-test/18**
Chano	2	6	Margie	2	6
Elvis	4	11	Mary	1	6
Cain	3	6	Kashiefa	1	10
Rudy	5	5	Kim	4	11
Dennis	2	6	Jean	4	10
Leonard	7	11	Rene	4	13
John	3	8	Mandy	4	10
Total	**26**	**53**	**Total**	**20**	**66**
Average mark	**3.71**	**7.57**	**Average mark**	**2.86**	**9.43**
Percentage	**20.63**	**42.06**	**Percentage**	**15.87**	**52.38**

The table is divided into two groups, boys' results and girls' results. The marks of the pre-test and the post-test are tabulated in columns next to the respective learner. The marks are accumulated; an average mark is calculated and is represented as a percentage in the final row.

In the table below, the results of the boys and the girls are added together; again the average mark is calculated and also represented as a percentage.

Table 10 Results from the pre-test the and post-test when not divided according to gender

	Pre-test/18	Post-test/18
Total mark	46	119
Average mark	3.29	8.5
Percentage	18.25%	47.22%

Initially, the girls did worse than the boys (they got 15.87% and 20.63% respectively). On average, both the boys and girls failed dismally in the pre-test with an aggregate percentage of 18.25%. After the computer-integrated lesson, the girls improved their marks by nearly 37% and the boys improved their marks by approximately 22%. The cumulative improvement was therefore 29%. Together they scored an average of 47.22%, which is a pass. Although this was undoubtedly a major improvement, I could not help but feel somewhat disappointed because I had expected a better result.

The figure below is a graph that shows the differences in the marks of the boys, and of the girls, and of all the learners assessed together without regard to gender difference.

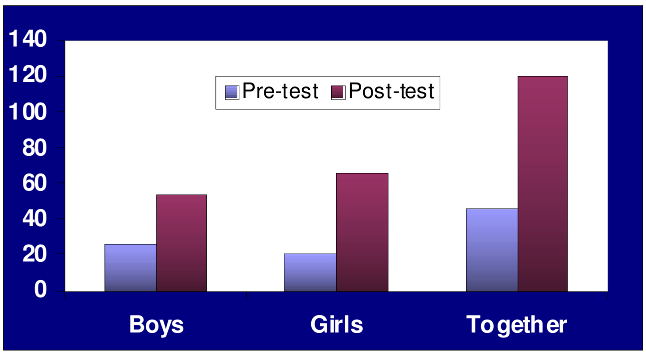

Figure 15 Total marks of the boys, of the girls, and of the learners together (without regard to gender difference)

From figure 15 one can deduce that the boys acquired better marks in the pre-test, but the girls got better results in the post-test. When the marks are added together one can

observe the significant difference in marks from the pre- to the post-test.
Even though the facilitator was not a scientist, he successfully facilitated a grade 11 Physical Science lesson in a computer-enriched learning environment. The average result shows that there was a significant transfer of subject content. This finding confirms that any computer facilitator should be able to facilitate a lesson in any high school subject in a computer-enriched classroom with a certain level of improvement in the transfer of subject content. While this might not be the most ideal situation, it might be the best solution for rural schools in South Africa that lack specialised educators.

With regard to learner interaction, I observed that the learners were more fascinated with the graphics and spent corresponding less time on the text. The learners skimmed through the pages and they were excited and curious to see what would happen when they clicked on the navigational links. When they had completed the quiz that was part of the software program, they all repeated it until they achieved a 100% success rate. The groups also competed with one another to be the first to achieve a totally correct score. Since the groups repeated the quiz without returning to the lesson part of the programme, I deduced that they were learning the correct answers through trial and error. After finishing the quiz which was part of the software program, they went on to complete the post-test and the final practical.

5.2 How much skill was transferred?

The learners were required to perform the experiment of the Ammonia Fountain before they engaged in the computer lesson so that I could measure how much skill was transferred. While the learners experimented in groups of two, only one group at a time performed the experiment. Even after they had read the procedure, the groups were still unsure about what they should do. Because of this I initially thought that the instructions for the experiment might not be sufficiently clear. But then I realised that the learners were very uncertain about how to handle the apparatus they had been given. Because of a lack of practical experience, some of them mixed the wrong chemicals while others added the indicator to the wrong solutions. None of the groups in fact followed the correct procedure. They even contaminated the chemicals by using the wrong extracting procedures. One group of learners tried to heat the ball flask by holding a match under it while the Bunsen burner stood unused on the table alongside them. Only after 14 matches had been expended did they realise that they would not be able to bring the contents of the ball flask to boiling point by using that method. I stood by each group so that I could pay due attention to the possibility of safety hazards because, at that point, they were as yet unfamiliar with the necessary safety precautions.

Figure 16 Learners engaged in the initial experiment

The learners then went on to take part in the computer-integrated lesson. After interacting with the lesson I observed that all the groups were eager and excited to show off the skills that they had learned from the video embedded in the software. At that stage all of them used the correct chemicals and the right indicators. But since they had not yet mastered the procedure for extracting chemicals, various degrees of contamination still took place. Although they had been briefed about what to do, their handling of the apparatus was on the whole still clumsy. But the atmosphere became much more joyful and relaxed after the final experiment had been performed, and the satisfaction of the participants became more than evident after they had completed the experiment for the second time. All of the groups managed to execute the Ammonia Fountain experiment successfully.

Figure 17 Learners performing the final experiment

6. Summary

The educator in my research had at no stage received any formal training in how to teach effectively in a computer-enriched environment. He only started to teach at the beginning of 2005 and his teaching style improved significantly as he learned how to teach learners successfully in a computer-enriched environment. The most significant improvement in his teaching style was detectable in the way in which he became a facilitator rather than a didactician and instructor. While he still had little understanding of the various teaching theories and what they entailed, his improved interactions with the learners enabled them to improve significantly as their transfer of knowledge increased and their skills improved.

He allowed his lesson to become learner-centred by giving them enough time to work by means of trial and error time and to explore the software. While it may be said that the educator was successful in his roles as pedagogue, social facilitator and manager, he was most outstanding in his role as a technician. Because he was familiar with the setup of the system, he knew how to manipulate it when the learners encountered a serious problem with regard, for example, to the sound. One might argue that if other methods had been used, they might well have been more successful. The aim of this research was merely to see whether or not the methods that he used were successful.

My conclusions with regard to the software are that one should rather use existing software for research purposes, especially if the research questions focus on more than just the software. Because I wrote my own software, I could not always address a particular topic adequately because of my inability to execute my intentions in the program itself. While the program was excellent in terms of Curriculum adequacy, some improvements could have been introduced to achieve better Instructional, Cosmetic and Programme adequacy. Having said this, I still believe that the program is of a better quality than most available Science software programs in South Africa and that it addresses the needs of South African learners directly in a context and language that non-mother tongue learners can understand.

With regard to interaction with the software, the learners responded pretty much as Miller (2003) forecasts that they will. It was clear that they were reproducing what Miller called the "Butterfly Defect" (Salomon, 1997, as cited in Miller, 2003:32). While the boys showed more confidence by taking the lead in front of the computer, the girls ultimately did better by obtaining better content knowledge results. A happy and relaxed atmosphere made learning possible and satisfying. There was only transient anxiety as some learners finished and moved on to the following task, thus leaving other learners who had not yet completed their tasks behind. The research had been designed so that learners would immediately move from one activity to the other without a break in between.

The data tabulated in Table 9 confirms that learning took place with respect to content. The results of the pre-test and the post-test confirmed that content learning took place. This proves that the methodology that the educator used had a degree of success with respect to the transfer of content. With regard to the transference of skills, I conclude that the video made the learners more confident in their knowledge of what to do and how to do it, but that it was not successful in transferring the skill of how to handle the apparatus efficiently.

Chapter 5

Conclusion and Recommendations

1. Introduction

The e-Education policy goal for South Africa is that "every South African learner in the general and further education and training bands will be ICT capable (that is, use ICT confidently and creatively to help develop the skills and knowledge they need to achieve personal goals and to be full participants in the global community) by 2013" (Government Gazette, 2004: 17). The government's vision is to enrich the learning environment through the use of ICT by learning about ICTs, learning with ICTs and learning through the use of ICTs (Government Gazette, 2004).

Because e-Education is a new learning programme, very few educators are trained to teach it. Educators have either been given very little or no guidance about the kind of methodology that they should use in computer-based lessons.

Newhouse, Trinidad and Clarkson (2002) come to the conclusion that the facilitator, the learner and the software are the three major role players in a successful computer-learning environment. In order to understand the methodology that is a pre-requisite for a successful computer-learning environment, one first needs to understand each of the major components listed above. This led me to investigate the interactions amongst the learner, the educator and computer software in a computer-learning environment.

I therefore conducted the research intervention in a school in my vicinity with a selected group of grade 11 learners who had chosen Physical Science as a subject for matriculation. On the basis of that intervention I sought answers to the following questions:

- What was the role of the facilitator in the computer-integrated learning environment at Gordon High School?
- Was the software for the lesson pedagogically well designed?
- How did the learners react to the information provided for them in a computer-enriched environment in the school?
- How much learning took place as a result of the computer-integrated lesson at the school?

In this chapter I will revisit the data presented in chapter 4 and will try to provide answers to the research questions that I posed in chapter 1 through an interpretation of the data.

2. Answers to research questions

2.1 What was the role of the facilitator in a computer-integrated learning environment at Gordon High?

I noted in chapter 4 that in a computer enriched environment, the facilitator fulfilled a pedagogical, a social, a managerial and a technical role.

The facilitator's pedagogical role was effectively judged by the checklist I used as assessment. He started off by giving guidance and examples and then he left the learners to explore for themselves. In his role as the social facilitator he managed to create a friendly and relaxed atmosphere in which the learners worked in groups of two (one boy and one girl in each group), and he only allowed learners to converse in their own dyadic groups. In his role as manager, he got them all to begin at the same time; he was also able to maintain a strict discipline with regard to the prescriptions of the research, and he allowed them all to work at their own pace. When the groups completed their computer-integrated lesson, he got them to move through to the laboratory next door where they completed their experiments under my observation. In his technical role, the facilitator was excellent. I mentioned in chapter 1 that although he is not a trained educator, he was hired for the computer laboratory because of his technical abilities and knowledge. He was thus able to set up the computers and run the software, and when a major obstacle emerged (the sound coming through the headphones was inaudible), he was able to remedy the defect by improvising brilliantly and ingeniously to solve the problem.

His approach to the lesson was more like that of a facilitator than that of an instructor. As I noted earlier in this text, the word *facilitator* comes from the Latin root that means "to make things easy". There will always be educators who vary in their skills as facilitators. The aim of this study was to produce definite guidelines about what might constitute good facilitation (as described in chapter 2), and to decide whether or not the facilitator at Gordon High School was successful in his way of teaching as a facilitator during the experiment lesson. I would like to confirm, on the basis of the information tabulated and discussed in chapter 4, that through the educator's facilitation, there was an increase in the marks which shows an increase in content knowledge on the part of the learners.

2.2 Was the software for the lesson pedagogically well designed?

I evaluated the software in chapter 4 by making use of the guidelines provided by Hannafin and Peck (1988) as shown in the questionnaire in Appendix F. After the final experiment the learners evaluated the software by completing a questionnaire (Appendix F) rating the different aspects of the software. While the learners rated the program as outstanding on the basis of indicators of curriculum and cosmetic adequacy, they felt that definite improvements could be made with regard to instructional and program adequacy. Their opinions in this regard are reported in detail in chapter 4.

I was careful not to overload the audio-processing and visual capacities of the learners by including unnecessary extras such as background music in conjunction with narration (Mayer and Moreno, 2003).

Since I myself was the creator of the software, I will be the first to admit that it could have been far better designed. My observations of the learners as they worked also enabled me to realise that there were a few sentences in the program that could have led to learner misconceptions. The quiz could also have had more questions and the content-base could have been much broader. The mere fact that the highest score was 65% indicates to me that there is a lot of room for improvement regarding the software program. The answers to some of the quiz questions were also not evident from the content of program. My very limited knowledge of Macromedia Authorware (I had to learn how to use the program by tutoring myself from the manual) did not enable me to create the kind of program that I envisaged.

2.3 How did the learners interact with the information in the computer environment at the school of investigation?

The learners behaved pretty much as Miller (2003) predicted they would in a similar situation with regard to cognitive perspective. There was clear evidence of the "Butterfly Defect" (Salomon, 1997, as cited in Miller, 2003:32). Some of the learners initially just browsed through the pages and hit on headlines and links without necessarily processing the information into knowledge because they were curious to see where the links would lead. Once they have browsed all the links, they decided what hyperlink to explore first. Even though the outcomes of the tests showed significant improvements, I had hoped for even better results.

With regard to the affective (emotional) dimension, the atmosphere in the class was very relaxed and friendly. The most significant finding was that all the boys without prompting selected to be the Keyboard Captains while the girls all chose to be the Navigators (Kluse, 2003). This supports the research conducted by Nielsen (Findings of CAL, online) who found that the men in her sample were more confident with computers and wanted to be in control.

With regard to the physical dimension, the learners worked quickly through the software. They only focused on selected parts of the lesson and especially on the video of the Ammonia Fountain because they were not successful in executing the experiment the first time around. The learners worked well in groups of two. The participants obtained a sense of security from working in pairs because it meant that they would not have to work alone on a new and unfamiliar program. The group was also small enough for everyone to make personal contributions.

2.4 How much learning took place in the computer-integrated lesson?

In order to measure the level of learning that took place during the computer-integrated lesson, I devised tests and a rubric for measuring the transfer of knowledge and skills. I prepared a pre-test and a post-test (Appendix B and Appendix C) to measure the amount of content that had been transferred, as well as an initial and final experiment with a rubric (Appendix H) to determine the extent of the skills that the learners obtained.

Table 10 in chapter 4 shows the results obtained from measuring the differences between the pre-test and post-test. There was a significant and clear improvement in the scores between the two tests. I nevertheless have to report that I had expected far better results.

Figure 18 Learners writing the pre-test at the beginning of the intervention

It is more difficult to measure the transference of skill because skills are somewhat more intangible. While none of the learners could perform the initial experiment, everyone completed the final experiment with the ammonia fountain actually squirting to the top of the ball flask. The results of the first experiment made it clear to me that these learners had never performed the Ammonia Fountain experiment previously. In the final experiment all of them knew what to do because the video clip inside the computer software had shown them how to do it. They nevertheless struggled to some extent with the handling of the apparatus because they were unfamiliar with handling Physical Science apparatus because of the shortage of such facilities in their own school. In spite of this difficulty, they all managed to complete the second experiment successfully.

I would like to conclude by saying that the learners observation of the video clip which is part of the interactive software gave them sufficient guidance and confidence to perform the experiment well but that the skill to do so without any difficulty whatsoever, will only come by repetition or as a result of continued practical experimentation.

3. Recommendations

If the educator had been trained in the old-fashioned methodology of didactics, he might well have stood in front of the blackboard and simply lectured for the whole of the lesson. Instead, he used the computer as a means for creating a pleasant and mostly constructivist learning atmosphere. It is a sad fact that most trained educators in South Africa do not know how to facilitate a class in a computer-rich classroom environment. My main recommendation would therefore be that extensive practical guidance should be given to educators who need to be computer facilitators on how best to enable teaching and learning in a computer-enhanced educational environment. This is essential as the government has rolled out a three-phase strategy to train educators to integrate ICT in their classrooms. The last phase of this training will start in 2010 whereby educators will be trained to use ICT effectively (Government Gazette, 2004: 41).

Even though the facilitator was a computer technician who had never been trained in formal teaching, he was able to facilitate a computer-assisted Physical Science lesson with great flair. The learners all passed the post-test and were able to perform the Ammonia Fountain experiment successfully. Because of the success of this intervention, my finding is that schools that do not have properly trained Physical Science educators should be able to create the appropriate learning experience for their learners by using this kind of educational software.

The practical component of this intervention showed that the boys grabbed the mouses and that the girls became the Navigators. One therefore needs to follow the recommendation of Kluse (2003) that when learners work in pairs, it is important for female learners to get as much experience as the male learners in being Navigators as well as Keyboard Captains.

Learners should be guided in how to interact with information so that they can turn information into knowledge and avoid the “Butterfly Defect” (Miller, 2003). Learners should spend more time processing *all* the information and should not be selective with regard to information.

When it comes to software, I would strongly advise against researchers writing their own software for their fieldwork. There are other Physical Science software programs that are appropriate to use as part of a lesson. The difficulties I experienced in manipulating the program I used as a writer most probably made a significant contribution to my disappointment at not getting the improvement that I had hoped for with the learners.

As for the inclusion of background music, I would recommend that facilitators be given the choice of whether to mute or include it in the program. I also recommend that learners be allowed to use headphones to listen to background sound so that other learners will not be distracted by asynchronous audio output.

I further recommend that the database of the quiz be made much more extensive – for reasons outlined earlier in this text. I also recommend that a Help button appear on every page so that learners will be in a position to get whatever guidance from the program they need. I would also recommend that methodology in how to facilitate computer integrated lessons be included in textbooks. Without such guidance, teaching in a computer environment might not be optimally successful. I would also recommend making changes to the program so that it does not react adversely to incorrect spellings and case changes in the answers provided by the learners in the quiz.

4. Further Research

A survey of the results of the tests in chapter 4 shows that while the girls results increased from 15,87% to 52,38%, the boys (who scored better in the pre-test with an average of 20,63%) only increased to 42,06%. While the girls thus improved by 36,51%, the boys only improved by 21,43%. I cannot account for the startling differences in these results. These results show that the girls acquired knowledge more efficiently than boys in the same amount of time. This can be an interesting topic for further research. It might also be possible to explain such differences on the grounds that all the girls were Navigators and it was part of their role to advise the boys where to explore next.

But because of the quite startling significance of this difference, I would recommend that similar research be undertaken with a decided emphasis on gender variations. In such research I recommend that all the boys be allowed to act as Navigators and that all the girls be allowed to act as Keyboard Captains – with various considered variations of these roles.

It is my hope that this study will stimulate further interest in the role of the educator in computer-assisted environments in South African school and that more software will be written to address the urgent needs of future South African learners.

5. Limitations

Berge (1995) reports on research that was undertaken over a fairly long period of time, in which the facilitator was assessed on small group activities, in which there were a lot of assignments, and in which a great deal of communication passed between the facilitator and the learners. In this research, the learners were required to make a number of contributions and all their responses were very carefully evaluated. Because my intervention with the learners and the facilitator was very brief, I was not in a position to evaluate the role of the facilitator pedagogically as fully or comprehensively as was necessary to reach more authoritative and transferable conclusions. In the computer-integrated lesson in my research, the learners were not, for example, asked to make any responses or return assignments. They were only asked to interact with the program and with one another in their groups. There were no group discussions other than those between the two partners in each group, and the learners were not asked to produce any assignments. I had to make a firm assessment of the role of the facilitator in one brief encounter with the learners. All these are limitations on the research design that it would be well to remedy for the purpose of similar research.

My research was also limited to the South African grade 11 learners from a predominantly Coloured school in the Boland area of the Western Cape of the Republic of South Africa. My research sample size was also too small to reach statistically significant conclusions. Because of all these limitations, due caution should be exercised in the application of any of my findings, conclusions and recommendations.

6. Conclusion

Newhouse, Trinidad and Clarkson (2002) regard facilitation, software and the learner as the three major role players in the creation of a successful computer-learning environment.

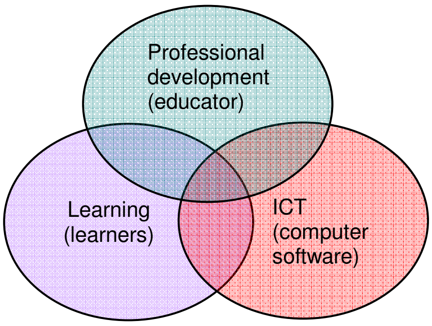

Figure 19 Relationship between educator, learners and computer software (adapted from Newhouse, Trinidad and Clarkson, 2002)

I studied the interaction among these respective role players and posed some critical questions that I felt were worth investigating. It is my belief that my research questions about the role of the facilitator, the software and the learners' interaction have been answered by this dissertation in the context of the particular circumstances represented by the experiment.

I would like to add that although I agree to the three-circle representation of Newhouse et al. (2002), I would suggest that the educator circle should be larger than the other circles as in the figure below.

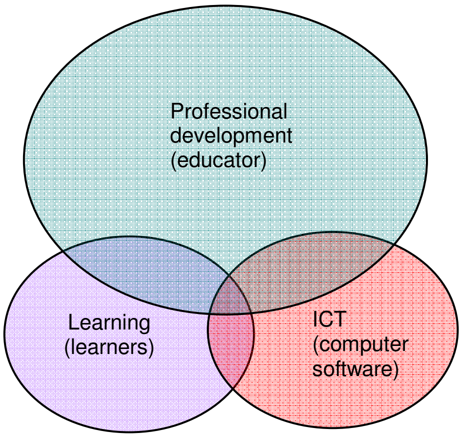

Figure 20 Relationship between educator, learners and computer software

My reason for inflating the educator circle is that, although none of the three entities are omissible, the facilitator is orchestrating the whole process. Educators prepare and plan how to involve the learners and make them the centre of this learning community. They also select suitable software that is relevant and stimulating for the learners to interact with. There will be learners who will not interact successfully and there might be software that lacks some qualities that are needed, yet the learning activity can still be successful. Should the educator, however, fail in his role as a facilitator, it is detrimental for the learning environment as there is only one educator per class in Governmental schools in South Africa. Thus by inflating the educator circle, I want to place emphasis on the importance of the role of the educator in this tri-circle relationship.

I have compiled a guide for educators (see Appendix E) who wish to facilitate a lesson in similar circumstances in a computer-enabled environment. I have also written software for the Ammonia Fountain experiment for grade 11 Physical Science learners that I have allowed the school to use.

While I believe that I adhered to all the necessary ethical precepts throughout the course of this research, other researchers who intend to replicate this research in similar circumstances should take careful note of the limitations that I have noted above.

Appendix A

The following questionnaire is used to get a bit of background information of the educator's approach to teaching, his teaching methods and his philosophy with respect to teaching and learning theories.

The educator needs to circle around the number that represents his perspectives, beliefs and understanding, where '0' is neutral and '5's are the extremes.

Objectivism	5 4 3 2 1 0 1 2 3 4 5	Constructivism
Knowledge exist separate from knowing Humans require knowledge in an objective manner through the senses		Knowledge does not exist outside the minds of human beings Humans construct knowledge subjectively based on prior experiences.

Instructivist	5 4 3 2 1 0 1 2 3 4 5	Constructivist
Instructivists stress the importance of goals and objectives, i.e. teaching by instruction		Constructivists believe in self-directed exploration and discovery learning

Behavioural	5 4 3 2 1 0 1 2 3 4 5	Cognitive
Instruction consists primarily in the shaping of desirable behaviours through the scientific arrangement of stimuli, responses, feedback, reinforcements and other contingencies		Cognitivist psychologists place much more emphasis on internal mental states than on behaviour

Didactic	5 4 3 2 1 0 1 2 3 4 5	Facilitative
A didactic environment has an educator as the provider of knowledge. Most of the lesson entails telling learners what to do		With facilitation the educator is a resource that can be consulted and sometimes the educator becomes the learner

Errorless learning	5 4 3 2 1 0 1 2 3 4 5	Learning from experience
One doesn't need to learn from making mistakes. You can be guided in order not to make errors		Learners learn by making mistakes

Learner control		Educator control
Allowing learners to make decisions on what sections to study and/or what paths to follow through interactive material		Not allowing learners to make decisions on what sections to study and/or what paths to follow through interactive material

Appendix B

Grade 11
The Ammonia Fountain
Pre-test
Time: 10 minutes

Name: ___________
Age: ___________

Gender: _________

a. What is the physical state of NH_3? (3)

_________________, __________________, _________________

b. Name 3 uses of NH_3? (3)

_________________, __________________, _________________

c. What safety precaution must be adhered to when working with NH_3? (4)

_________________, _______________, _________________, _______________

d. What is an indicator? (2)

____

____

e. What indicator am I using when it is clear in an acid and pink in a base? (2)

____

f. What first aid procedure must be followed when ammonia spills on your skin? (2)

____

____

g. Calculate the molecular mass of NH_3 from the information supplied below. (4)

Symbol: N	Symbol: H
Atomic Number: 7	Atomic Number: 1
Atomic Weight: 14.00674	Atomic Weight: 1.00794
Oxidation states: +1, +2, +3, +4, +5, -1, -2, -3	Oxidation states: +1, -1

h) What phenomenon does the ammonia fountain experiment demonstrates? (2)

i) Write down the chemical equation for the ammonia fountain reaction. (4)

j) Describe the cleanup procedure when working with Ammonia. (4)

Total: **[30]**

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Appendix C

Grade 11
The Ammonia Fountain
Post-test
Time: 10 minutes

Name: ___________
Age: ___________

Gender: _________

a. Describe the look and feel of ammonia? (3)
_________________, _________________, _________________

b. What is ammonia used for in the industry? (3)
_________________, _________________, _________________

c. What are the safety measures one should practice when working with NH_3? (4)
_________________, _______________, _________________,
____

d. What is a substance called that changes colour when in an acid or base? (2)
____
____

e. What is the colour-change when Phenolphthalein is added from an acid to a base?(2)
_________________ to _________________

f. What first aid procedure must be followed when excess ammonia spills on your eyes? (2)
____
____

g. Calculate the molecular mass of H_2O from the information supplied below. (4)

Symbol: O	Symbol: H
Atomic Number: 8	Atomic Number: 1
Atomic Weight: 16.00674	Atomic Weight: 1.00794
Oxidation states: -2	Oxidation states: +1, -1

h. Why was the water drawn up into the ball flask? (2)

i. Write down the chemical equation for the reaction of ammonia and water. (4)

j. How does one discard of ammonia? (4)

Total: [30]

Appendix D

Experiment of the ammonia fountain:

Grade 11
The Ammonia Fountain
Time: 10 minutes

Name: ______________
Age: ___________

Gender: _________

Description:

Ammonia reacts with water to form Ammonium Hydroxide. Water is pulled up a glass rod creating a fountain effect.

Materials:

- 500 ml round-bottom flask
- 500 ml beaker
- Glass tube narrowed at one end.
- Stopper for flask with one hole to fit glass tube in
- Bromothymol Blue indicator
- Ammonia solution
- Water
- Bunsen burner

Procedure:

In the fume hood fill the round-bottom flask with ammonia solution. Place the rubber stopper with the glass tube in the flask so that the narrow end is inside the round-bottom flask. Fill the beaker with water and 5 drops of Bromothymol Blue indicator. One might add a drop of acid to the solution to get a yellow colour. Heat up the solution until boiling point. Turn the flask upside down and put the end of the glass tube in the beaker with water. The water will flow up the glass tube and react with the ammonia.

Cleanup:

Dissemble the fountain in the fume hood. Neutralise the solution to a neutral pH and pour down the drain under running water.

Assessment:

Handling of apparatus	**Follow of instructions**	**Safety precautions**	**Verbal Communication**

Appendix E

Checklist for Educator observation

Pedagogical role of the facilitator

Factor	Measure	
Outcomes	Learners must know what the outcomes of the lesson are. Provide clear instructions with options from which to select. Make sure the learners understand and comprehend the instructions.	
Flexibility	Because of the individuality of the learners, courses need to remain flexible.	
Activities	Encourage participation and interaction, small group discussion, debates, polling activities, one-on-one message exchanges. Provide a mental environment where exploration is the norm. Spend a long period teaching learners in a collaborative environment before letting them work alone or at a distance.	
Style	Avoids being the ‘authority figure’; rather be a co-learner or collaborator. Don’t lecture. Instead, use open-ended remarks and examples to get a discussion going.	
Be Objective	Be neutral, avoid agreeing or disagreeing with comments, but take cognisance of it.	
Expectation	Don’t expect too much. This medium and methodology is new to many learners.	
Communication	Design opportunities for private conversations among 2 or more learners. Weave unifying threads of a conversation into a summarization. Facilitator should present conflicting opinions that could lead to debates and peer critiques. Utilise peer interaction and support in the teaching methodology.	
Assignments	Don’t over complicate group assignments; keep it simple. Provide readily accessible examples for learners to improve upon.	
Material/Content	Use relevant material. Develop activities related to learners’ experiences. Ensure learners are able to use applications well before they are required to transmediate information. Discourage the use of ready-made images. They seldom add value to the meaning of information in the context.	
Contributions	Learners should be required to sign on and contribute to a discussion a certain number of times.	
Responses	Prepare learners to comment on topics and give them time to respond, for instance ‘by tomorrow’.	
Motivation	Provide motivation for both academically brighter and weaker learners.	

Social role of the facilitator

Factor	Measure	
Lurkers	Accept that there will be lurkers. People also learn by just listening. Both lurkers and latecomers must be acknowledged and welcomed.	
Introduction	Encourage learners to introduce themselves building a sense of community.	
Interactivity	Facilitate interactivity by using “introductory techniques, dyadic partnering and some assignments that facilitated informal discussion among learners” (Berge 1995:4).	
Behaviour	Reinforce and model good discussant behaviour. Request change privately, in poor discussant behaviour. Have a written code of conduct ‘netiquette’ statement to refer to.	
Classroom ecology	Permit learners to select their own seating positions and keep them for a length of time. Arrange seating of learners in compact areas to convenience group work.	

Managerial role of the facilitator in a computer environment

Informality	The facilitator may decide to encourage informality, e.g., to let learners know that perfect grammar and typing are less important than making their meaning clear.	
Private List	Distribute a list of all learners’ emails to make private discussions possible.	
Synchronise	Ensure that all learners begin in unison and in an orderly fashion.	
Contributions	Control responses from learners. If a learner seems overly out-spoken, ask them privately to wait a few responses before contributing. Similarly, ask less outspoken learners to contribute more actively.	
Student Leaders	Have learners facilitate parts of a class or a discussion. This however is determent by the content, skill and attitude of the learners.	
Time	Structure time in the laboratory for work. Plan time usage to cater for slow and fast learners – enrichment work for fast learners. Break work up in easily manageable chunks and set a limit for each chunk, thus teaches learners to manage time.	

Technical role of the facilitator in a computer environment

Support	Have technical support available in the beginning for educators who are not feeling competent to facilitate a class alone.	
Feedback	Provide swift feedback, especially to technical problems.	
Study guide	Have a workbook that addresses content and technical assistance. This could serve as a basis for discussion; provide introductory information, description of course activities, resources materials and other information about the course components or procedures.	
Time	Provide time to learn. Learners need support as they learn and use new software.	
Peer learning	Encourage novice users to work with more experienced peers.	
Direction	Do not give too much direction.	
Software	Encourage the use of the software available at school so that there are common applications.	

Appendix F

Software Evaluation Questionnaire: Science Alive

5 – Good, 1 - Bad

	5	4	3	2	1	Remarks
Instructional Adequacy						
Are the outcomes of this lesson clearly stated?						
Are the instructions easy to follow?						
Do you understand what you are doing?						
Is there a lot of interaction needed from you to reach the outcomes?						
Does the programme give you examples of how things must be done?						
Is the computer addressing you by name?						
Is the computer guiding you through the steps?						
Is there a Help button or any button of assistance?						
The pupil determines the pace at which the lesson conducted?						
Were you enthusiastic to finish the lesson?						
Could you score any marks?						
Could the computer store your marks to continue at another time?						
Could you stop at any stage of the lesson?						
Is the screen space used effectively?						
Is the screen attractive?						
Did the colour and/or sound disturb you in any way?						
Did you like the effects on the screen?						
Did you have to scroll up or down?						
Was the lesson appealing to you?						
Curriculum Adequacy						
Is the topic relevant to the present syllabus?						
Does the programme enhance knowledge, skill and attitudes?						
Does the lesson contain information that is likely to become outdated?						
Can the lesson be complete within a school's period?						
Has it taken less time than your normal experiment in class?						
Cosmetic Adequacy						
Do you need special hardware to run this programme?						
Could you acquire any skills from using this programme?						
Do you enjoy this way of teaching?						
Was this lesson more fun than your normal chemistry class?						
Can this lesson also be integrated with other subjects at school?						

Programme Adequacy						
Will this programme run on any standard computer?						
Did you have any problems in operating the programme?						
Can you save your work and continue at another stage?						
Can anybody else work on your experiment after you log out?						
Does the system terminate when you press a wrong key?						
Does the programme have an assessment build into it?						
Does it give guidance in case of a wrong answer submitted?						
Can you give more than one right answer to a question?						
Does the programme allow different case answers, spelling errors, etc?						
Does the lesson display information accurately?						

Appendix G

Application letter to school:

1 February Close
Helderzicht
Somerset West
7130
16 September 2006

Mr B. Simons
Principal
Gordon High
Somerset West
7130

Dear Sir

Application for conducting research at Gordon High

I hereby wish to apply for permission to conduct research for my Masters Degree at your school. I also ask permission for the use of your Computer Room for 2 one-hour sessions with a selected group of grade 11 learners.

I do intend to intervene for a maximum of 2 days, but I will be considerate enough not to cause a distraction to your normal daily programme.

Furthermore I request your permission to conduct an interview with your Computer facilitator.

I do thank you for your attention.

Scientifically yours
Mr A. Williams
083 235 2154

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Appendix H

Activity:
Name of Learner: Date of Assessment:

Assessment Criteria	Outcomes	Level 1	Level 2	Level 3	Level 4	Learner's Level
Making observations	PSLO1	Careless, rudimentary and/or incorrect observations made.	Simple observations made but some inferences included in error.	Correct, but only obvious observations made.	Detailed, careful and accurate observations made.	
Weight		1	2	3	4	
Conducting an explorative investigation	PSLO1	No evidence of any investigative steps followed.	Some investigative steps have been followed but the order doesn't make sense.	Basic investigative steps have been followed in a meaningful order.	Clear and ordered steps through the investigation have been followed and evaluated.	
Weight		1	2	3	4	
Choosing apparatus	PSLO1	Inappropriate and incorrect choices made in use of apparatus.	Limited and poor choices made in use of apparatus.	Good choices made in use of apparatus.	Interesting and creative choices made in use of apparatus.	
Weight		1	2	3	4	
Setting up a given experiment	PSLO1	Set-up of apparatus is careless and incorrect. No correct activity is possible.	Set-up of apparatus is flawed and compromises activity.	Apparatus is set up carefully and correctly allowing for activity to take place.	Apparatus is set up with extreme care and precision, allowing for most successful activity.	
Weight		1	2	3	4	
Conducting an experiment	PSLO1	No experiment is conducted.	Experiment is conducted poorly and with limited success.	Experiment is simply conducted.	Experiment is expertly conducted with care and precision.	
Weight		2	4	6	8	

Total

____ 24	____%

Code (encircle the right code)						
0-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-100%
1	2	3	4	5	6	7

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Reference List

Becta. (2001). *Designing software for schools*. Retrieved: November 02, 2004, from http://www.becta.org.uk/page_documents/teaching/summary.pdf.

Berge, Z. L. (1995). *Facilitating computer conferencing: recommendations from the field*. Educational Technology, 35(1), 22-30. Available from http://www.emoderators.com/moderators/teach_online.html

Bevis, E.O. and Watson, J. (1989). *Toward a caring curriculum: A new pedagogy for nursing*. New York: National League for Nursing Pub. No. 15-2278. Available from http://publish.uwo.ca/~maandrus/cmcguide.htm

Cadwell, C. M. (2004). *How to be an effective facilitator*. Retrieved: November 20, 2004, from http://www.flexstudy.com/catalog/index.

Carey, D. M. (1993). *Educator roles and technology integration: moving from educator as director to educator as facilitator*. Computers in schools, 9(2/3), 105-118.

Carlson, A. and Silverman, R. (1986). *Microcomputers and computer-assisted instruction in special classrooms: Do we need the teacher?* Learning Disability Quarterly, Vol. 9, No. 2. Available from http://www.joster.org/stable/1510358

Cohen, L., Manion, L. and Morrison, K. (2000). *Research methods in education – 5th edition*. New York: RoutledgeFalmer.

Cronjé, J. C. (2000). *Paradigms lost: Towards integrating objectivism and constructivism*. ITForum. Available from http://it.coe.uga.edu/itforum/paper48/paper48.htm.

Cronjé, J. C. (2006). *Paradigms Regained – Towards integrating objectivism and constructivism in instructional design and the learning sciences*. Educational Technology Research and Development. Available from https://www.up.ac.za/dspace/bitstream/2263/2247/1/Cronje_Paradigms(2006).pdf

CSAP Training Library. (2001). *Toolbox for collaborative prevention campaign*. Retrieved: November 20, 2004, from http://p2001.health.org/toolbox/fact5t1.htm.

Exploring the environment (ETE). (2004). *The teacher's new role in the ETE classroom.* Retrieved: October 15, 2004, from http://www.cotf.edu/ete/teacher/facrole.html.

Findings of CAL research. (n.d.). Retrieved November 20, 2004 from http://archives/CP/default.htm#TOC.

Forsyth, I. (1996). *Teaching and learning materials and the Internet*. London: Kogan Page. Available at http://www.jstor.org/stable/

Goodson, I. F. and Mangan, J. M. (1995). *Subject Cultures and the Introduction of Classroom Computers.* British Educational Research Journal, Vol. 21, No. 5. Available at http://www.jstor.org/stable/1501742

Government Gazette (2004). *White Paper on e-Education*. No. 26762. Department of Education. Formeset Printers, Cape.

Halpern, S. (n.d.). *Inner peace*. Retrieved: March 15, 2005, Retrieved from http://www.innerpeacemusic.com/music_learning.html.

Hannafin, M. and Peck, K. (1988). *The design, development and evaluation of instructional software*. New York: MacMillan.

Jager, A. K. and Lokman, A. H. (1999). *Impacts of ICT in education: The role of the educator and educator training*. European conference on educational research. Lathi, Finland.

Khanya (2008). *The Khanya technology in education project*. Available at www.khanya.co.za

Kirkpatrick, D. L. (1998). *Evaluating training programs: The four levels***.** Berrett-Koehler Publishers. Retrieved: March 15, 2005, from http://www.questionmark.com/uk/learningcafe.

Kluse, K. (2003). *The Benefits and drawbacks of e-learning*. Retrieved: June 18, 2004, from http://www.e-learningguru.com/articles/art1_3.htm.

Koschmann, T. D., Myers, A. C., Feltovich, P. J. and Barrows, H. S. (1994). Using technology to assist in realizing effective learning and instruction: a principled approach to the use of computers in collaborative learning. The Journal of the Learning Sciences, Vol. 3, No. 3. Available at: http://www.jstor.org/stable/1466821

Mayer, R. E. and Moreno, R. (2002). *Aids to computer-based multimedia learning.* Learning and Instruction. Vol 12. p.107-119.

Mayer, R. E. and Moreno, R. (2003). *Nine ways to reduce cognitive overload in multimedia learning*. Educational psychologist. 38(1). 43-52.

MILES (2004). *Marine institute learning electronics services*. Retrieved: November 20, 2004, from http://www.mi.mun.ca/miles/role.htm.

Miller, P. A. (2003). *The dynamics between the digital environment and the way in which South African Further Education and Training learners acquire, recall, process and present information*. Unpublished Ph.D. thesis. University of Pretoria.

NECC (2002). *School district 54*. Schaumburg. Illinois. Retrieved: October 20, 2004, from http://web54.sd54.k12.il.us/necc2002/roles.htm.

Newhouse, C.P. (2002). *The impact of ICT on learning and teaching.* A literature review: Specialist Educational Services. Perth. Western Australia. Available at: http://ww.jstor.org/

Newhouse, P., Trinidad, S. and Clarkson, B. (2002). *Quality pedagogy and effective learning with information and communications technologies: a review of the literature*. p12. Retrieved: March 13, 2004, from http://www.eddept.wa.edu.au/cmis/eval/downloads/pd/litreview.pdf

Newman, D. (1990). O*pportunities for research on the organizational impact of school computers*. Educational Researcher, Vol. 19, No. 3, (Apr., 1990), pp. 8-13. Published by: American Educational Research Association Stable URL: http://www.jstor.org/stable/1176065

Reeves, T. C. (1997). *Evaluating what really matters in computer-based education*. University of Georgia. Retrieved: March 15, 2004, from http://www.educationau.edu.au/archives/cp/reeves.htm.

RNCS. (2004). *Revised national curriculum statement*. Retrieved: September 10, 2005, from http://wced.wcape.gov.za/home/home.html.

Shepherd, C. (2004). *Training the e-trainer*. Retrieved: October 12, 2004, from http://www.fastrak-consulting.co.uk/tactix/Features/etrainer.htm.

Vrasidas, C. (2000). *Constructivism versus objectivism: Implications for interaction, course design, and evaluation in distance education.* International Journal of Educational Telecommunications, 6(4), 339-362.

Wheeler, S. (2000). *The role of the teacher in the use of ICT*. Retrieved: October 12, 2004, from http://www.fae.plym.ac.uk/tele/roleteach.html.