AN INVESTIGATION INTO THE INTRODUCTION AND USE OF NEW TECHNOLOGIES IN SECONDARY SCIENCE TEACHING

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ABSTRACT

This is a case study of teachers and students in selected secondary schools in the UK. It looks at the way two recently developed technologies, Virtual Learning Environments (VLEs) and Electronic Voting Systems (EVSs) were being used in the teaching and learning of science in selected secondary schools. The study made use of a combination of semi-structured interviews and questionnaires to elicit the views and experiences of teachers and students from their use of the technologies. Qualitative data was analysed using thematic analysis and quantitative data was analysed by the use of Excel. The study revealed that the use of both VLEs and EVSs is relatively new in schools. Both technologies were shown to have potential to enhance students' learning experiences. I found that despite local authority support and strong initial interest from teachers, a project to introduce the use of a VLE into science teaching ultimately failed. The study explores possible reasons for this and suggests changes that may help to avoid similar failures in the future. In particular, the study established the need for staff development and technical support to optimise the use of the new technologies in schools.

TABLE OF CONTENTS

Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS

BECTA.....................British Educational Communication and Technology Agency

BERA...British Educational Research Association

BTEC..UK national vocational qualification

DCSF..Department of Children, Schools and Families

DFE..Department for Education

DFES..Department for Education and Skills

EVS..Electronic Voting System

EVSs...Electronic Voting Systems

GCSE..General Certificate of School Education

H.O.D..Head of Department

HE...Higher Education

ICT..Information Communication Technology

ICTs..Information Communication Technologies

IT...Information Technology

JISC..Joint Information Systems Committee

LA..Local Authority

OFSTED...Office for Standards in Education

SEN..Special Education Needs

UK..United Kingdom

VLE..Virtual Learning Environment

VLEs...Virtual Learning Environments

DEDICATION

To my children, Lisandra, Emmanuel and Ropafadzo, who sustained the lack of attention whilst I was busy with the study; to my wife Violet, your concern was overwhelming and your support was relentless.

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CHAPTER 1: INTRODUCTION

1.0 Introduction

The introduction and use of new technologies has become a significant feature in the education landscape in many countries. In the UK, for instance, promotion of Information and Communication Technologies (ICTs) has been a substantial priority for the Government in line with its expectation that increased use of technology should enhance learning (BECTA, 2005). With Government support, there has been a dramatic increase in the uptake of ICTs in educational institutions including schools, colleges and universities (BECTA, 2008). It is rationalised that, 'ICT enables learning to be tailored to the needs of the pupil. [Pupils] can learn where and when they want to, at a pace and in a style that best suits their needs' (DFES, 2005, p.43). Recent evidence shows that ICT is having a profound impact on teaching and learning. Coffman et al. (2007, p.1) argue that 'education is shifting from directed to constructivist learning, largely aided by the expansion of technology in the classroom'. This view has been further buttressed by Kok (2010) who highlighted that instruction and learning processes are gaining new dimensions due to the proliferation of ICTs. The present study has been conducted to examine the use of Virtual Learning Environments (VLEs) and Electronic Voting Systems (EVSs) in the teaching and assessment of science in the secondary school sector in selected UK schools. In the next section, I will give a brief background and describe the context of my study.

1.1 Background and context of my study

During the month of October in 2008 I started working on a PhD course as a full time student in the school of Education at the University of Sheffield. I was registered as an MPhil/PhD student in Science Education. Although it was clear to me that my interests were in Science Education, during the first days of my study, I struggled to narrow my focus down to one specific thing that I could pursue during the three year study period. Having done a Master's degree in Curriculum Theory I had a strong bias towards issues to do with the improvement of the science curriculum. The big questions were: which aspects of the science curriculum in the UK were in need of a careful scrutiny and to what extent could I be successful dealing with issues of a curriculum unfamiliar to me as an outsider to the system? While I was busy working out what exactly was to become my study topic, my research Supervisor introduced me to the idea of conducting a study in collaboration with one Local Authority (LA). This was to become a big relief to my search for something concrete to work on as I immediately got fascinated with the idea of becoming the principal researcher in the collaborative research project focusing on the use of new technology in science education.

Midshire LA (a pseudonym) was contemplating trying out some innovative projects in some of their schools with a view to improving the teaching and learning of science in line with the aspirations of the National Challenge programme (DCSF, 2008). The National Challenge was an ambitious programme by the Department for Children, Schools and Families (DCSF), under the Labour Government, to ensure that at least 30% of pupils in every maintained secondary school and academy in England achieves at least five higher grade GCSEs including English and Maths by 2011 (DCSF, 2008). This national strategy was meant to encourage schools to learn from each other with a view to enhancing students' learning experience. The School Improvement Services department within Midshire LA embraced the aspirations of the National Challenge programme and sought to engage some of their schools in the County in trying out some innovative projects. The County had a number of schools whose pupils were low attaining at GCSE and the LA sought to raise standards in such schools. They got in touch with our Department to see if any one of the research students would be interested to work with them as a researcher. My supervisor became a very important conduit here linking me up with the LA. I attended a few important meetings where the idea to work with the LA was discussed to see if it matched with my own research interests and to make explicit the nature of the collaboration. Through these meetings I realised that there was great potential for some form of collaborative research work between the LA and myself and, consequently, I agreed to conduct a research study on one of the innovative projects that was to be tried out in four secondary schools in the Midshire County.

The LA identified the project schools as four of the lowest attaining schools in the north of the County. Once they decided the schools of interest they convened a meeting which included science Heads of Departments (HODs) from the schools. LA officials, my supervisor and myself. At the meeting the LA made it clear that they had some money to spend on an innovative project that schools would be willing to try out, aimed at improving the teaching and learning of science. Various ideas were brainstormed until the HODs finally agreed to try out the use of a VLE in the teaching and assessment of science. The four schools were going to identify a single topic, develop learning materials and teach the topic using a VLE. I agreed to study the implementation of this project and to assess the impact of using a VLE on both teachers and learners. The HODs and science teachers were keen to ascertain whether the use of a VLE would contribute to the development of critical thinking skills. My role as a researcher was clearly defined right from these initial stages. Although I was like an insider, being present alongside the teachers and other staff from the LA including the science consultant and IT consultant, my role was to observe but not to steer the development of the VLE.

Having agreed on the project, the next step was the arrangement of a meeting where HODs and science teachers from the participating schools and myself, as a researcher, gathered to deliberate on some fine details regarding the project. During that meeting, the schools agreed on the topic that was to be taught using a VLE and they also divided and distributed tasks for each school to develop the materials for use with the VLE. A teacher from one of the participating schools agreed to break the ice and lead an induction session using a VLE in a lesson. In March 2009, teachers from the other schools attended this session, as did the IT and Science Consultant from the LA. After the lesson, I administered a questionnaire (see appendix 1) to the students to learn about their experiences of first use of the VLE. Students were happy with it and felt that this was a good alternative to the traditional lessons (face to face lessons with the teacher). They enjoyed working independently. We also had a meeting with the teachers and we discussed their views as well as students' views concerning the project. It was unanimously agreed that the project was a viable one and so each school was to proceed to implement it.

As explained above, initially my study focused on the introduction and use of a VLE in the teaching and assessment of science. However, when the Midshire VLE project ran into difficulty (as will be explained in chapter 4), I made some changes resulting in the incorporation of another new technology to my study, that is, the EVSs.

1.2 Problem statement

We live in times where whatever takes place in schools is placed under public scrutiny. Apart from the fact that funding of education is made possible from the taxpayer's money, I believe that generally people are becoming more and more conscious about the importance of education in many societies. The education enterprise and what goes on in schools can no longer be treated as a 'secret garden', hence, issues such as 'accountability' have emerged. This has put enormous pressure on those involved with the provision of education. Issues such as quality of students' performance and whether the school curriculum serves its purposes are echoing from all corners in many educational debates. Attempts to ensure that good quality education is provided have seen a number of innovative projects being tried out in schools, including curriculum reforms. While this is true in many countries, in this case, attention will be paid to the situation obtaining in the schools in the UK with particular reference to science education. Science education remains one of the top priorities in secondary schools in the UK. Over years, the school science curriculum has undergone various changes and different innovative projects have been implemented with a view to improving quality. Currently, a few schools have adopted the use of VLEs and EVSs in the teaching and learning of science. While the use of these new technologies has gained popularity in Higher Education (HE) institutions, their use is still relatively new to the schools sector (BECTA, 2009; Weller, 2007; Caldwell, 2007). From my literature search I found out that most of the academic literature on VLEs and EVSs is from HE. This dearth of information concerning the use of VLEs and EVSs in schools aroused interest in me to embark on this study. I had a keen interest to establish the impact that these innovative technologies have on both students and teachers. I was interested to establish whether students' attitudes[1] towards science and their overall performance in the subject, among other things, could be changed by the use of these new technologies. On the other hand, teachers' perceptions, interpretations and attitudes towards the use of VLEs and EVSs in science education had not yet been sufficiently brought to light. It was, therefore, my cherished hope that this study would help to illuminate these important issues.

1.3 Aim of the study

To develop an understanding of the impact of using new technologies such as VLEs and EVSs in the teaching and assessment of science in schools on both teachers and students.

1.4 Objectives of the study

This study sought to:

- Describe the background to the teachers' decision to select the innovative technologies under study

[1] The term 'attitude' is defined in many different ways in literature; however, I use it in my thesis to refer to perceptions or views. I apply it in this way which I believe teachers use it daily in schools.

- Describe the impact of using new technologies on the teachers' ideas about the teaching and assessment of science
- Evaluate how the innovations were being viewed by the students in the learning of science.
- Identify indicators of the efficacy of the use of VLEs and EVSs in the teaching and assessment of science

1.5 Research questions

To address the above aim and objectives the following research questions were formulated:

1. What are the circumstances which led to the adoption of the innovative technologies by the participating teachers?
2. Can the innovations help to change teacher ideas about the teaching and assessment of science?
3. What are the students' perceptions of the value of using the innovative technologies in the teaching and assessment of science?
4. Are there observable indications that the use of the new technologies in the teaching and assessment of science helps to improve student's academic performance/achievement or views about science?

1.6 Significance of the study

Both VLEs and EVSs are rapidly growing technologies in schools and colleges within the UK and in some other countries. I felt that the findings from my study would be valuable at this time. The study focused on an area that has not yet been sufficiently addressed; hence, the findings are likely to be useful to different stakeholders in education including educational policy-makers, educational planners, teachers, students and parents. While it can be said that technology itself is neutral, the purposeful use of technology always occurs in some historical-structural context with human agency and cultural significance (Hansen, 1981). According to Papagiannis et al. (1987, p.13-14) this requires that: ‘we examine the technology not only in terms of its promise and intended purpose but also in terms of its actual implementation and consequences and its actual uses and their side effects and outcomes, in its social, political, economic and cultural context...’. It was my hope that the study would bring to light the benefits of using the VLEs and EVSs in the teaching and assessment of science and that this feedback would provide the basis for policy formulation and/or possible improvement in the way the new technologies are used to enhance student learning experiences and teachers’ pedagogical practice. It is vitally important to provide evidence to substantiate the use of these new technologies. Solomonides & Levidow (1986) argue that while in the public mind ICT appears to be a solution to many of our current problems there is a growing number of critics who have begun to question the all too simple acceptance of ICT as a solution to all the problems with which the world is faced today. I think that such critics will be informed by research findings and this makes a study such as mine valuable. While there is much expectation surrounding the potential impact of educational technologies on teaching and learning, it must be appreciated that the history of technology in education is a history of unfulfilled expectations and false promises (Cuban, 1986). It is not enough to provide access to hardware and software (Cuban, 2001).

1.7 Organisation of the thesis

The thesis consists of six chapters as explained below:

Chapter 1: Introduction

In this chapter, I explain the background and describe the context of my study, making explicit how I started working on the project, the project aim, objectives, research questions and the significance of the study. I also highlight where I came from as a researcher, that is, my positionality, focusing on how I chose my study area and my research topic.

Chapter 2: Literature review

This chapter introduces the theoretical framework of my research as well as the body of knowledge within which my research is located and aims to make a contribution.

Chapter 3: Research Methodology, Procedures and Ethical concerns

This is where I describe, analyse and justify the approaches used to address my research questions including the specific techniques used to generate the research data. The chapter also includes a thorough discussion of the proceedings of the fieldwork, that is, the designing, piloting and use of the research instruments. An account of the ethical principles underpinning the study is included in this chapter.

Chapter 4: Data Presentation and Analysis

Data generated from the participants from the schools involved in the study is presented in a clear and concise manner to enable transparent interpretation and analysis. Two data sets are evident; one set of data focuses on VLEs and the other set focuses on EVSs.

Chapter 5: Discussion of Findings

The themes that emerged from the study are discussed in this chapter. The discussions are developed with reference to research data and the literature. Findings from the use of VLEs and EVSs are discussed under common themes.

Chapter 6: Conclusions and Implications

This chapter summarises some important conclusions drawn from my research findings, with discussion on their educational implications. Opportunities for future research are outlined in this chapter.

1.8 Positionality

Making one's positionality explicit is a commonly agreed ethical practice in social science research. In this section I will define this concept and proceed to highlight my positionality with regards to the research that I am working on. Sikes (2004, p. 18) offers a simplified definition of positionality when she says positionality reveals your stance as a researcher, that is, where you are coming from 'in terms of [your] philosophical position and [your] fundamental assumptions concerning social reality, the nature of knowledge and human nature and agency'. Several factors including one's gender, class, political allegiance, sexuality, historical and geographical location colour the nature of these assumptions. The same view is held by Scheurich (1997) who in addition to identifying the above factors stresses that all of these interact and influence, limit and constrain productions of knowledge. Haraway (1998) cited in Jones (2006, p. 185) posits that: 'unlocated knowledge is irresponsible knowledge'. On a similar note, Wellington et al. (2005, p.99) say that: '…the methodology and methods selected will be influenced by a variety of factors, including the personal predilections, interests and disciplinary background of the researcher…' Bearing this mind, I will explain briefly 'where I am coming from as a researcher' (Sikes, 2004). In the words of Winter (2000, p.129), I believe that as a researcher in the social sciences, my own values 'are inevitably embedded within the research and play a significant role in shaping it'.

It is my submission that my educational and professional background, as well as other factors like the economic and political climate, has played a significant role in defining my position as a researcher in science education. My country, Zimbabwe, became politically independent in 1980. This ushered in a new era in the country's education system and other sectors. The new government put in place new policies in education in line with the newly espoused political ideology, socialism. In line with the socialist tenets science education was emphasised in the school curriculum for it was believed that it constituted a fundamental base for the country's development agenda. A high premium was placed behind the teaching and learning of sciences and there were better opportunities on the job market for science graduates. As a result of this I developed a lot of interest and enthusiasm in learning science at school level. After my GCSE I opted to pursue sciences at 'A' level which saw me studying mathematics, biology and chemistry. Although I enjoyed all the three subjects I had greater interest in biology. Upon completion of my 'A' levels I got a scholarship from the Zimbabwean government to train in Cuba as a science teacher. My country enjoyed good socio-economic and political relations with Cuba as both countries were socialist. Cuba offered to help my country with the training of science teachers who were in short supply at that time. I also believe that the government sought to transmit socialist values and principles through education and we were meant to be important agents for the desired change. While in Cuba, I managed to do different research projects in the teaching of biology. I had the opportunity to attend seminars where I presented my research findings and this did not only help to enhance my research skills but also triggered a lot of interest in research in science education. Upon completion of my training I went back to Zimbabwe and started working as a science/biology teacher in secondary schools. While working as a teacher I realised that although science enjoyed high status on the school curriculum, the pass rates in public examinations were very low. Most of the schools especially those in the rural areas did not have facilities and equipment for the proper teaching and learning of science. Possibly this explains in part why most of the students found it difficult to achieve good results in public examinations. The situation was, however, the same even in the urban schools where facilities were much better: science continued to be among those subjects registering very low pass rates in public examinations. This stimulated a lot of interest in me to find out ways of improving the teaching and learning of sciences. Unfortunately, I could not get the support to carry out any research until I decided to do my self funded postgraduate studies at one local University, the University of Zimbabwe. I feel that there is a lot of work that needs to be done to improve the teaching, learning and assessment of science in my country. The harsh economic and political climate obtaining in my country has seen a lot of academics including myself in the Diaspora. Fortunately, issues related with the improvement of science education are also high on the agenda in the UK and this has made it possible for me to continue with my research work. While I do my research in the UK schools, I realise that I am an outsider to the education system and may not be able to interpret everything that goes on in the school easily. English is my second language and it is possible that due to cultural differences my interpretation of events and activities during the research process may be heavily influenced by my background.

My previous research work involved the use of qualitative and quantitative methods. I subscribe to the idea of adopting anything that works to give a solution to the problem at hand. In this regard I view myself as a pragmatist. On the other hand, although I am a Christian my religious allegiance does not impact on my ontological assumptions in the same way it does to other people I would consider to be extremists. I believe in the existence of God who has given people the capacity to think on their own and create institutions and participate actively in knowledge production. With this in mind I consider the social world to be socially constructed and subjectively experienced. There are, however, issues where objective consensus is applicable like lots of science which makes it necessary to use quantitative methods of enquiry. I feel that in a given research endeavour, sometimes it is useful to use a combination of qualitative and quantitative methods. Concerning my epistemological assumptions, I would argue that knowledge is experiential and hence it is important to raise questions to the people involved in the study. Looking at this, I consider myself to be aligned with the constructivist perspective and this will constitute the theoretical framework underpinning my study, as shall be explained later in chapter 3.

The next chapter focuses on literature review.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature related to the topics under consideration in my study. This was conducted in consonance with Hart's (1998, p.1) apt observation that a review of the literature is important because: 'without it you will not acquire an understanding of your topic, of what has already been done on it, how it has been researched, and what the key issues are'. For my literature review I have had to look at the following areas which were all relevant to my study:

- Use of ICT in teaching and learning
- Factors influencing the uptake and implementation of innovative technologies in education
- Use of Virtual Learning Environments (VLEs) and Electronic Voting systems (EVSs) in education contexts
- Assessment and feedback in science education

2.2 Use of ICT in teaching and learning

The use of ICT resources by teachers has continued to grow in schools and FE colleges in the UK (BECTA, 2007). According to BECTA (ibid.) over 40% of teachers indicated that they were using subject specific software regularly in lessons, up from 10% in 2002. Schools continue to make huge investments in ICT hoping to realise the potential that technology has in terms of enhancing and enriching student learning experience. In a survey conducted by OFSTED in maintained primary and secondary schools in England, it was noted that: 'using ICT was contributing positively to the personal development and future economic well-being of pupils and students. It developed their skills of working independently and cooperatively and was in most cases motivating and engaging' (OFSTED, 2009, p.6). The modern society is described as an 'information age' and this presents a challenge to schools whose '...products are expected to be well equipped to withstand the challenges in society and be able to solve problems inherent in these societies' (Barron et al., 2002, p.2). Use of ICT can be viewed as being in tandem with the developments in modern society; as posited by Bingimlas (2009, p. 235), 'the use of ICT in the classroom is very important for providing opportunities for students to learn to operate in an information age'. In my view, education should be responsive to societal needs for it to be experienced as relevant. This view is further energised by Yelland (2001) who argues that traditional educational environments do not seem to be suitable for preparing learners to function or be productive in the workplaces of today's society. She claims that organisations that do not incorporate the use of new technologies in schools cannot seriously claim to prepare their students for life in the 21st Century. This view is buttressed by Grimus (2000, p.362) who argues that, 'by teaching ICT skills in primary schools the pupils are prepared to face future developments based on proper understanding'. Although in this case reference is being made to the use of ICT in primary schools, the same can be equally true for the secondary schools, which are my area of interest in this particular study. It is my submission that students should be capable and productive users of new technologies who understand the impact of these technologies on society if its use is to be at all sustainable.

Use of ICT has got several benefits in teaching and learning processes. Jonassen et al. (1999) presented a dynamic perspective on the role of technology in learning. The maximum benefits of technology derive when it energises and facilitates thinking and knowledge construction. In this reconceptualisation, technology can serve the functions shown in table 1 below:

TABLE 1: FUNCTIONS OF TECHNOLOGY

- **Tool to support knowledge construction**
- **Information vehicle for exploring knowledge to support learning by constructing**
- **Context to support learning by doing**
- **Social medium to support learning by conversing**
- **Intellectual partner to support learning by reflecting**

Source: Jonassen et al. (1999)

Schunk (2009, p.311) contends that:

> It seems clear that technology has the potential to facilitate instruction in ways that formerly were unimaginable. For example, not long ago technological classroom applications were limited to movies, televisions, slide projectors, radios, and the like. Today, students can experience simulations of environments and events that they never could in regular classes, receive instruction from and communicate with others at long distances, and interact with large knowledge bases and expert tutoring system

According to Bransford et al. (2000) several studies have reviewed the literature on ICT and learning and have concluded that it has great potential to enhance achievement and teacher learning. It is interesting to note that technology has benefits for both students and teachers. In my study I will be exploring the experiences of both teachers and students regarding their use of new technologies in science classrooms. Wong et al. (2006) reinforce the view held by Bransford et al. (2000) arguing that use of ICT can play an important part in supporting face-to-face teaching and learning in the classroom. In my view, use of ICT has benefits that go beyond enhancement of face-to-face teaching and learning. Use of virtual learning platforms, which constitutes one of the areas of focus in my study, suggests that ICT can be useful in actually reducing the amount of direct instruction given to students yet encouraging them to develop relevant life skills. This view is captured in studies carried out by many researchers who assert that the use of computers can help students to become knowledgeable, reduce the amount of direct instruction given to them and give teachers an opportunity to help those students with particular needs (Idling et al., 2002; Shamatha, et al., 2004 and Romeo, 2006). I will discuss the role played by virtual learning platforms in more detail later on in this chapter.

One of the potential benefits of using ICT in education is that it expands the pedagogical resources available to teachers (Al-Alwani, 2005). Skinner & Preece (2003) consider that the new ICT have other potential benefits as tools for enhancing science teaching and learning in schools. Osborne & Hennessy (2003) highlight the different tools that can be used, which include tools for data capture, multimedia software for simulation, publishing and presentation tools, digital recording equipment, computer projection technology and computer-controlled microscopes. To this list can be added the more recent development and use of voting technology in UK schools, colleges and universities. I explored the experiences of teachers and students using the voting technologies in my study.

Recent reviews of ICT in science education state that ICT use: 'can make science more interesting, authentic and relevant, allow more time for observation, discussion and analysis, and increase opportunities for communication and collaboration' (BECTA, 2003, p. 1). Osborne & Hennessy (2003) describe the benefits of using ICT in the science classroom. Benefits include the development of students' critical thinking skills, ease of data collection and manipulation, increased access to information in a visual format, and enhanced motivation and engagement. There is even some evidence that using ICT will reduce teacher workloads (Selwood & Pilkington, 2005). On the other hand, Cox & Webb (2004) argue that the range of ICT types used and the overall use of ICT in secondary school science is limited. Their review of ICT uses in science classrooms found that use focused on the internet, email, word processing, simulations, and data logging. Reasons for the poor uptake of ICT in schools included school-related factors such as lack of access to computers and technical support, and teacher-related factors such as low levels of confidence and ICT skills, concerns about the role of teachers, resistance to change, lack of time to prepare resources, and lack of awareness of pedagogical issues (BECTA, 2004). Veen (1993) found that teacher-related factors, especially beliefs about science teaching, were more significant than school factors. Osborne and Hennessy (2003) identified similar constraints and also found that students' lack of ICT skills impeded ICT use by teachers. In my view, students are quite conversant with ICT skills, as argued by Prensky (2001) who considers students to be the 'digital natives' while teachers are the 'digital immigrants'. Coffman et al. (2007, p.1) assert that '[D]igital natives are students who have had frequent and consistent exposure to technology throughout their lives'. Jones (2002) contend that the digital native has the ability to multitask, can watch television, instant message friends, research on internet, and play computer games all simultaneously while talking on a cell phone about the day's events. If teachers are to be considered as 'digital immigrants', this underscores the need for staff development prior to the adoption of innovative technologies if these are to be used successfully. Coffman et al. (2007, p.1) advise that : 'instead of feeling threatened by the knowledge students bring to the classroom, teachers must learn to embrace students' skills with technology and implement students' strengths into the classroom environment'. Education is shifting from directed to constructivist learning, largely aided by the expansion of technology in the classroom (ibid.). I agree with Mackenzie (1988, p.17) who stated that, 'a good teacher knows when to act as a "Sage on the Stage" and when to act as a "Guide on the Side".

Although not confined to science teaching, a recent review of the use of ICT in teaching highlighted several key factors (World Bank, 2005). These factors are: preplanning is essential to enable effective ICT use; the availability of technology alone does not change teacher pedagogy or use of ICT; and technical expertise alone by the teacher is insufficient to increase ICT use. They found that when teachers do use ICT, it is predominantly for administrative tasks such as word processing for lesson planning, maintaining student records, producing worksheets, and internet research by the teacher. Teacher confidence and access to reliable and up-to-date ICT hardware and software

are important enabling factors. Research studies reveal that a very significant determinant of teachers' levels of engagement in ICT is their level of confidence in using the technology. Teachers who have little or no confidence in using computers in their work will try to avoid them altogether (Larner & Timberlake, 1995; Russell & Bradley, 1997). Finally, the availability of ongoing professional development is essential as it motivates teachers and raises awareness of new resources and pedagogy. There is a close relationship between levels of confidence and many issues which themselves can be considered as barriers to ICT. For example, levels of confidence and therefore levels of ICT use are directly affected by the amount of personal access to ICT that a teacher has (Ross et al., 1999; Cox et al., 1999; Guha, 2000), the amount of technical support available (Cuban, 1999; Russell & Bradley, 1997), and the amount and quality of staff development available (Pina and Harris, 1993; Lee, 1997). The availability of suitable teacher preparation and professional development is particularly important. Osborne and Hennessy (2003) established that merely providing computers and software in schools is insufficient. They emphasised that the role of the teacher is crucial. Understandably, science teachers need support to integrate ICT through sustained professional development. The most appropriate form of professional development seems to be that which is targeted and specific for the needs of the teachers and occurs in technology-rich schools (Ainley et al., 2002; Granger et al., 2002). In USA, Cuban (2001) found out that resistance to change is a factor which prevents the full integration of ICT in the classroom. This resistance can be seen in terms of teachers' unwillingness to change their teaching practices, and also in terms of schools as institutions finding it difficult or being unable to reorganise in ways which facilitate innovative practices involving ICT. Teachers are sometimes unable to make full use of technology because they lack the time needed to fully prepare and research materials for lessons. Time is needed for teachers to become familiar with hardware and software (Fabry & Higgs, 1997).

In another study to assess the impact of ICT in science classrooms it was established that computer assisted instruction led to improvement in student achievement, and improvement in student achievement in science significantly influenced students' attitudes toward science, future course selections, and career aspirations related to science (Park et al., 2009). It will be interesting to find out through this study how the use of VLEs and EVSs will impact on students' achievement and attitudes towards science. My study offers an opportunity to look at how some new technologies are being used in science classrooms and will elicit the views of teachers and students participating in using the new technologies. The next section focuses on the review of literature on technology adoption and implementation.

2.3 Technology adoption and implementation

I conducted a literature review to support or otherwise my assumptions of factors influencing the uptake and implementation of innovative technologies. According to Weller (2007) the seminal work in the adoption of technology is Rogers' (1962) 'Diffusion of Innovations'. In it he describes the innovation-decision process, the attributes of the innovation and the adopter categories, which I found to be very useful in the analysis of the two innovative technologies in my study, particularly the VLE. Rogers' innovation-decision process provides a basic model for change. It consists of steps that typically occur in sequential order. The innovation-decision process is defined as: 'the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision' (Rogers, 1983, p.163).

Along with a process for adoption, Rogers provides a theory of how the innovation itself can affect this process. He identified five attributes of innovations that influence the decision to adopt an innovation. These attributes are relative advantage, compatibility, complexity, trialability and observability (Rogers, 1983). In addition to the attributes of the innovation, the traits of an individual or group can also influence the rate of the adoption. Rogers identified five adopter categories namely innovators; early adopters; early majority; late majority; and laggards, and these groups have different social and psychological characteristics. Research shows that the adopter categories approximate a bell shaped curve within a social system (Rogers, 1983) as shown in Figure 1 below:

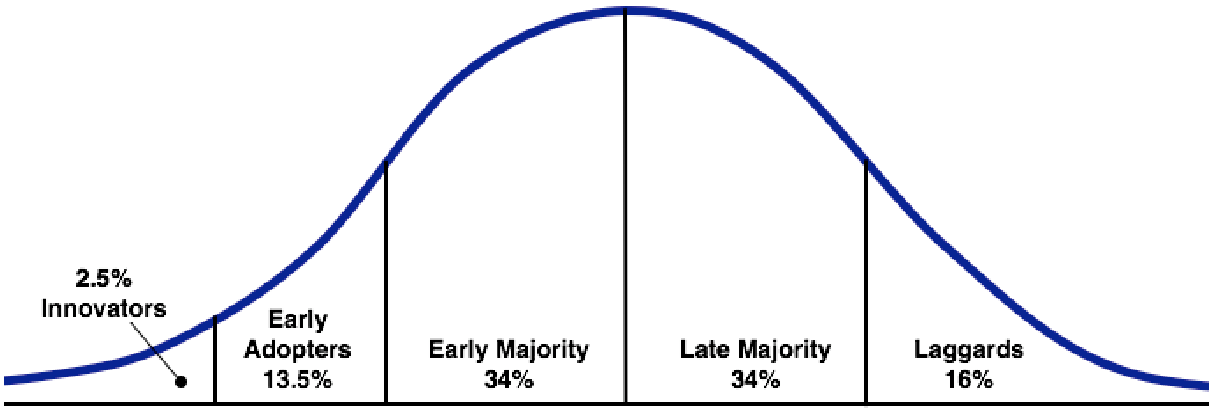


Figure 1: Rogers' bell shaped curve of innovation diffusion. Adapted from: Rogers (1983, p.247)

The innovators are the first individuals to adopt an innovation followed by the early adopters. The early majority are those who adopt the innovation after a varying degree of time. The late majority are those who adopt an innovation after the average member of the society. Individuals in this category approach an innovation with scepticism. The laggards are the last to adopt an innovation and such individuals tend to be advanced in age. Rogers' theory has been adapted and modified by many others but it remains a convenient model for both predicting and analysing the adoption of any innovation, particularly technologically ones (Weller, 2007).

Focus of change research has traditionally been on adoption; however, much of the recent research in this area has been related to implementation (Surry & Ely, 2001). Adoption refers to the initial decision to begin using an innovation while on the other hand, 'implementation is the process of introducing an innovation into an organisation and fostering its use' (Ensminger et al., 2004, p.62). Researchers have looked at the variables that influence the success or failure of implementing an innovation within an organisation such as a school, college or University. In my study, I focused mainly on the implementation phase of the two innovative technologies (VLEs and EVSs) being used in schools. Dhanarajan (2001) found that the lack of existing infrastructure, lack of commitment from the change agents, low level of skills and the need to provide staff development to intended users influenced implementation. Herson et al. (2000) listed knowledge and skills of users, involvement of the intended users in the development of the product, and a perceived need to change old methods as factors that influenced implementation. Ebersole & Vornddam (2003) list numerous variables affecting implementation including insufficient time, insufficient resources, lack of leadership, and lack of skills and knowledge. Rogers (2000) identified issues related to user involvement in design, insufficient time for learning or developing instruction and inadequate resources. Ely is a widely cited author in the area of implementation of instructional innovations. Ely (1999; 1990) lists eight conditions that facilitate implementation of an innovation and I am going to discuss these in the following paragraphs. The eight conditions developed by Ely are:

1. Dissatisfaction with the status quo: refers to an emotional discomfort resulting from the use of current processes or technologies that are perceived as inefficient, ineffective or not competitive. This affective state is either self-induced or results from organisational awareness or leadership campaigning for the need to change (Ely, 1999, 1990; Surry & Ely, 2001). This condition is similar to relative advantage (Rogers, 1983). The change agent needs to understand the cause of the dissatisfaction in order to communicate the innovation to the adopters in a more effective way. Arguably, understanding sources and the levels of dissatisfaction can help the change agent to position the innovation to be more compatible with their felt needs.

2. Knowledge and skills: refers to users possessing and or acquiring the needed skills and knowledge to employ the innovation. Staff development may be a necessary part of the implementation plan (Ely, 1999; 1990). The

people who will ultimately implement any innovation must possess sufficient knowledge and skills to do the job.

3. Availability of resources: refers to availability and accessibility of resources needed to implement the innovation. These include finances, hardware, software, materials, personnel and technological support (Ely, 1999; 1990).

4. Availability of time: refers to the willingness for organisations to provide paid time for users to learn the new skills or procedures in order to use the innovation, as well as the user's willingness to devote time to develop these new skills (Ely, 1999; 1990).

5. Rewards or incentives exist for participants: people need to be encouraged in their performance of innovation or use of the innovation. Extrinsic or intrinsic rewards can add some value of the innovation and thus promote its implementation

6. Participation: refers to the level of involvement stakeholders have in the decision-making process to adopt and implement an innovation. Participation may take the form of user group representatives if it is difficult to get feedback from all potential users (Ely, 1999; 1990). With the opportunities to communicate their ideas and opinions, the participants can have a sense of ownership of the innovation. Moreover, the communication among all parties can help monitor the progress of the innovation.

7. Commitment by those involved: refers to visible support by the upper level leaders. The key to this condition is how the users perceive the leaders' commitment to the implementation of the innovation. Simple verbal endorsement of the innovation by leaders does not constitute commitment (Ely, 1999; 1990). Since the implementation take a great deal of endeavour and time, the people who are involved in the implementation need to make commitment to their efforts and time. There must be firm and visible evidence that there is endorsement and continuing support for implementation.

8. Leadership is evident: refers to the level of ownership and support given by the leaders who will manage the daily activities of those using the innovation (Ely, 1999; 1990). The enthusiasm of these leaders directly affects the motivation of the users of the innovation. Immediate supervisors must provide support and encouragement, answer questions, address concerns, and serve as role models. Even though individuals act alone, especially in classroom endeavours, they need inspiration and continuing support of others whom they respect. These individuals, often called leaders, provide initial encouragement to consider new ideas; they ensure that the necessary training is given and that the materials to do the job are easily available; they are available for consultation when discouragement or failure occur; and they continually communicate their enthusiasm for the work at hand.

Although presented independently, these conditions are interrelated. They affect each other by either supporting or undermining one another (Ely, 1990; Ensminger, 2001). These factors constitute a good basis for analysis of innovative technologies such as VLEs and EVSs as they are tried out in schools.

2.4 Use of Virtual Learning Environments (VLEs) and Electronic Voting Systems (EVSs)

> Top class school facilities, ICT, music and sport facilities are central to having a world-class education system, raising standards and inspiring young people…

(Vernon Cooker, former Minister of State for Schools and Learners, DCSF, June 2009)

The above statement by the then Minister of State for schools and learners under the Labour Government in UK underscores the vital role of ICT, among other factors, in the education of pupils and young people. Within the National Curriculum, all pupils are required to become familiar with a range of technological applications and develop the necessary skills to use within their everyday learning environment. The promotion of ICT in schools has been a substantial priority for the UK government in line with its expectation that increased use of technology should enhance learning. This was clearly articulated in the Government's 2005 strategy paper 'Harnessing Technology: Transforming learning and children's services' (DFES, 2005). This strategy was implemented in a variety of ways and through various funding routes with BECTA[2] tasked to 'work with Government and its key agencies to create the conditions in the system that will lead to the majority of institutions and learning providers making more effective use of technology' (BECTA, 2007). In the following sections I will focus on some of the technologies that have been exploited in some secondary schools in the UK, namely, the VLEs and EVSs. I will provide a conceptual framework for each of these technologies and also discuss the main features and functions of each piece of technology including some issues emerging from their use in schools.

2.4.1 Virtual Learning Environments (VLEs)

VLEs are playing an increasingly significant part in students' learning experiences in different educational settings including schools, colleges and Universities within the UK. In a survey conducted by Ofsted in 2009, it was found out that in all the settings surveyed the concept of VLEs was relatively new and colleges were making the most use of them while primary schools were making the least. Commenting on the same issue of VLE usage in UK, Weller (2007, p.2) points out that VLEs are widely used in Higher Education (HE) 'VLEs are perhaps not the most innovative technology in recent years, but they are one of the most pervasive in HE…'. Brown and Jenkins (2003) indicate that 86% of respondents from UK HE institutions reported the presence of a VLE in their institution and 70% of UK Further Education (FE) colleges were using a proprietary VLE (BECTA, 2004). In its Harnessing Technology review for 2007, BECTA indicated that 11% of primary schools and 46% of secondary

[2] BECTA was the Government agency (under the Labour Government) specifically charged with promoting the integration of ICT in the UK education system. In May 2010, the incoming coalition government announced the closure of BECTA by March 2011.

schools used a learning platform. In 2008 the same study showed that although the use of learning platforms was increasing, overall only three-fifths of secondary school respondents had access to a learning platform, compared with just under one-fifth of primary school respondents and a third of special school respondents (BECTA, 2009). It is difficult to define exactly how long VLEs have been in use. There are examples of the employment of television in the USA in 1953 to give a form of remote technology-based teaching (Cuban, 1986); the UK's Open University has been offering remote learning since the 1970s, but it was only in the year 2000 that one of the commercial computer-based VLEs that is still in use today-Blackboard-was patented, with the commonly used Moodle system being trialled in 2001 (Ofsted, 2009).[3] According to Gillespie et al. (2007) VLEs first began to develop in the late 1990s. Since then they have become increasingly important (BECTA, 2003) and more and more research has been undertaken into educational possibilities of virtual learning. The European schoolnet[4] report in 2010 also highlights that in UK schools started to discover the VLE in early 2000.

What is a VLE?

VLEs are defined differently by various authorities. In the following section I will make reference to some of the definitions being used. According to Weller (2007, p.3) definitions can be in terms of functionality, for instance whatis.com states:

> The principal components of a VLE package include curriculum mapping (breaking curriculum into sections that can be assigned and assessed), student tracking, online support for both teacher and student, electronic communication (e- mail, threaded discussions, chat, web publishing) and internet links to outside curriculum resources.

[3] There is further information on Blackboard at www.blackboard.com; Moodle is a free-to-user system available through the internet; http://moodle.org/.

[4] European Schoolnet, a network of 31 ministries responsible for innovation and for ICTs applied to education

Gillespie et al. (2007, p.1) consider a VLE to be an application which contains tools that enable teachers and learners to do some or all of the following:

- Share files
- Download information
- E mail
- Use discussion boards
- Undertake tests and surveys
- Share information
- Organise time and resources
- Link teaching and learning applications and activities with management information systems.

A popular definition is that provided by the Joint Information Systems Committee (JISC, 2000) in the UK, cited in Weller (2007, p.3), which states that the term VLE refers to: 'the components in which learners and tutors participate in "on-line" interactions of various kinds, including on-line learning'. The same view is echoed by the Department for Education and Skills as cited by European Schoolnet (2010), who defines a VLE as:

> ...an umbrella term that describes a broad range of ICT systems used to deliver and support learning. As a minimum, we expect it to combine communication and collaboration tools, secure individual online working space, tools to enable teachers to manage and tailor content to user needs, pupil progress tracking and anytime/anywhere access (p.7).

Various terms have been used to refer to VLEs; these include Learning Management Systems (LMS), Learning Platform (LP) and Managed Learning Environment (MLE). Paulsen (2002) suggests that LMS is a broad term that is used for a wide range of systems that organise and provide access to online learning services for students, teachers, and administrators. These services usually include access control, provision of learning content, communication tools, and organisations of user groups. JISC (2000, p.2) defines a MLE as 'the whole range of information systems and processes of an institution that contribute directly, or indirectly, to learning and the management of that learning'. These terms, that is, LMS, LP, MLE and VLE are often used interchangeably. According to Gillespie et al. (2007, p.1) the distinctions between these different kinds of virtual learning facilitators have become increasing blurred as functionality develops and rather than switch between them, in my writing, I will opt for VLE, simply because it is the term I have become accustomed to. I will also use a definition proffered by Weller (2007, p.5) which defines a VLE as a 'software system that combines a number of different tools that are used to systematically deliver content online and facilitate the learning experience around that content'. Weller (ibid.) argues that this definition is sufficiently broad to encompass most recognised VLEs, regardless of whether they have an underlying pedagogy associated with them. According to Weller (ibid., p.2) 'the term virtual learning environment is often objected to because of the "virtual", as it seems to be in contrast to "real", which implies that learning through such an environment is a poor relation to any learning that takes place in a face-to-face setting'. The same view is echoed by Finnis (2009) who posits that the name VLE is somewhat unfortunate as it tends to imply the learning (rather than the environment) is somehow virtual or unreal. As you read my work, it is important to bear in mind that the term "virtual" refers to the environment and not the learning itself.

Functions of VLEs

There exist different types of VLEs, for instance, the schools I worked with in my study used VLEs called Frog, Fronter, Kaleidous and others used one called Moodle. They are made by different commercial companies but basically they are all meant to contribute to technology enhanced learning. The VLEs can either be an open source software or proprietary software. Weller (2007, p.96) distinguishes between these two types clarifying that:

> [A]n open source can be seen as legal framework for the shared development and use of code, but it is also a set of shared beliefs about how code should be developed and who should own it [it can be adapted

to the needs of an institution]. By contrast, proprietary software is owned by the software producer and users pay a licence fee to use it and crucially they do not have access to the source code and cannot see how the software works or modify it.

On the other hand, Weller (ibid., p.16) argues that 'while the specifics of any one VLE will vary, on the whole they offer similar functionality'. He identifies three dimensions to its functionality (institutional, academic and learner), each of which represents a different interface and audience, as shown in figure 2 below. Regarding the institutional dimension, a VLE will need to be integrated with other school systems including student records, library systems and content management among others. On the other hand, the academic staff determine the success of a VLE; hence it is important to provide support for a range of subject areas and pedagogies as well as ease of use. The end user of a VLE can be seen as the learner and if their experience is not a good one, for example the system is difficult to navigate or is not robust, then the feedback and use of the system will be poor and this will inhibit its uptake. Weller (ibid.) argues that for the learners 'the system must be easy to use and consistent in its layout, but most importantly it needs to add value to the learning experience…if the system does not add any value…most learners will avoid it'. Adding value can be in terms of additional content, more flexible study patterns, increased support, increased engagement and for some users, a more appropriate environment.

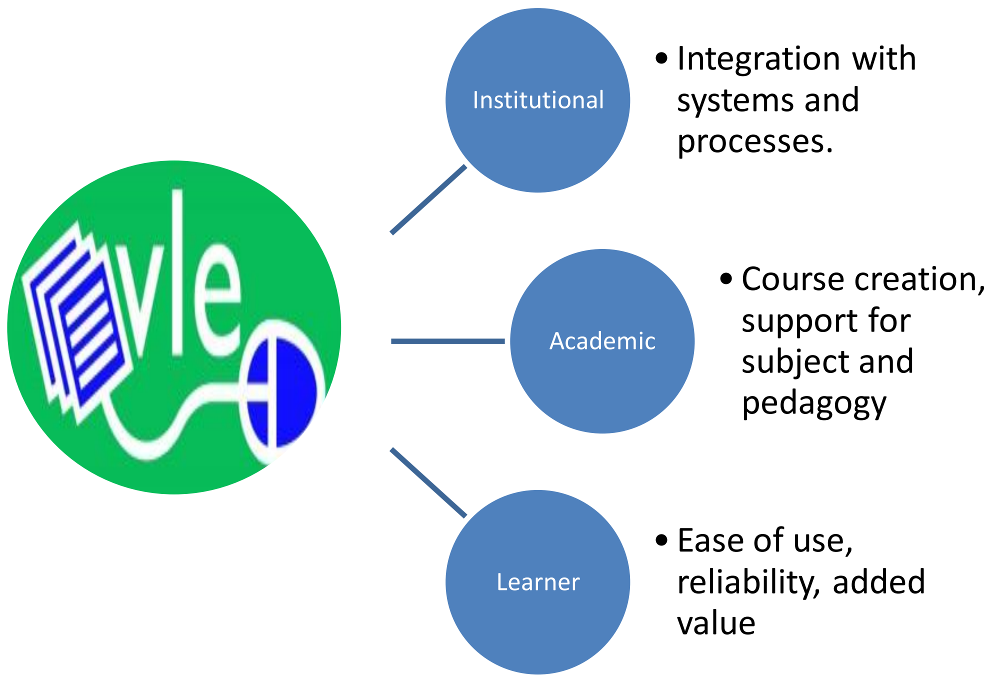


Figure 2: The dimensions of a VLE interface.
Adapted from Weller (2007, p. 17)

The three dimensions stated in figure 2 indicate that the VLE as a system needs to appeal to different audiences, each of whom will have different priorities and needs. A'Herran (2000) cited in Weller (2007) suggests that there are four perspectives from which a VLE is analysed:

- 'Administrators - scalability, value for money and integration with existing systems are important for these users
- Technicians - robustness, user base, technical support and ease of maintenance will be significant
- Course developers or teachers - customizability, flexibility and the integration of legacy materials will be paramount
- Learners - consistency, accessibility and quality of design will be the main concerns' (Weller, 2007, p. 17).

In my study the focus was on teachers and learners. These dimensions have a high degree of overlap, with the academic interface often being an extension of that offered to the learner. According to Weller (2007) the main learning and teaching functions of the VLE can be summarised as:

- 'Content delivery - easy upload and management of content in a variety of formats
- Asynchronous discussion - text based discussion boards that can be easily created and are straightforward to use, with threading of messages and attachment capability.
- Online assessment - a range of assessment tools including multiple choice, matching pairs and short text answers
- Student tracking-the ability to record a student's progress through a course and have this information presented in a concise format
- Synchronous discussion-text based discussion in real time, perhaps combined with other real time tools such as a shared whiteboard or webcasting
- Student tools-these usually include a calendar, a personal area for uploading resources, a note-taking tool, and email' (Weller, 2007, p. 18).

BECTA has specified the functions of VLEs and divided them into four categories and these are highlighted by European Schoolnet (2010) as shown below:

1. 'Content management: enables teaching staff to create, store and adapt resources and exercises accessible online;
2. Curriculum mapping and planning: offers tools and storage spaces to support learning assessment, customisation, lesson planning, etc.;
3. Learner engagement and administration: allows access to information about the student, attendance, calendar, e-portfolios and information management;
4. Tools and services for communication and collaboration: provides communication tools such as email, messaging, discussion forums and blogs' (p.21).

The above list of tools is not exhaustive; however, it still represents a comprehensive set of tools with which a great deal can be achieved pedagogically. Their successful use depends in part on the creativity of the teacher.

VLEs and web 2.0

The term Web 2.0 was coined in 2004 (Solomon & Schrum, 2007). Weller (2007, p.151) asserts that this term has been defined by O'Reilly (2005) and '…can be seen as an umbrella term to describe some collective trends in the use of the internet'. Solomon & Schrum (2007, p.1) posit that Web 2.0 is, 'all about the free new tools such as blogs, wikis, photo and video sharing and social networking that people are talking about and that many are using already'. These tools are changing how people, including students, interact with the world and consequently it becomes imperative that educators consider new strategies and new tools for teaching and learning if students are to be prepared adequately for a changing society. Students know how to use these tools for their own purposes; however, schools can help them to use the tools in educationally appropriate ways. Solomon & Schrum (2007, p.9) argue that: 'because these new technologies and new capabilities engage and motivate students, we can use them to educate'. They further assert that 'web 2.0 tools promote creativity, collaboration, and communication and they dovetail with learning methods in which these skills play a part' (ibid., p.21). Unlike in the past, the web is now a participatory, interactive place where information can be created collaboratively and the results shared. The differences between the old and new ways of working, dubbed as Web 1.0 and Web 2.0, can be seen in Figure 3 below:

Figure 3: Comparison of old and new ways of working (Web 1.0 and Web 2.0)

Web 1.0	Web 2.0
Application based	**Web based**
Isolated	**Collaborative**
Offline	**Online**
Licensed or purchased	**Free**
Single creator	**Multiple collaborators**
Proprietary code	**Open source**
Copyrighted content	**Shared content**

Source: Solomon & Schrum (2007, p.23).

In terms of applications the following transitions all represent a shift from Web 1.0 to Web 2.0 (Weller, 2007):

- 'Brittanica Online →Wikipedia
- Personal website →blogging
- Mp3.com →Napster
- Content management systems →wikis
- Kodak/Ofoto →Flickr
- Netscape →Google' (p. 23).

The Web 2.0 version of each of these is more participative. More recently VLEs have begun to incorporate web 2.0 features such as wikis (for example to form a student-generated glossary of key concepts) and blogs (for example as reflective learning journals that may be private or shared) (Finnis, 2009). Weller (2007, p. 122) argues that, 'if you want students to forge a community then wikis would be useful, and if you want them to engage in quick, social type interaction, then instant messaging is useful'. To my knowledge there is not much literature available around Web 2.0 and its implications for the VLE, however, some authorities like Weller (2007) consider that the VLE can become a conduit for new technologies and the accompanying good practice; hence he envisages the development of a VLE 2.0.

Teaching and learning using a VLE

The general teaching requirements element of the National Curriculum in the UK stipulates that:

1. Pupils should be given opportunities to apply and develop their ICT capability through the use of ICT tools to support their learning in all subjects (at Key Stage 1, there are no statutory requirements to teach the use of ICT in the programmes of study for the non-core foundation subjects. Teachers should use their judgement to decide where it is appropriate to teach the use of ICT across these subjects at Key Stage 1. At other key stages, there are statutory requirements to use ICT in all subjects, except physical education)
2. Pupils should be given opportunities to support their work by being taught to:

a) Find things out from a variety of sources, selecting and synthesising the information to meet their needs and developing an ability to question its accuracy, bias and plausibility;
b) Develop their ideas using ICT tools to amend and refine their work and enhance its quality and accuracy;
c) Exchange and share information, both directly and through electronic media;
d) Review, modify and evaluate their work, reflecting critically on its quality, as it progresses.
(Gillespie et al., 2007, p.2)

According to Gillespie et al. (ibid.) '…teaching and learning using a VLE enable schools and teachers to meet the general requirements effectively and in a meaningful way'. They highlight the following examples which match the general teaching requirements:

- A VLE can give opportunities for pupils to apply their ICT knowledge skills and understanding in a useful context

- A VLE can offer pupils a range of sources of information for their studies which can be selected and organised by their teachers in order to ensure that the resources are relevant to the learning
- A VLE enables pupils to create and store digital work which can be refined as the project progresses
- A VLE enables pupils and teachers to communicate and collaborate in a number of ways.

Teachers and their teaching skills are considered to be critical for the effective use of VLE. They must develop their teaching skills in order to make the best use of the new possibilities for creative and good quality teaching and learning which virtual learning offers. Historically, ICT developments in schools have been hampered by inappropriate in-service staff development (Gillespie et al., 2007). For the majority of pupils in schools, virtual learning experience comes as a complement to existing face-to-face teaching strategies. In some fields of education, especially in HE, VLEs are being used as the sole tool for teaching courses to students. However, in the compulsory schooling sector, in both primary schools and secondary schools, virtual learning looks set to be a significant tool in enhancing teaching and learning but some authorities like Gillespie et al. (2007) argue that it will not replace the traditional interface of teachers and pupils in classrooms. The use of VLEs has led to the rise of the term 'blended learning' or 'integrated learning' which is defined as 'a mixture or combination of face-to-face and online teaching and learning activities, resources and methods to create a particular blend of learning for [the] pupils' (Gillespie et al.,2007, p.7).

Pupils may require more intervention from the teacher to enable them to discern and extract relevant information from online sources than would have been the case in face-to-face textbook-type lessons (Deaney et al., 2006). On the other hand parents can also be involved in online learning of their children by teachers giving some online homework which encourages internet searches that can be done as a joint effort between pupil and parent. There are issues that need to be considered, though, if this is to be implemented effectively. One issue with parental involvement in online learning is that of the hardware and software differences in the homes of pupils. For pupils who live in homes without broadband connections, there may be an issue of access with this kind of homework if they are using the telephone line for long periods of time. Another issue with parental involvement is that of the computer skills of the parents, resulting in even the most minor of technical faults possibly being barriers to the access to the computer for the pupils. Issues of access need to be monitored in this way so as not to cause problems for the pupils when setting this type of work (Boulton, 2006).

Introducing a VLE into school

Gillespie et al. (2007) discuss important considerations that have to be made before embarking on installing a VLE in a school. These include a consideration of the organisation's requirements and needs, conduct of a feasibility study that looks at the technical, economic, legal, timescale and scale aspects of the VLE. They also emphasise the need to gather information relating to staff and pupil ability and confidence with the use of ICT, technical support available, the technical aspects of the current computer system in the organisation, and the teaching and learning styles of the staff and pupils who will use the VLE. I will briefly discuss these issues next.

The adoption of a VLE at school level can be a result of any of the following reasons (Gillespie et al., 2007, pp. 84-85):

- Enthusiasm of a group of staff who want to introduce blended learning and believe the VLE is the best way to do this;
- National test levels not reaching those predicted;
- A need to increase GCSE results;
- Boys' underachievement
- A need to address students who cannot attend school for whatever reason;
- The need to address distance learning, etc.

It is also argued that individual teachers may adopt the use of a VLE because they may want to use blended learning as a way of meeting different learning styles and increasing the motivation of their students. On the other hand, it may also be that the individuals were introduced to VLEs through their initial teacher education and are keen to put in practice blended learning starting from small beginnings.

In terms of technical feasibility, important considerations about the infrastructure are to be made. This involves considering the hardware and software options in line with the organisation's requirements and needs. The adoption of a VLE entails some economic considerations which can be split into two categories namely the one-off capital costs of setting up the VLE and the ongoing costs. Capital costs include the purchase of the VLE, the initial costs of the web server, any costs involved with cabling and connectivity and initial staff development. The ongoing costs of a VLE involve any yearly licences or subscriptions to the VLE, costs of ongoing staff development, technical support, purchasing updates, paying for connectivity, and renting a server if there is not one located within the school. Gillespie et al. (2007, p.86) advise that, 'it is important to be realistic about these costs; otherwise an initial good idea could rapidly turn into something too costly to run in the medium to long term'.

Those considering installing a VLE are advised to think about some important issues including pupils' access to broadband at home and teachers' preparedness to use the technology (Gillespie et al.,2007; Weller, 2007). Arguably, if some students do not have internet access at home, there is need to consider what steps can be taken to address this at school given that if this is not addressed some pupils will suffer exclusion. It is also important to consider whether staff are technically capable of developing the skills needed to successfully use the VLE, particularly in terms of creating and uploading the materials. Use of a VLE also has some legal implications. A VLE usually needs to keep personal details about its users, and as such is subject to the provisions of the Data Protection Act. In terms of timescale feasibility, Gillespie et al. (2007, p.87) suggest that, 'you need to consider how long the VLE will take to introduce and when it will be introduced. In some cases, too long a period of time will reduce the effectiveness of the VLE in terms of the initially identified need'. They advise that it may be a good idea to start with a small course or project, evaluate its success and effectiveness, and then expand it. Moreover, any future growth of the VLE should be taken into account from the beginning as this impacts on the choice of VLE and server specifications.

As indicated above, the feasibility study should generate some information from stakeholders like staff (teachers and technicians) and pupils. It is important to ascertain how confident the various users are with ICT. For instance, the level to which students are able to use ICT may well affect the choice of VLE, as different VLEs have different characteristics with regard to ease of use. It may also affect the type of activities and learning objects which are used. Both teachers and pupils should be invited to express their views regarding how they intend to use the VLE. In addition to this, the current computer system needs examining to ensure that it is compatible with a new VLE. Providing staff development is a crucial part for the effective implementation of the VLE.

Gillespie et al. (2007, pp.93-94) identify some of the benefits of VLE use to staff and pupils as highlighted below:

For staff:

- Pupils will be able to access resources from home as well as school. Many staff already have a lot of resources available in electronic form. Any of these resources can be placed on the VLE. The VLE can also act as a central repository for resources, meaning that all staff in the department have access to all the resources at any time. This can prevent many of the problems involved in transferring work to and from school
- Online assessments are a way of reducing teachers' workload. Once assessments are set up, they can be used for other groups, with the majority of VLEs providing some form of computerised marking. VLEs

usually allow summaries of assessments to be printed or exported for use in summative assessment and reporting to parents.

- There are several benefits of online assignments/projects. Any assignments can be marked at home or at school, again, without the problems of transferring/losing work. These assignments are available for work sampling and, in the case of course work, moderation. Staff also benefit from pupils having less opportunity to 'lose' work, as once it is uploaded, it can be accessed from any computer connected to the internet
- Pupils are able to work collaboratively on projects or peer-review each other's work. The benefits to the teacher are that there can be simple sharing of work, group evaluations and target setting, and the teacher can see which pupils have spent most time on the project.

For pupils:

- Pupils can participate in 'anytime-anywhere learning'. This helps match learning patterns to pupils' preferred learning styles, and also allows curriculum access for pupils who, for whatever reason, are not attending school.
- There will be increased enthusiasm, as pupils are generally much more open to learning mediated by technology. This could lead to a higher proportion of deadlines being met, and a greater overall participation in the learning process.
- Pupils gain increasing independence, as VLEs provide a scaffold to enable pupils to engage in learning without direct supervision. Increased independence should result in greater performance, as the opportunities to achieve are much wider.
- Other benefits include faster feedback, linked target setting, chat forums, developing social skills, more 'fun' tasks, access to lesson materials that may have been missed due to absence, parents being able to share target setting, etc.

In my view, VLEs use in schools is as yet limited, it remains to be seen how well aspirations like those expressed above by Gillespie et al. (2007) will translate into practical reality.

2.4.2 Use of Electronic Voting Systems (EVSs) in teaching and learning

Introduction

EVSs are being adopted in learning and teaching strategies with a view to facilitating the students' active engagement in their learning. This technology enables teachers to instantaneously collect student responses to a posted question. For each question, the students select an answer and press the associated button on the 'clicker'. The answers are immediately tallied and the teacher then has the option of displaying a histogram of student responses on a classroom projection screen where both students and the teacher can see and discuss them. There is an increase in the number of teachers in different educational institutions who are using EVSs (Caldwell, 2007).The technology is being used in a variety of fields and at all levels of education (Caldwell, 2007; Read 2010). Beatty (2004) identifies the generic EVS technology of today as one which:

- Allows an instructor to present a question or problem to the class;
- Allows students to enter their answers into some kind of device; and
- Instantly aggregates and summarises students' answers for the instructor, usually as a histogram.

There is a growing body of literature on EVSs, and the data are scattered across many disciplines and tend to be very fragmented (Banks, 2006). MacArthur & Jones (2008) reviewed the use of this technology in college chemistry contexts, and the reference list therein shows that there is a wealth of other literature relating to tertiary level use of EVSs in science education. This view is also supported by Judson & Sawada (2006) who assert that much of the recent research on EVSs is from sciences. However, finding existing research into the use of EVSs at secondary school level proved more problematic. Judging from the literature search I conducted there appears to be very little literature on the use of this technology in secondary schools. Most of the available literature is on the use of EVSs at tertiary level. This view is echoed by Wasteney (2005, p. 6) who opines that: '[a]lthough the technology [EVSs] itself has been available for some considerable time and has come through many stages of development the research is largely limited to studies carried out in higher education'. In the same vein, Penuel et al. (2004, p.2) state that: 'audience response systems have been in use for several years in higher education and have shown promise for transforming classroom participation and learning, especially in the sciences'. As indicated earlier on, this implies that there is not much research done in this area at secondary school level and this may justify the conduct of research such as mine. I have relied heavily on literature derived from research conducted in higher education realising that the issues addressed at tertiary level on the use of the technology can be applied to the secondary school level as well.

EVSs have been described by many names in the literature: Classroom Feedback Systems (CFS), Interactive Response Systems (IRS), Group Process Support Systems (GPSS), Group Decision Support Systems (GDSS), Audience Paced feedback (APF), Classroom Communication Systems (CCS), Personal Response Systems (PRS), Group Response Systems (GRS), Student Response Systems (SRS), Audience Response Systems (ARS), Clickers, Zappers, handsets and voting machines (Patry, 2009; MacArthur & Jones, 2008; Caldwell, 2007; Banks, 2006; Draper et al.,2002). In my writing I will use the term 'EVSs' to refer to this technology which is the name I am accustomed to but you may also come across any of the above names when I quote an authority or when I use a direct quotation from any one of my participants who prefers calling them by another name. In the subsequent section I will discuss the basic elements of the technology, motivations for using EVSs in educational contexts, the various ways in which the EVSs are being used and lastly but not least, I will also discuss general findings from related studies on the use of this technology in educational contexts.

EVSs: Hardware and Software

EVSs comprise hardware and software that are used in conjunction with face-to-face educational processes to support, deepen, and enhance learning by promoting greater interaction between all those engaged in a learning activity (Bank, 2006). The systems generally involve four basic elements: 1) Computer with projection, 2) keypads 3) hardware connected to the computer for receiving signals from keypads, and 4) software for processing data from the keypads. The keypads are the handheld devices used in an EVS and these are called 'clickers' in the United States and 'handsets' or 'zappers' in the United Kingdom (d'Inverno et al., 2003; Simpson & Oliver, 2006). Bruff (2009, p.1) offers a brief explanation of how this system works:

> First, an instructor poses a question, often a multiple choice question, to the students. The students think about the question and submit their responses to the questions using handheld wireless transmitters, usually called clickers, which often look like television remote controls, and beam signals to a receiving device attached to the instructor's classroom computer. Software on the computer produces a bar chart showing the distribution of student answers. Instructors then use these results to decide how to proceed during class…

The process described above has been shown diagrammatically by Banks (2006, p. viii) to facilitate easy comprehension of how an EVS works

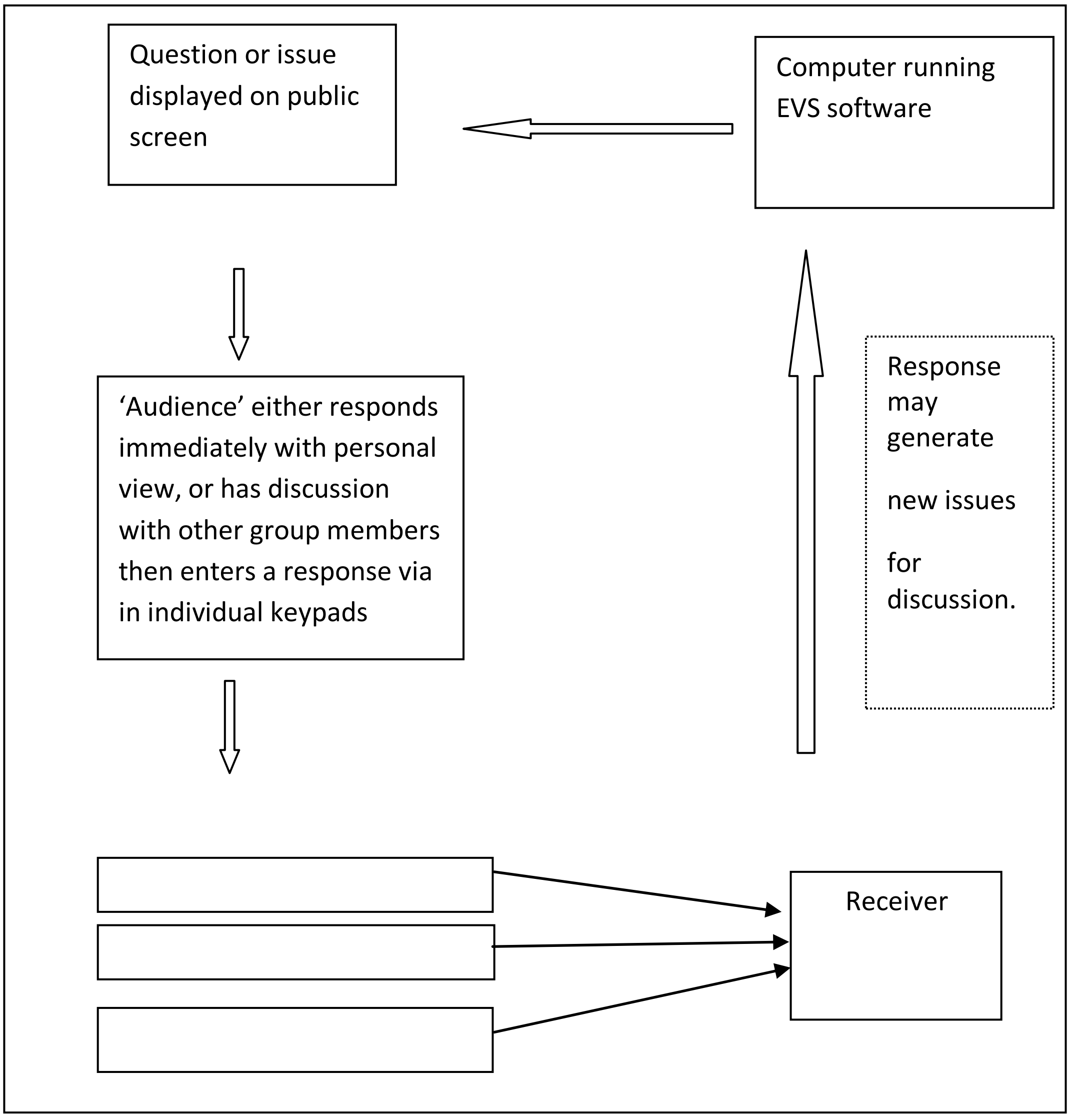


Figure 4**:** The EVS outline process

The question is typically displayed via PowerPoint slides. Each participant indicates their response from a set of options provided on the slide by using a personal data entry device (clicker) to transmit one or more digits to a receiver attached to a computer. The input device may be a simple numeric keypad, sometimes referred to as a clicker or a full text entry device such as a laptop computer, personal digital assistant or mobile phone. The EVS software on the computer then processes the acquired data and displays the resulting transformed data on a public screen via a data projector.

Abrahamson (2006) contests that the concept of EVSs is new stating that mechanical feedback systems have been used in classrooms for about forty years. MacArthur & Jones (2008) also report that technologies similar to EVSs were used in the 1960s and 1970s. This view is also echoed by Judson & Sawada (2002, p.176) who claim that many similar systems have been in use since the 1960s stating that:

> Electronic Response Systems cannot be considered emerging technology. The essential configuration allowing instructors to pose questions and students to provide informative electronic feedback has been in place since the 1960s in college lecture halls. A marked advancement among modern systems was the ability to display graphic representations of student responses. This innovation has been coupled with a general shift in how electronic response systems are used in college courses.

However, the widespread use of EVSs in the classroom is believed to be a recent phenomenon (Cline, 2006). The 1990s saw a marked rise in the use of this technology particularly in higher education in the United States (Wasteney, 2005). In the UK, Draper et al. (1996-2004) have been outstanding in researching the impact of EVSs technology as a means of increasing student participation in lectures (Wasteney, 2005).The earlier systems were typically used as quizzing devices, and the discussion was limited to communication of student answers to the instructor as opposed to class discussions of them (Ward et al., n.d.), although there is at least one report of these devices 'accidentally' fostering student collaboration (Littauer, 1972). Modern technology makes these devices more powerful and user-friendly than in the past. Beatty (2004) distinguishes three generations of EVSs. Classtalk was the first popular EVS; it was developed as part of a research project and was installed in several Universities during the 1990s. The voting devices used were graphing calculators, connected with cables to a central computer. The second generation of EVSs consists of infrared clickers which resemble television remote controls, usually with a very simple design which allows answering multiple choice questions. The third generation of EVS consists of laptops and mobile devices with access to the internet. This is currently being developed and all the schools I worked with during my study are actually using these systems. Advances continue to make EVSs technology increasingly cost-effective and therefore accessible to students and teachers alike (Patry, 2009). Read (2010, p.107) echoes that: 'the use of EVS has become more widespread over the last few years as the cost of the technology comes down and the functionality of the package increases'.

Theoretical motivation for the use of EVSs

Draper (1998) argues that technology is only worth using in the classroom when it addresses a specific instructional deficit. It has been revealed that one of the weakest points in the teaching of large classes is the lack of interactivity (Draper & Brown, 2004). Davis & McLeod (1996) suggest that groups become large when they reach about forty because it is at this point that the number of students begins to inhibit a teacher's ability to make individual connections and students begin to feel anonymous. A more theoretical view is that because no overt response is required of students, little mental processing in fact takes place, and hence little learning, at least during the lesson (Ibid.). A technology aimed directly at this gap would be an EVS. Many teachers have adopted EVSs technology to compensate for the passive, one-way communication inherent in lecturing and the difficulty students experience in maintaining sustained concentration. Some institutions have adopted EVSs solely for this reason, in the hope of addressing high attrition rates in the sciences by making lecture lessons less passive and impersonal (Burnstein & Lederman, 2001). Many of the courses that use EVSs have abandoned lecture altogether or at least reduced it to a smaller component of class time (Draper et al., 2002; Cutts et al., 2004; Knight & Wood, 2005). In a large lecture setting, EVSs can be used to engage students and involve them in the class session beyond the passive role traditional to large lectures (Cutts, 2006). Knight & Wood (2005) consider that even when simply added to a traditional lecture, the give-and-take atmosphere encouraged by use of EVSs makes the students more responsive in general, so that questions posed to the class as a whole during lecture are much more likely to elicit responses and discussion. Recent research suggests that using EVSs can be advantageous in large classes across a variety of types of learners (MacGeorge et al., 2008)

EVSs can be used to increase student participation during class by allowing all students to respond to all questions asked by the teacher (Bruff, 2009). MacArthur and Jones (2008) posit that the primary advantage offered is the option that allows students to submit either identified or anonymous responses, providing opportunities for both formative and summative assessment. Such feedback is important for teachers to know whether students have mastered a topic before they go on (Black & Wiliam, 1998). A number of authorities have hailed EVSs as a mechanism for enhancing active learning. For example, Hinde & Hunt (2006) hailed this technology as an active learning tool. McCabe (2006) identified EVSs as a useful way to engage students through question-asking in large classes. Advocates have argued that EVSs are especially effective with shy students because student responses can be collected, aggregated, and shared anonymously (Bank, 2006), though some data suggest the anonymity aspect to EVSs is of little value to students (Hinde & Hunt, 2006). On the other hand, Hinde & Hunt (2006) argue that regardless of whether the anonymous aspect of EVSs is important to many students, the systems have clear advantages over more traditional 'show of hands' or coloured flash card student response systems because they can quickly and accurately aggregate and quantify students responses. In addition an analysis was developed of ways in which this technology might be used pedagogically (Draper et al., 2002) and the main pedagogic categories of use of the technology are:

1. 'Assessment: both formative and summative, for example, practising exam questions with, in effect, instant self-marking and feedback.
2. Formative feedback on learning (for teacher as well as learners): Self-assessment questions, which then show both each individual learner how well they know the material, and the teacher how well the class as a whole knows it.

3. Formative feedback on teaching to the teacher: Anonymous feedback on questions about the teaching, for example, too fast, more examples wanted, etc.
4. Peer assessment: where the class rates the performance of each learner's presentation or other work
5. Community mutual awareness building: whether a group of researchers at a workshop or a new first year class, a few minutes spent in asking and sharing some basic questions on where the participants are from (local, abroad), gender, age bands, other subjects they are taking, whether they view this subject with enthusiasm or trepidation can make everyone feel more at home, and more oriented within the group.
6. Experiments using human responses: In subjects such as psychology, effects can not just be described but demonstrated by collecting responses from the audience, and furthermore this allows each participant to experience their own personal response and relate it to the group's mean and variability.
7. To initiate a discussion, especially in small groups. Peer discussion particularly of topics where peers disagree, is well known to be excellent in promoting conceptual advance. A good way to initiate this is to display a 'brain teaser' question, have the audience each select an answer, display the group disagreement, and then without announcing the correct answer (if any), have the audience discuss it with their neighbours' (Draper et al., 2002, p. 14)

From the above pedagogic categories, categories number 2 and 3 are examples of 'diagnostic assessment' according to Scaife & Wellington's (2010) classification. Arguably, EVSs have a considerable diagnostic value and this has the potential to enhance students' learning experiences.

The above constitute the background for the use of the EVSs technology in educational contexts. In the following section I will focus on some recent research findings on EVSs. Related literature has shown that most of the recent studies which have been conducted mainly in science courses at Universities have focused either on formative assessment or student collaboration (MacArthur & Jones, 2008). These will be reviewed separately in the following subsections. I have decided to refer to these studies as I see a lot of applications to the secondary school sector.

<u>EVSs and assessment of students</u>

EVSs enable teachers to collect information on student learning from all students in a classroom quickly, easily and simultaneously (Bruff, 2009). This means that quick diagnostic assessment of student learning can be conducted several times in a single session. Teachers and students need not wait for weekly essays or homework assignments or less frequent tests and papers to find out what students do and do not understand (Ibid.). The information on student learning provided by EVSs can be used by teachers to modify their lesson plans during class to respond to immediate student learning needs. This may be called 'contingent teaching' (Draper & Brown, 2004), 'agile teaching' (Bruff, 2009) or 'diagnostic teaching' (Scaife, 2012). Draper & Brown (Ibid.) argue that when using EVSs, most teachers naturally do this in a small way by varying the amount of explanation of the question and alternative responses, cutting it short if most students gave the correct answer, expanding it if many got it wrong. Feedback on the level of student understanding before or during instruction is called diagnostic and formative feedback. This is very important in science education because the concepts build on one another. Diagnostic assessment provides teachers with useful information about student learning and formative assessment lets students know what they understand and do not understand. Since EVSs provide this information several times during a class session, they allow students to have a better sense of how well they understand material during a session while they are able to ask questions to their teachers and their peers.

A number of studies have compared EVS courses to courses taught with a different method, and focused on formative and diagnostic assessment as the reasons for the observed improvement. Hall et al. (2005) observed an improvement in student grades when EVSs were used in a high enrolment chemistry course. Boyle & Nicol (2003) using this technology found a small upward shift in exam scores. In another study, Poirier & Feldman (2007) found students who used EVSs in a large introductory psychology course had better scores and more positive attitude towards the technology. However, in that study the use of the EVS was embedded in a small group discussion activity. The control group had no such discussion component. In other words, the design confounded use of the EVS with an interactive discussion element. While it seems very likely that the effective use of the EVS was at least partially the cause of the higher performance in their treatment group, it was not possible for the researchers to tease out the differential effects of the EVS feedback system from the interactive discussion activity. Not all results have been positive. In another study by Stowell & Nelson (2007) there was no proof of better performance on learning outcomes for the EVS users as compared to flash card and hand raising audience participation methods. Kennedy & Cutts (2005) did not see any improvement in grades when EVSs were used in a computer science course.

Engaging students with EVSs

As indicated earlier on, one of the reasons for using the EVSs is that they are an effective tool for engaging students during lessons. The term engagement shall be understood to refer to more than just participation in class as Bruff (2009, p.6) explains, '[e]ngaged students are those who are actively involved in class discussions and thinking intentionally about course content during class'. It is evident from the literature that many teachers use EVSs to engage students in a variety of ways including class-wide and small-group discussions.

Class-wide discussion can be a useful way to help students learn during a lesson and EVSs can be used to generate and foster this. A typical structure for doing so is the one called 'think-vote-share' which works in the following way, as explained by Bruff (2009, p.6):

> [Teachers] using clickers this way first pose a multiple choice question to their students. Students think about the question and submit their answers using their clickers. The [teacher] then displays the bar chart generated by the system showing the results of the question, indicating how many students selected each answer choice. These results, along with the thinking that students do prior to submitting their responses, inform and enhance subsequent class-wide discussion facilitated by the [teacher]

Class-wide discussion can be a useful way to help students learn during a lesson. Students can pay more attention and stay engaged during the lesson. Teachers can use an EVS to identify the individual responses of their students and this allows them to hold students accountable for their participation in a class session. In light of this, students are often more likely to participate constructively in class (Bruff, 2009, p. 6). The other common method of engaging students in the learning process with an EVS is the use of peer instruction, a method that has been developed and adopted for use with EVSs by Mazur (Mazur, 1997; Crouch & Mazur, 2001). Bruff (2009, p.14) gives a clear explanation of how this method is implemented in a classroom:

> Many teachers implement peer instruction by first posing a multiple choice question. Students think about the question silently and independently and submit their answers with their clickers. The teacher then displays a bar chart showing the results. Instead of moving to a class-wide discussion at this point, the next step is to have students discuss the question in pairs or small groups…after this discussion time, students again answer the same clicker question, this time submitting answers informed by their small-group discussions

Peer instruction has attracted a high level of interest because this method together with other active learning methods have been demonstrated to result in higher learning gains than more traditional approaches (Hake, 1998; Pollock, 2006). For the teacher, EVSs offer an efficient means to monitor progress and problems in peer-learning groups and to intervene when either the class is very confused or has understood the concept thoroughly and is ready to move on. In practice, such interactive engagement methods have been shown to be more effective than traditional lecture (Hake, 1998). The strength of peer instruction is the interaction it fosters between students, who by virtue of their similar ages, language, and common experience, are often better at clearing up each other's confusions and misconceptions than their teacher (Wood, 2004). Some studies have shown that students giving the explanations in a peer group show greater learning gains than those receiving the explanation (Webb, 1999; Coleman et al., 1997). This suggests that the active process of explaining forces a student to integrate new knowledge with existing knowledge (Chi et al., 1994). Students themselves feel that discussion with other students is helpful. In surveys about peer instruction (Nicol & Boyle, 2003), 92% of students agreed that discussing questions with others aided understanding, 82% agreed that hearing others' explanations helped them learn, and more than 90% reported that the moment they felt most engaged during class was while working in small peer groups. The benefits of this approach are that it improves both conceptual understanding and problem solving skills more than courses that focus primarily on solving numeric problems (Hake, 1998).

Asking students to discuss a given question with their peers is a way of actively engaging them in course material. Small group discussions allow more students to participate actively than is possible in class-wide discussions. 'Small group discussions such as those used in peer instruction can help prepare students to participate more fully in subsequent class-wide discussions because students have the opportunity to develop and test their ideas before being asked to share them with the entire class' (Bruff, 2009, p.16). A variety of studies have been conducted investigating the effects of peer instruction on student learning and the reports argue for peer instruction's positive effects on student learning. Many teachers also use EVSs to prepare students for 'times for telling', a term Schwartz & Bransford (1998) use to describe moments in a learning experience when students are ready and interested to learn from a lesson. EVSs can also be used to structure a class session in ways that help students learn. The think-vote-share activity helps to focus students' attention on a particular question and introduce a time for class discussion. The peer instruction method can provide a useful way to structure an active learning exercise for students regardless of what time it takes. Many teachers see value in structuring a class session into a sequence of activities (small-group discussions, large group discussions, individual writing exercises, etc.). The simple act of picking up a keypad and responding to a question can provide the change up in a lesson Middendorf and Kalish (1996) argue is often needed to hold students' attention. Furthermore, some students respond well to kinaesthetic activities, which involve movement and tactile sensation. EVSs can provide these experiences. They can also be used in a variety of ways to structure class time beyond asking quick clicker questions and are thus often useful tools for helping students maintain attention during a class session. Bruff (2009, p. 34) contests that 'students who know that they will be asked to respond to a specific question or complete a specific task in the next five, ten or fifteen minutes are often more likely to engage seriously with classroom activities…' On the other hand, many EVSs include features that can be used to add an element of competitive fun to a classroom. Although the primary goal of a lesson is student learning, not fun, a little fun can help students maintain attention and engagement with course activities. Some students find competition motivating. These students engage more seriously with a task when they know they have a chance of outperforming their peers publicly and so enjoy participating in classroom activities in which they compete.

The use of EVSs to promote interactive engagement among students has been shown to help students to learn more (MacArthur & Jones, 2008). A significant increase in student understanding of concepts has been shown to occur when interactive methods are used in science courses (Hake, 1998). Use of EVSs encourages all students to participate actively in class (Caldwell, 2007), responding to each question. When using EVSs they are offered the opportunity to think independently before hearing other students' answers. However, it is not clear from the literature the extent to which EVSs technology plays a role in these learning gains. It is possible that the methods themselves are responsible for learning gains and EVSs technology merely facilitates and supports those methods. This remains a potential area for further research as my current study did not encompass that.

Student attitude towards the use of EVSs

Research suggests that for EVSs to be successful at bringing about some learning gains, the teachers' focus should be on the students' use and acceptance of the technology and not on the technology itself. Bergtrom (2006) identified EVSs as interactive and learner-centred devices and reported that they may be particularly useful in enabling critical thinking in large lecture classes. Trees & Jackson (2007) noted that the success of EVSs is more a social issue than a technology issue and that the role of the teacher should be to facilitate students embracing the learning potential the EVSs allow. Draper and Brown's (2004) and Trees & Jackson's (2007) studies analysed the use of EVSs in both sciences and humanities courses but there was no indication of a difference in student attitudes between disciplines of use.

The overall trend in the literature reflects that most students like using EVSs in class. Barnett (2006) examined student attitudes when EVSs were implemented on a large scale in biology and physics courses. Despite a host of technical difficulties, the majority of students had favourable responses, listing feedback, interactivity, and peer comparison as significant reasons why they liked EVSs. In a study conducted by Caldwell (2007) about 88% of students taking biology course either 'frequently' or 'always' enjoyed using EVSs in class. When asked if EVSs were enjoyable, helpful or should be used, students typically gave approval ratings around or above 70%, or average Likert scale ratings above 4 on a scale of 1-5 (Draper et al., 2002; d'Inverno et al., 2003; Simpson & Oliver, 2006). Students' ratings of the system were less consistent when asked if the system helps them to learn or concentrate, but are still generally positive (Elliot, 2003; Hatch and Jensen, 2005; Beekes, 2006). Sometimes students felt that the system was helpful even when there was no evidence of significant improvement in exam scores over non-EVS classes (Bunce et al., 2006). When EVSs were used, students tended to view the teacher as more aware of their needs and the teaching style as more friendly (Nichol & Boyle, 2003) or caring (Knight & Wood, 2005). Features that students particularly liked about the system were its anonymity (Jackson & Trees, 2003), its potential to reinforce learning (Bunce et al., 2006), and the possibility of comparing one's answers with the rest of the class (ibid..) because they like the reassurance that they are not alone even when they are wrong (Beatty, 2004). The EVSs help teachers to understand the students' level of understanding so that they can explain concepts to the students better (Sian et al., 2003). In this way, EVSs indicate to students that their teachers are interested in their learning and this can help to create a positive rapport between teachers and students (Bruff, 2009). Often students are hesitant to share their perspectives in class out of worry about their classmates' reactions, particularly if they are unsure of their answers to a question. EVSs allow them to participate without such matters and students often cite this as a reason they like EVSs. In her study, Sawdon (2009) observed that students' satisfaction with the use of EVSs for feedback and the learning experience was extremely high. Similar results have been found in other studies as pointed out by Fies & Marshall (2006) in their comprehensive literature review of the EVSs literature. A review of twenty-six EVSs studies found indications of greater student engagement, increased student understanding of complex subject matter, increased student interest and enjoyment, heightened discussion and interactivity, increased student awareness of individual levels of comprehension and increased teacher insight into student difficulties.

However, not all students like EVSs. Some students have actually asked their teachers to stop using the technology and return to basic teaching (d'Inverno et al., 2003). In some cases students complained about the cost of buying the clickers but this does not apply to institutions that purchase and keep the clickers for use in their Departments. Some of the difficulties mentioned by students include technical problems, poor implementation, and wasted class time (Barnett, 2006). Some students report anxiety about using EVSs, usually because the scores are part of their course grade, and they are unsure whether answers are recorded properly (Jackson & Trees, 2003; Johnson & McLeod, 2004). Teachers have noted that regular communication about clicker scores may reduce this anxiety (Jackson & Trees, 2003). Others recommended a low-stakes contribution of clickers to grades so that attention remains focused on reasoning and not scores (Beatty, 2004). Other problems occur when the learning value of the questions is unclear and they seem to be included just for the sake of using the EVS technology to gather data for future years or for no reason at all (Simpson & Oliver, 2006). Students are understandably unhappy when the clickers seem to be driving course content and not vice versa (Ibid.). Draper & Brown (2004) surveyed students in a number of courses that used EVSs and discovered that the greatest degree of student apprehension about EVSs occurred when the students perceived the lesson as being technology-centred rather than focused on the course content. Similarly, students who believe that the teachers are using EVSs primarily or exclusively to enforce student attendance are likely to resent being tracked or monitored (Bruff, 2009). Some students who prefer a competitive class atmosphere dislike the use of EVSs for cooperative learning activities (Knight & Wood, 2005). Some students also highlight that the use of EVSs can be a problem especially when the clickers do not function properly or when some students do not take voting seriously (Sian et al., 2003). In my study I sought to establish the perceptions of students who were using the EVSs in their science lessons at secondary school level.

Teachers' attitude towards use of EVSs

'Examples of EVSs use occur throughout the literature and often detail positive attitudes from both students and teachers, although exceptions do exist' (Caldwell, 2007, p.9). Like students, most teachers rate the EVSs experience favourably. In general, they view it as a quick and convenient way to check student understanding. They note that their students are more active, attentive, and pleasant to teach (Beatty, 2004; Elliot, 2003; Wood, 2004; Draper, 2002). In a study conducted in England in 2005 on the impact of EVSs in the classrooms (Wasteney, 2005), teachers were asked if the use of EVS had changed their courses: 72.2% answered affirmatively and only 22.2% said no. The main disadvantage found in the study was the time needed by the teachers to set up the questions and the equipment, as well as the portability of the complete system. Typically, a school or Department has a single set of EVS machines which must be transported to the classroom and back to a repository. The overhead is considerable especially taking into account the time teachers have to invest in setting up the questions while planning the lesson. There is a consensus that it takes some time and practice to develop good questions and that they must be carefully designed and woven into a lesson (Burnstein & Lederman, 2001; Elliot, 2003; Beatty et al., 2006; Simpson & Oliver, 2006). Esponda (2008, p. 93) posits that, 'our experience is that EVSs can increase the level of participation in class and can be an effective educational tool. However, sometimes even enthusiastic teachers use EVSs just a few times before giving up due to the considerable overhead'. Negative reactions understandably occur when the systems experience technical problems or lack technical support from IT staff, but also if they are only used for recording attendance. Other concerns about using EVSs include their expense and the time that questions consume during class (Brewer, 2004). Brown & McIntyre (1993) argue that the practicable development of pedagogy calls for better understanding of how teachers perceive and think about what they do in their classrooms. In light of this, my study sought to find out the perceptions of teachers regarding their use of EVSs in teaching science lessons.

Other aspects of EVSs

Although the largest portion of published research on EVSs focuses on their use to foster student engagement, some studies have considered other possible benefits. Draper et al. (2002) and Draper & Brown (2004) proposed that clickers are niche technologies that work best when selected to fill a particular perceived deficiency in a course. Two effective implementations mentioned are the use of EVSs to foster student collaboration, and 'contingent' or 'diagnostic' teaching in which the direction of the lesson is determined by student responses to key questions.

Some studies have also shown that use of EVSs increases attendance levels (Cue, 1998; Jackson & Trees, 2003). Cue (1998) proposes that if a teacher wants to increase attendance he/she must use EVSs daily and link their usage to grades. This is consistent with a physics teachers' report which stated that when EVS scores accounted for 15% or more of the course grade, attendance levels rose to 80-90%, preparation for quizzes became more serious, and students were noticeably more alert during class (Burnstein & Lederman, 2001). Other teachers, however, report that when EVSs contribute 5% or less to the course grade, their effect on attendance remains negligible. On the other hand, some teachers suggest that linking interactive instruction to grade incentives causes students to take it more seriously (Hake, 1998; Cutts et al., 2004).

Some studies have also looked at the use of class time when EVSs are used and there is a general consensus that when time is spent on EVS activities there is usually a decrease in content coverage (Burnstein & Lederman, 2001; Simpson & Oliver, 2006). Generally this decreased coverage is considered more than compensated by perceived improvements in student comprehension, instructor awareness of student difficulties, and the ability to assess instantly whether the pace of the course is appropriate (Elliot, 2003; Beatty, 2004). Other teachers find that including EVS questions and small group and class-wide discussions in their courses does not prevent them from including as many topics in their courses as they would without these activities (Bruff, 2009). Crouch & Mazur (2001) describe moving the transfer of information to pre-class reading assignments which allows teachers to spend class time helping students assimilate that information. On the other hand, some studies of lecturing indicate that more coverage does not necessarily indicate more learning or more retention by students (Johnstone & Su, 1994). Sawdon (2009, p. 487) contends that 'knowledge retention following conventional teaching often decays at an undesirable rate', and she suggests that the use of EVSs helps to improve knowledge retention. An underlying assumption noted in much of the literature on EVSs usage is the conviction that covering content is not the most effective way to teach and that active engagement leads to more effective learning (Draper et al., 2002; Cutts et al., 2004; Knight & Wood, 2005; Simpson & Oliver, 2006; Caldwell, 2007).

2.5 Assessment and feedback in science education

A literature review was conducted to define the concept of assessment and identify the different types of assessment. I rationalised that the new technologies would provide teachers the opportunity to incorporate assessment and provide student feedback innovatively in science education. In line with this view, Holmes et al. (2001) argue that teachers are encouraged to reassess their teaching methods due to the flexibility and new opportunities presented by the technologies. There is a large amount of literature on assessment (Irons, 2008) and it can be appreciated that assessment is viewed quite positively by many authorities in terms of its role in enhancing student learning experience (Irons, 2008; Carless, 2007; Hattie & Timperley, 2007; Taras, 2005; Black & Wiliam, 1998). Feedback is considered essential to the process of learning. As Laurillard (1993, p.61) has said, 'action without feedback is completely unproductive for the learner'. Literature shows that students want feedback and appreciate good feedback (Scaife & Wellington, 2010; Higgins et al., 2002; O'Donovan et al., 2001; Hyland, 2000). Irons (2008, p.8) contends that, 'feedback to students should focus on the task, should be given regularly and while still relevant and should be specific to the task'. This formative feedback should also enhance students' future understanding and achievement (Boud, 2000), that is, feedback must be relevant to future work. Nicol and MacFarlane-Dick (2004) argue that both feedback and feed forward should be systematically embedded in curriculum practices. It will be interesting to establish the extent to which the use of new technologies such as VLEs and EVSs can promote assessment and provision of individualised and consistent student feedback. Providing feedback to students is a valuable part of the learning process and should be ongoing, frequent and comprehensive (Garrison & Anderson, 2003).

Scriven (1967) defines assessment and provides the original distinction between summative and formative assessment. Scriven (1967, p. 40) considers "assessment" to refer to 'a judgement which can be justified according to specific weighted set goals, yielding either comparative or numerical ratings'. Drawing from the work of Scriven (1967) and others including Black and Wiliam (1998), Irons (2008, p.7) distinguishes the two forms of assessment as follows: Summative assessment is any assessment activity which results in a mark or grade which is subsequently used as a judgement on student performance. Ultimately judgements using summative assessment marks will be used to determine the classification of award at the end of a course or programme. Formative assessment is any task or activity which creates feedback (or feedforward) for students about their learning. Formative assessment does not carry a grade which is subsequently used in a summative judgement. Black & Wiliam (1998) did not talk about diagnostic assessment although this is referred to implicitly when they discuss formative assessment.

The distinction between summative and formative assessment is very useful and acknowledged in most of the literature. However, Scaife & Wellington (2010, p.137) argue that, '...there is a lack of clarity in distinguishing between forms of assessment and especially between the concepts of formative and diagnostic assessment'. From my own literature search, I realised that reference is only made to summative and formative assessment and very few authors make reference to the distinction between formative and diagnostic assessment. Scaife & Wellington (ibid.) make an interesting distinction highlighting that formative assessment is 'primarily about assessment for learning' while diagnostic assessment focuses on '...assessment for teaching'. Having identified the different forms of assessment it was possible for me to explore the role of technology in facilitating the different forms of assessment. Although some of the authors do not make a distinction of the forms of assessment, they make reference to diagnostic assessment indirectly. For instance, Gibbs (1999) contends that formative assessment provides feedback to both tutor and student. It provides tutors with a way of checking on students' constructions, what Scaife & Wellington (2010) refer to as 'diagnostic assessment' or 'assessment for teaching' and provides students with a means by which they can learn through information on their progress (Brown & Knight, 1994; Ding, 1998).

Black & Wiliam's (1998) meta-analysis of 250 research studies relevant to the subject of classroom formative assessment (or formative and diagnostic assessment in Scaife & Wellington's terms) concluded that formative assessment does make a positive difference to student learning. This view is further buttressed by Hyland (2000, p.234) who asserts that feedback from formative assessment 'has the capacity to turn each item of assessed work into an instrument for the further development of each student's learning'. Biggs (1999) argues that formative assessment, by providing feedback, helps develop 'deep learning' among students. The following observations about effective teaching were made by Hattie (2009) after conducting a 'meta-meta analysis' that involved data generated from several million students in over 50,000 studies: 'The most powerful single influence enhancing achievement is feedback … the most important feature was the creation of situations in classrooms for the teachers to receive more feedback' (p.12). The feedback that Hattie refers to here is diagnostic feedback to the teacher. He further argues that: ''When teachers seek ... feedback from students as to what students know, what they understand, where they make errors, when they have misconceptions, when they are not engaged – then teaching and learning can be synchronised and powerful. Feedback to teachers helps make learning visible' (Hattie, 2009, p.173).

CHAPTER 3: RESEARCH METHODOLOGY, PROCEDURES & ETHICAL CONCERNS

3.1 Introduction

> Trying to produce a definitive definition of methodology as used in the social sciences and to serve the purposes of all researchers is rather like trying to catch water in a net. Different researchers offer slightly differing definitions according to their own training, discipline and purposes (Clough and Nutbrown, 2002, p.27).

In this chapter I focus on defining and clarifying the methodology of my research study. I start off by looking at the definitions of methodology. The above quotation captures an important observation I came up with while reading different educational research textbooks. I found out that different authorities define methodology differently, however, for all their differences I also noted that all the definitions proffered share a common idea of justification. It is not the aim of this chapter to interrogate the different views offered by different authorities pertaining to methodology. For the purposes of my study, methodology shall be interpreted in line with the view held by Wellington, et al. (2005, p.97) who say, 'methodology refers to the theory of [generating] knowledge and the activity of considering, reflecting upon and justifying the best methods'. This view is echoed by Clough and Nutbrown (2002, p.27) when they say that: 'one of the tasks for a methodology is to explain and justify the particular methods used in a given study'. In the same vein Sikes (2004, p. 16) observes that: 'methodology is concerned with the description and analysis of research methods rather than with the actual, practical use of those methods. Methodological work is, therefore, philosophical, thinking work'.

It is important to notice that all the authorities cited above make a clear distinction between method and methodology. In my writing method is conceptualised as being part of methodology which is about doing, which is, generating data whereas methodology is about understanding doing. In my view, the aim of methodology is clearly defined in Kaplan's (1973) words (as cited in Cohen & Manion, 1994, p. 39), which also echoes the ideas given by the authorities cited above:

> to describe and analyse these methods, throwing light on their limitations and resources, clarifying their presuppositions and consequences, relating their potentialities to the twilight zone at the frontiers of knowledge. It is to venture generalizations from the success of particular techniques, suggesting new applications, and to unfold the specific bearings of logical and metaphysical principles on concrete problems, suggesting new formulations

My research questions are outlined in chapter one. Here, I intend to elaborate how I generated answers to the questions at hand. I will discuss the ontological (nature of reality) and epistemological (nature of knowledge) assumptions that underpinned the conduct of my study. I am aware that different views about the nature of investigation and research into social phenomena arise out of the assumptions made about, and philosophical stances taken on, issues of ontology and epistemology (Guba and Lincoln, 1989). This is well illustrated by Creswell (2009) who argues that the types of beliefs held by individual researchers will often lead to embracing a qualitative, quantitative or mixed methods approach in their research. Several terms have been used to refer to these sets of beliefs held by researchers. Some authorities call them 'world views' (Guba, 1990) and others call them 'paradigms' (Lincoln and Guba, 2003; Mertens, 1998). According to Guba (1990) world view means a set of beliefs that guide action. On the other hand, Denzin and Lincoln (2008, p.31), based on Kuhn (1970), define a paradigm as a 'net that contains the researchers' epistemological, ontological and methodological premises'. This view is further buttressed by Babbie (2007, p.32) who defines paradigms as 'models or frameworks for observation and understanding which shape both what we see and how we understand it'. Researchers are guided by these different research paradigms as argued by Prasad (2005, p.8) who says: 'researchers are often trained in one particular scientific paradigm, with specific guidelines on how to conduct research'.

Epistemology explores issues such as: 'what the relationship is between the inquirer and the known' (Denzin and Lincoln, 2008, p.31), and 'what might represent knowledge or evidence of the social reality that is investigated, and what is counted as evidence' (Mason, 2002, p.16). Epistemological assumptions guide the researcher's judgement of the appropriateness of different methodological choices in an inquiry. Thus one of the fundamental considerations of any research inquiry is an understanding of what counts as knowledge in that inquiry. As Lakomski (1992, p.93) expresses it:

> The application of any type of research method and the defence of the results of inquiry thus obtained implies a view, or views, of what is to count as knowledge. The point of preferring one set of methods over another is to believe that the chosen set will lead to knowledge rather than mere belief, opinion or personal preference.

Ontology refers to what we think reality looks like and how we view the world, for example, the question of 'what kind of being the human being is' (Denzin and Lincoln, 2008, p.31) or to reflect on 'the nature of phenomena, or entities, or social reality' (Mason, 2002, p.14). The methodology that is adopted in research is embedded in the ontological and epistemological assumptions of the researcher. In education, '...there is evidence of widespread acceptance of alternatives to objectivism, one of which is constructivism' (Tobin cited in Nola, 1995, p.31). In the following section I will discuss the constructivist knowledge framework which forms the basis of my study.

3.2 A constructivist knowledge framework

Constructivism is a theory about knowledge and learning, it describes both what is 'knowing' and how one 'comes to know' (Fosnot, 2005). This theory is opposed to objectivism. It describes knowledge 'not as truths to be transmitted or discovered, but as emergent, developmental, non-objective, viable constructed explanations by humans engaged in meaning-making in cultural and social communities of discourse' (Ibid., p. ix). Objectivists define knowledge as a representation of a real world that is thought of as existing, separate and independent of the knower; and this knowledge should be considered true only if it correctly reflects that independent world (Glasersfeld, 1995). This view has dominated the traditional western philosophy. It is built on the idea that reality exists independently of the observer and can be discovered through the use of a series of systematic steps to achieve verifiable facts about the external real world. Constructivism breaks away from this tradition. In the words of Kuhn (1970), constructivism introduces a 'paradigm shift' in educational thinking and practice for it departs from the traditionally held beliefs and interpretations of knowledge and the conceptualisation of teaching and learning. It holds that there is something wrong with the traditional objectivist concept of knowledge and it proposes to change it. According to Glasersfeld (1995, pp.6-7) the change consists of this:

> Give up the requirement that knowledge represents an independent world, and admit instead that knowledge represents something that is far more important to us, namely what we can do in our experiential world, the successful ways of thinking with abstract concepts.

Before I proceed to give more details about the axioms of constructivism I think it is useful to reflect on the constructivist landscape. Constructivism has been used in such a variety of ways that a great deal of confusion can result if no effort is made to distinguish the major senses of the concept from each other. Phillips (2000) provides a useful way of classifying 'constructivisms'. He holds that there are at least two major orientations namely social constructivism and psychological constructivism. Social constructivism focuses on the nature of disciplines of knowledge as human constructs and stresses the primacy of social processes in the generation of knowledge. Phillips (2000, p.6) argues that:

> [T]he forms that knowledge has taken in these fields has been determined by such things as politics, ideologies, values, the exertion of

power, and the preservation of status, religious beliefs and economic self-interest.

This thesis denies that the disciplines are objective reflections of an 'external world'. Social constructivism is frequently contrasted with the orientation of psychological constructivism. Proponents within this broad orientation place emphasis on how individuals actively reorganise cognitive processes rather than the social and cultural processes of learning (Cobb, 1994). This second type of constructivist view is that learners actively construct their own sets of meanings or understandings; knowledge is not a mere copy of the 'external world', nor is knowledge acquired by passive absorption or by simple transference from one person (a teacher) to another (a learner). In sum, knowledge is made, not acquired. The term constructivism is not prevalent in the traditional philosophy lexicon in discussions of epistemology, however, the concepts underpinning constructivism can be found in the intellectual heritage of Kant and more recently in the educational writings of Piaget and Vygotsky (Glasersfeld, 1995). The influences of these forerunners of modern variations of constructivism are evident in psychological constructivism and it is the issues that are common to this orientation that will inform the conduct of this study.

3.3 Constructivism: ontology and epistemology

In this section I will make explicit the constructivist ontological and epistemological assumptions upon which the conduct of this study is based. While objectivists talk of an ontological world, the constructivists introduce the concept of an experiential world. The emphasis here is on the role an individual plays in the whole process of knowledge construction. From the constructivist perspective, as Piaget stressed, knowing is an adaptive activity. This means that one should think of knowledge as a kind of compendium of concepts and actions that one has found to be successful, given the purposes one had in mind. This notion is analogous to the notion of adaptation in evolutionary biology, expanded to include, beyond the goal of survival, the goal of a coherent conceptual organisation of the world as we experience it (Glasersfeld, 1995). The customary conception of truth as the correct representation of states or events of an external world is replaced by the notion of viability. To the biologist a living organism is viable as long as it manages to survive in its environment. To the constructivist, concepts, models, theories and so on are viable if they prove adequate in the contexts in which they were created. Viability quite unlike truth is relative to a context of goals and purposes. These goals and purposes are, however, not limited to the concrete or material. In science, for instance, there is, beyond the goal of solving specific problems, the goal of constructing as coherent a model as possible of the experiential world. Contrary to the objectivist view, knowledge consists not merely of the facts, principles and theories deduced from observations of phenomena and events. Knowledge includes the ability to use information in meaningful ways and encompasses thoughts, feelings and interpretations. Knowledge involves an ongoing interpretation of the meaning of events and phenomena. In view of this psychological constructivist perspective the role of the learner also differs from that perceived under the objective perspective. In this case the learner is not to passively receive information but to participate actively in knowledge construction.

A more detailed perspective of this idea has been developed under one variant of constructivism, namely radical constructivism. Glasersfeld is said to be the pioneering thinker of the radical version of constructivism both as a theory of scientific knowledge and as a guide for scientific education (Nola, 1998). His personal life experiences and the strong dissatisfaction with the traditional theories of knowledge prompted him to develop these ideas. However, he asserts that the constructivist ideas have been in existence but they were not well developed. Glasersfeld describes constructivism as, 'an unconventional approach to the problems of knowledge and knowing' (Glasersfeld, 1995, p.1). According to Glasersfeld (ibid..), radical constructivism 'starts from the assumption that knowledge, no matter how it can be defined, is in the heads of persons, and that the thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experiences'. This position has been criticised by some people who feel that the emphasis on subjectivity is tantamount to solipsism (the view that nothing exists outside a person's head), because, they seem to think, it implies that individuals are free to construct whatever realities they like; others claim that the constructivist approach is absurd because it disregards the role of society and social interaction in the development of an individual's knowledge. I consider that an individual plays an active role in constructing meaning. In line with the constructivist perspective, this study placed emphasis on getting individuals' views and perspectives regarding the issues under consideration. I was interested in 'understanding people's lived experiences from the perspective of people themselves which is often referred to as the emic perspective or the inside perspective' (Hennink et al. (2011, p.14). A study with a constructivist perspective, therefore, emphasises 'the importance of interpretation and observation in understanding the social world', which is an integral component of qualitative research (Snape and Spencer, 2003, p.7).

3.4 Quality Criteria for an inquiry with a constructivist knowledge framework

Issues related to quality or goodness of an inquiry are unavoidable whenever one decides to design and carry out a research activity in an academic setting. To this end, in this section, I intend to discuss the criteria I consider to be viable for judging an inquiry within a constructivist knowledge framework which is the basis of my study. It is clearly shown in research literature that there exist different criteria for judging the quality of an inquiry and these are basically related with the chosen research paradigm. It becomes important for one to know which criteria to adopt for judging the quality of an inquiry. This view is further buttressed by Scaife (2004, p.66) when he argues that, 'before one comments on whether a process is reliable it makes sense to decide whether it is reasonable to judge the process this way'. This quotation captures a very important observation which I intend to explore in some greater detail in the subsequent section.

In the field of educational research, researchers can adopt strategies and procedures derived from different paradigmatic origins for use in the conduct of their inquiries. From a positivist perspective, which employs the conventional criteria, judging the rigor or quality of an inquiry would include these four aspects: internal validity, external validity, reliability and objectivity. Internal validity is defined as 'the extent to which variations in an outcome or dependent variable can be attributed to controlled variation in an independent variable' (Lincoln and Guba, 1985, p.290). 'Assessing internal validity is the central means for ascertaining the 'truth value' of a given inquiry, that is, the extent to which it establishes how things really are and really work' (Ibid.). The other criterion is external validity and this is defined as, 'the approximate validity with which we infer that the presumed causal relationship can be generalised to and across alternate measures of the cause and effect and across different types of persons, settings, and times' (Cook and Campbell, 1979 cited in Guba and Lincoln, 1985, p. 291). External validity focuses on the applicability of findings from one study to other different contexts. Just as is the case with internal validity, several threats to external validity have been identified and these include: selection effects, setting effects, history effects and construct effects (Guba and Lincoln, 1985; LeCompte & Goetz, 1982). Arguably when these threats are taken care of, then a given study should have applicability to the larger population from which the sample was drawn. The third criterion is reliability, and, it responds to questions about the consistency of a given inquiry and is typically a precondition for validity, because a study that is unreliable cannot possess validity (Lincoln and Guba, 1985). 'Reliability refers to a given study's (or instruments') consistency, predictability, dependability, stability and / or accuracy, and the establishment of reliability for a given study typically rests on replication, assuming that every application of the same, or equivalent, instruments to the same phenomena will yield similar measurements'(Guba & Lincoln, 1989, p.235). The fourth criterion is objectivity and it 'is usually played off against subjectivity' (Guba & Lincoln, 1985, p.292). It 'responds to the positivist demand for neutrality, and requires a demonstration that a given inquiry is free of bias, values and or prejudice' (Guba & Lincoln, 1989, p.235).

My argument is similar to the position adopted by Guba & Lincoln (1989, p. 235) when they say, 'within the framework of this paradigm (positivism), the foregoing criteria are perfectly reasonable and appropriate'. However, 'the traditional criteria are unworkable for constructivist approaches on axiomatic grounds' (ibid. p.235-236). For example, internal validity which is 'the extent to which variations in an outcome (dependent) variable can be attributed to controlled variation in an independent variable' (Lincoln & Guba, 1985, p.290) cannot have meaning as a criterion in a paradigm that rejects a realist ontology (Guba and Lincoln, 1989). Guba & Lincoln (1989, p. 236) further argue that:

> If realities are instead assumed to exist only in mentally constructed form, it would not make sense to look for connection between the dependent and independent variables. External validity, a concept that embodies the very essence of generalizability, likewise can have little meaning if realities to which one might wish to generalise exist in different forms, in different minds, depending on different encountered circumstances and history, based on different experiences, interpreted within different value systems. Reliability is essentially an assessment of stability of the phenomena being assessed and the instruments used to assess them. Ordinarily it is assumed that phenomena are unchanging, so that any instrument that assesses them should, on replicated readings, provide essentially the same assessment (otherwise it is judged unreliable). But if the phenomena can also change – and change is central to the growth and refinement of constructions - then reliability is useless as a good criterion (Ibid.). Finally, 'objectivity clearly reflects the positivist epistemological positions that subject / object dualism is possible, but if a rival paradigm asserts that interaction (monism) is inevitable, what can objectivity mean?' (Ibid., p. 236).

In light of the arguments presented above (Guba, 1989, 1985), it becomes necessary for one to spell out clearly the research paradigm informing their study and the criteria for judging the quality of the study. For example, my study is guided by constructivist epistemological and ontological position, hence for the judgement of its quality it requires different criteria to that used to judge the quality of positivist studies. Morgan (1983) cited in Guba & Lincoln (1989, p. 236) has noted so well: 'goodness criteria are themselves rooted in the assumptions of the paradigm for which they are designed; one cannot expect positivist criteria to apply in any sense to constructivist studies'. Guba and Lincoln developed a set parallel to those conventional four, staying as close as possible to them conceptually while adjusting for the change requirements posed by substituting constructivist for positivist ontology and epistemology (Guba and Lincoln, 1989) and my study was heavily influenced by their views. The parallel criteria consider trustworthiness to be a more appropriate indicator of the quality of an inquiry.

> Trustworthiness, according to Lincoln and Guba (1985) involves credibility, transferability, dependability and confirmability. These four concepts are extensions, or adaptations of the 'traditional' categories of internal validity, external validity, reliability and objectivity (Scaife, 2004, p. 71).

A brief discussion of each criterion will be made to highlight differences with the conventional criteria. The credibility criterion is parallel to internal validity (Guba & Lincoln, 1985; 1989). According to Sturman (1999) credibility constitutes a useful indicator of goodness in case study research and given that my study adopted a case study approach this criterion became more useful to me compared to the other three criteria. 'credibility criterion is parallel to internal validity in that the idea of isomorphism between findings and an objective reality is replaced by isomorphism between constructed realities of respondents and the reconstructions attributed to them' (Guba & Lincoln, 1989, p.236-237). Several techniques exist for achieving credible results in a study and these include prolonged engagement, persistent observation, peer debriefing, member checks, among others (more details accessible in Guba & Lincoln, 1985; 1989). The second criterion is transferability. This is parallel to external validity or generalizability (ibid.). The positivist paradigm requires both sending and receiving contexts to be at least random samples from the same population. In the constructivist paradigm, external validity is replaced by an empirical process for checking the degree of similarity between sending and receiving contexts. Further, the burden of proof for claimed generalizability is on the inquirer, while the burden of proof for claimed transferability is on the receiver. Generalisation, in a conventional paradigm is absolute, at least when conditions for randomisation and sampling are met. Constructivism offers a plausible view by holding the idea that transferability is always relative and depends entirely on the degree to which salient conditions overlap or match. The third criterion, dependability, is parallel to the conventional criterion of reliability. This is because of what Guba and Lincoln (1989, p. 242) explain '…it is concerned with the stability of the data over time'. In conventional studies, alterations in methodology of the study would render reliability greatly suspect, if not totally meaningless. Likewise, shifts in hypotheses, constructs and the like are thought to expose studies to unreliability. Methodological changes and shifts in constructions are expected products of an emergent design dedicated to increasingly sophisticated constructions. Far from being threats to dependability, such changes and shifts are hallmarks of a maturing and successful inquiry. Lastly but not least, I will discuss confirmability. This is parallel to the conventional criterion of objectivity. Like objectivity, confirmability is concerned with assuring that data interpretations and outcomes of inquiries are rooted in contexts and persons apart from the researcher and not simply figments of the researcher's imagination (Guba and Lincoln, 1989). Unlike the conventional paradigm which roots its assurances of objectivity in method- that is, follow the process correctly and you will have findings that are divorced from the values, motives, biases or political persuasions of the inquirer- the constructivist paradigm's assurances of integrity of the findings are rooted in the data themselves. This means that data (constructions, assertions, facts and so on) can be tracked to their sources, and that the logic used to assemble the interpretations into structurally coherent and corroborating wholes is both explicit and implicit in the narrative of a case study.

‘Trustworthiness is established by the use of techniques that provide truth value through credibility, applicability through transferability, consistency through dependability, and neutrality through confirmability’ (Erlandson, et al. 1993, p.132). The techniques and their relationship to traditional inquiry are summarised in the Table 2 below (adapted from Lincoln and Guba, 1985). Some of the techniques have been used in the conduct of this study.

TABLE 2: ESTABLISHING TRUSTWORTHINESS: A COMPARISON OF CONVENTIONAL & NATURALISTIC INQUIRY

Criterion	Conventional Term	Naturalistic Term	Naturalistic Techniques
Truth value	Internal Validity	Credibility	Prolonged engagement Persistent observation Triangulation Referential adequacy Peer debriefing Member checks Reflexive journal
Applicability	External Validity	Transferability	Thick descriptions Purposive sampling Reflexive journal
Consistency	Reliability	Dependability	Dependability audit Reflexive journal
Neutrality	Objectivity	Confirmability	Confirmability audit Reflexive journal

Source: adapted from Lincoln & Guba, 1989

3.5 Methodology- Research Approach

Various terms have been used to classify research approaches. Sikes (2004, p.16) contends that the term methodology itself can be used 'to denote the overall approach to a particular research project, to the overarching strategy that is adopted. Thus case study, life history and action research are examples of methodological approaches'. Denzin and Lincoln (2000) use the term 'strategy' to refer to the kind of research approach that has been adopted. To me, research strategy, research approach and methodological approach mean one and the same thing, hence, in this thesis, I will use these concepts interchangeably. For the purposes of my study, I adopted the case study approach. The study involves several secondary schools and each school constituted a unit of analysis involving participating science teachers and students. Case study has been described as, 'an umbrella term for the family of research methods having in common the decision to focus on inquiry around an instance' (Adelman, et.al. 1977 cited in Bell, 1999, p.10). This approach seeks to uncover the interaction of significant factors characteristic of the phenomenon. The case study seeks holistic description and explanation.

The choice of the case study approach is based on the following aspects:

> It provides an opportunity for one aspect of a problem to be studied in some depth within a limited timescale… (Bell, 1999, p.10)

> Unlike the experimenter who manipulates variables to determine their causal significance or the surveyor who asks standardised questions of large, representative samples of individuals, the case study researcher typically observes the characteristics of an individual unit - a child, a clique, a class, a school or a community. The purpose of such observation is to probe deeply and to analyse intensively the multifarious phenomena that constitute the life cycle of the unit with a view to establishing generalisations about the wider population to which that unit belongs (Cohen and Manion, 1989, pp. 124-125).

In Yin's writings the essence of case study is that it is enquiry in a real life context, as opposed to the contrived contexts of experiment or survey. He wrote that case study is an empirical study that: 'investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. It relies on multiple sources of evidence, with data needing to converge in a triangulating fashion' (Yin, 1994, p.13).

Case study is criticised by some authorities in terms of the nature and difficulty of generalisation. Others disagree, for instance, Denscombe (1998, pp.36-37) makes the point that, ' the extent to which findings from the case study can be generalised to other examples in the class depends on how far the case study example is similar to others of its type'. Bassey holds similar views, but prefers to use the term 'relatability' rather than 'generalizability'. In his opinion, an important criterion for judging the merit of a case study is the extent to which the details are sufficient and appropriate for someone working in a similar situation to relate her / his decision making to that described in the case study. The relatability of the study is more important than its generalizability (Bassey, 1999). One should develop an understanding of generalisation that is congruent with the basic philosophy of qualitative inquiry as Bassey puts it across. Bassey (1999) contends that while it is not possible to make statistical generalisations from case studies, it is important to reckon that some 'fuzzy generalisations' can be made which in essence are claims about the possibility of what might be found in situations which are similar to the case study. Stenhouse (1975) cited in Bassey (1999, p.26) asserts that, 'case study does not preclude an interest in generalisation'.

Case studies are frequently associated with interpretative methodologies (Cohen et al., 2000) but the notion that only qualitative data can be generated is refuted by others who promote a more pluralistic approach. I feel that a case study allows for the use of both qualitative and quantitative procedures for generation of data. This is echoed by Sturman (1994) who argues that the techniques used in the investigation may be varied, and may include both qualitative and quantitative approaches. Bell (1999, p.10) holds similar views, she asserts that, 'though observation and interviews are most frequently used in case study, no method is excluded'. This view is further buttressed by Merriam (1988, p.10) who claims that: 'unlike experimental, survey or historical research, case study does not claim any particular methods of data collection or data analysis: any and all methods of gathering data from testing to interviewing can be used in a case study'.

On the basis of the strengths of case study approach outlined above, I decided to adopt the approach in my study. In the subsequent section I will focus on the research procedures used in the study for purposes of generating data.

3.6 Methodology- Research Procedures

This section focuses on the process of data generation. The account seeks to justify the suitability of the particular methods of data collection that I employed in my research study. These methods are described and analysed in the light of their potentialities, but also a clear view of their limitations is provided. For the purposes of my research I adopted a 'triangulation by procedures' approach (Opie, 2004) which allowed me to gain a richer picture of the issues under study. Triangulation refers to the observation of a research issue from at least two different points (Flick, 2002). In this case, I triangulated the data gathering methods as shown in the table below. The choice of a research procedure was done in light of the guidance offered by Cohen et al. (2000) who posit that a key determining factor in choosing a particular research procedure, whether it lies within quantitative or qualitative approaches is the suitability of that procedure for use when examining the research questions. Wellington (2000, p.50) gives another important piece of advice when he suggests that researchers should consider at the early stage of planning their research 'a question-methods matrix (horses for courses)'. Following below is a matrix tabulating the research questions against the methods I used in the stud

TABLE 3: RESEARCH QUESTIONS- METHODS MATRIX

Research Question	Research Method
1. What are the circumstances which led to the adoption of the innovative technologies by the participating teachers?	Semi-structured interviews
2. Can the innovations help to change teacher ideas about the teaching and assessment of science?	Semi-structured interviews
3. What are the students' perceptions of the value of using the innovative technologies in the teaching and assessment of science?	Semi-structured interviews, Questionnaires and Focus Group Discussions.
4. Are there observable indications that the use of the new technologies in the teaching and assessment of science helps to improve students' academic performance/achievement or attitude towards science?	Semi-structured interviews, Questionnaires and Focus Group Discussions

3.6.1 Semi-structured interviews

A researcher interviews people to learn about their knowledge, experiences, feelings and expectations, to gain insight and to obtain descriptions of events that are normally unavailable for observation. Perakyla (2005) cited in Denzin and Lincoln (2005, p.869) says, 'interviews consist of accounts given to the researcher about the issues in which he or she is interested'. As indicated above, some of my research questions required me to find out and analyse participants' perceptions on the use new technologies in the teaching and assessment of science. I chose semi-structured interviews in light of my epistemological assumptions that knowledge can be generated through finding out and analysis of people's subjective accounts. Secondly, as Perakyla (2005) cited in Denzin and Lincoln (2005, p.869) observes, interviews enabled me to 'reach areas of reality that would otherwise remain inaccessible such as people's subjective experiences and attitudes'. This view is echoed by Wellington (2000, p.71) when he says, 'interviews can reach the parts which other methods cannot reach…allowing a researcher to investigate and prompt things that we cannot observe like the interviewee's thoughts, values, prejudices, perceptions, views, feelings and perspectives'. The issues I pursued are not straight forward matters, I was looking at perceptions, experiences and feelings about the use of new technologies and this justifies the use of interviews (Denscombe, 1998). My interviews were semi-structured ones rather than structured or unstructured. In a semi-structured interview, even though I had a clear list of issues and questions to be addressed, the questions were not closed. The answers were also 'open- ended' and there was more emphasis on the interviewee elaborating points of interest (Denscombe, 1998). It was also possible for me to probe and expand the interviewee's responses and it allowed for deviation from a prearranged text and to change the wording of questions and the order in which they were asked (Opie, 2004).

The method allows the interviewee to speak widely to develop their ideas. Data is generated through the genuine reflection and thoughts of the interviewees. This view is supported by Oppenheim (1992, p.81) who claims that: 'interviews should encourage respondents to develop their own ideas, feelings, insights, expectations or attitudes and in so doing allow the respondents to say what they think and to do so with greater richness and spontaneity'. Semi-structured interviews have attracted interest and are widely used in qualitative research. According to Uwe (2002, p.74), 'this interest is linked to the expectation that the interviewed participant's view points are more likely to be expressed in a relatively openly designed interview situation than in a standardised interview or a questionnaire'.

All the participants were chosen as Denscombe (1998, p.119) posits, 'because they have some special contribution to make, because they have some unique insight or because of the position they hold'. Structured interviews have not been considered because they involve predetermined list of questions where respondents are asked to offer limited option responses. In addition to this, structured interviews give less opportunity for new and unexpected points to emerge because they use closed questions. Closed questions are restricted and not suitable for the type of data I intended to generate in my research. On the other hand, unstructured interviews are open ended and free ranging such that the interview may veer from the main focuses. This is because instead of the interviewer preparing a list of questions, he or she would normally introduce the topic and what follows depends on the interviewee's thoughts, unguided by the interviewer's priorities. Therefore, unstructured interviews were not suitable for my research because I already had an idea about the issues and themes I wished to explore in my study and at the same time I wanted to allow the opportunity for participants to come up with any issues they felt were of particular importance to them (Cohen and Manion, 1994; Cohen, Manion and Morrison, 2002). I did not want to go to talk to the participants with a rigid predetermined set of questions that would limit their input due to questions asked or not asked. Instead I had a very fluid list of key topics related to my research questions I wished to include. I wanted an open discussion that would be more like a conversation rather than a formal interview. This allowed for more spontaneity of interaction and the direction the exchange took was in the hands of both the participants and myself as the researcher. During the course of the interview I tried to talk as little as possible to allow the participants to talk about their thoughts and experiences. I prompted when I felt there was a need and at times posed a few questions to focus the discussion.

Interview questions were pilot tested in order to test the suitability of my research instrument. I used PGCE science students in our Department for pilot testing of my interview questions for teachers and students who were not participating in my study were used to pilot test interview questions for students. I used a digital voice recorder to record responses from the participants. This helped me to concentrate on how the interviews were proceeding and where to go next (Smith, 1995). I also took some notes especially regarding the body language of the participants and this was very helpful during analysis of findings.

3.6.1. (a) Interview with teachers

In the first part of my research project I interviewed teachers who were using the VLE in their teaching and assessment of science (see appendix 2 for interview guide). During the second part of the project I interviewed teachers who were using EVS in their classrooms (see appendix 3 for interview guide). In both cases, I was interested to elicit the views of these teachers pertaining to worthiness of these technologies in their classrooms and to assess whether they had changed anything in terms of their perceptions of teaching and assessment of their subject.

3.6.1. (b) Interview with students

I also interviewed some students who used a VLE to elicit their views regarding the effectiveness of the VLE in their learning of science (see appendix 4 for interview guide). I wanted to ascertain their attitudes towards this instructional technology, to know whether they were happy learning science through the use of a VLE or whether they would prefer continuing to receive the lessons using the conventional method. The students did not raise the possibility of using a blended approach and I did not discuss this with them. For the EVSs project, I decided not to use interviews because I was working with many students and felt that a questionnaire would be more effective in terms of generating the information I needed over a short time.

3.6.1.(c) Interviews with other education professionals

I also conducted an interview with a staff member from the Midshire LA to elicit her views on the Midshire VLE project (see appendix 5 for interview guide).

During the course of my study I also met an education professional who works at a polytechnic in Singapore and who was responsible for VLE development in the institution. I decided to interview her (see appendix to find out how they had managed to institutionalise a VLE in their institution and to elicit her views on how VLE might be developed in UK secondary schools.

3.6.1. (d) Interview transcriptions

'If data have been recorded using technical media, their transcription is a necessary step on the way to their interpretation' (Flick, 2002, p.171). In consonance with this apt observation by Flick, all the recorded interviews had to be transcribed. In keeping with the ethical commitment to the participants' confidentiality and anonymity I had to transcribe all the interviews myself. Transcribing the interviews was very labour intensive, taking me on average, half a day to transcribe a thirty minutes interview. Although Edwards and Westgate (1987) estimated transcription to take about 15 hours for one hour of audio recording, I think I took longer because it was difficult for me to understand the accents of the participants who used English as their mother tongue whilst it is a second language to me. However, despite being a time consuming process, it actually helped me to become more familiar with the data and this was helpful for data analysis purposes. In the same vein, May (2001, p.138) posits that although transcription is a very long process, '...recording can assist interpretation as it allows the interviewer to concentrate on the conversation and record the non-verbal gestures of the interviewee during the interview'.

There exist different transcription systems, however, a standard has not yet been established (Flick, 2002). I was influenced by the views of Strauss (1987) who says that it is more reasonable to transcribe only as much and only as exactly as is required by the research questions. I did not include transcriptions with annotations about voice stress, accent, paralinguistic features, precise duration of pauses, or signalling of instances of conversation overlap since my purpose was to elicit the views of participants on the use of new technologies. I focussed on the speech and during transcription of the interviews I decided to include three columns as indicated below:

I. The line/paragraph number
II. The speaker (Myself and the Participant)
III. The text of the transcribed interview

Occasionally I added contextual information by writing a brief note about the interaction, particular body movement, when for example, the teacher referred to work on the VLE or EVS. These little notes helped me when I looked at the transcriptions later, since they served as reminders of particular events. I also kept more detailed field notes that I did not include with the transcriptions. When taking a quote or an excerpt from transcriptions in the results and discussion chapter, I include reference to the source that includes the participant or myself and the position of the text in the transcript. Here is an example: (EZ-6). In this case the data is from line number 6 in the transcript of an interview conducted with a participant whose pseudonym is Edna Zara and likewise, (GC-1) will mean data from line 1 in the transcript of a question posed by the interviewer.

3.6.1.(e) Validation of the interview data

There exist different 'validation strategies' (Creswell, 2007, p.207). In this section I am going to explain briefly how I ascertained the validation of the data obtained through interviews. As part of the research process when I finished writing the first drafts of the interview accounts I solicited participants' views of the credibility of the findings and interpretations (Lincoln and Guba, 1985; Merriam, 1988; Miles and Huberman, 1994). This technique called member checking, is considered by Lincoln and Guba (1985, p.134) to be 'the most critical technique for establishing credibility'. The approach involves taking data, analyses, interpretations and conclusions back to the participants so that they can judge the accuracy and credibility of the accounts. Stake (1995, p.115) argues that participants should 'play a major role directing as well as acting in case study research. They should be asked to examine rough drafts of the researcher's work and to provide alternative language, 'critical observations or interpretations'. For this validation strategy, I emailed all teachers and other education professionals who took part in interviews and asked them if they wanted to read the accounts of their interviews and give me some feedback. I was interested in their views of these written analyses as well as what was missing. I failed to get hold of one of the participants from the Midshire LA but managed to get in touch with the rest of the participants who were very cooperative. They agreed to look at the interview accounts and provided some feedback to me. Commenting on the importance of participant validation of data Borg (2006) and Silverman (2005) indicated that participant validation enhances credibility of the data collected.

In my first email to the participants I made it clear that reading the interview accounts was voluntary and whoever wanted to write some comments on their interview was free to do so. The interview accounts I sent to them included pseudonyms, I wanted the participants to appreciate that anonymity was preserved in the research. I did not give any dates by which I wished to receive any feedback they would send me to avoid putting any pressure on them. I did not want them to have a feeling that this was an additional task to the interviews they had voluntarily participated in. After sending them the first email where I wanted to find out whether they would be interested to have a look at the interview accounts, more than 80% of the participants replied me almost instantly agreeing to read the account. I sent the accounts and less than 50% of the participants sent me feedback which ranged from simple and straight forward statements such as 'it's ok' to minor corrections of content. No additional data were generated.

3.6.2 Questionnaire

Students were surveyed to facilitate an understanding of their perceptions about the learning experiences using a VLE and an EVS. In this case a self completion questionnaire was chosen. It provided a quick and easy way of getting information and also had the advantage that questions could be standardised and anonymity could be assured. Since there is no interviewer present when a self-completion questionnaire is being completed, interviewer effects can be eliminated: '…it has been suggested that such characteristics as ethnicity, gender, and the social background of interviewers may combine to bias the answers that respondents provide' (Bryman, 2004, p.133). Use of a questionnaire made it easier for me to ascertain information from large numbers of students over a short time compared to interviews. Given the tight schedule in the schools, you cannot afford to access students or teachers for a long time! For me, time was not a problem, however, the participants had a strict timetable to adhere to in the schools and they could not spare a lot of time to accommodate me.

On the VLEs project, I used a questionnaire on two different occasions. Firstly, I administered a questionnaire to elicit the views of students on the use of a VLE (soon after the VLE induction lesson, which was held at school C). A questionnaire was also used to get views of a teacher from school A, who could not be interviewed face to face due to time constraints.

On the EVSs project, a questionnaire (see appendix 8) was used mainly to elicit views of students on the use of EVS. A total of 150 students participated in the study and these were ranging from y7 up to y12. The raw data generated from the 150 students who were surveyed is shown in appendix 11. I included the raw data to enable anyone interested to conduct own analysis of the data to be able to do so. I also used a questionnaire to gain insights of two teachers who I could not meet up with for face to face interviews.

3.6.2. (a) Piloting the Questionnaires

Cohen and Manion (1985) argue that, 'An ideal questionnaire possesses the same properties as a good law. It is clear, unambiguous and uniformly workable'. To achieve the designing of such a questionnaire, Wellington (2000) emphasises the need to pilot test questions highlighting that, 'the printed word raises problems unforeseen in spoken, human contact' (p.105). In the same vein, De Vaus (1993, p.54) advises that, 'do not take the risk. Pilot test first'. In line with this advice, after designing my questionnaires I pilot tested them to ensure that my participants would understand and interpret the questions easily allowing me to generate the data that I wanted. For the teachers' questionnaires, I asked three PGCE science student teachers in the school of education at my university to complete the questionnaires and comment on the clarity of the questions. These students were familiar with the use of the technologies that I was studying as they were being used in their placement schools. They also agreed to pilot test the students' questionnaire with their own students in the placement schools. I gave each one of them five questionnaires which they took and administered to some year 10 and year 11 students. I then analysed the completed questionnaires and found out that all students had managed to complete the questionnaires without facing any difficulties. Feedback on the clarity, length, content and relevance of the questionnaires (both for students and teachers) was positive. The only observation made was that voting systems were known by different names in different schools. I took note of this when I conducted the main study; I made sure that I used the right name for the voting systems that teachers and students in each school in my study were familiar with. For instance, in some of the schools, voting systems were referred to as 'handsets' while in some schools they were known as 'clickers'.

3.6.3 Focus Group Discussions

Making reference to group interviews, May (2001, p.125) asserts that group interviews, '...constitute a valuable tool of investigation, allowing researchers to explore group norms and dynamics around issues and topics which they wish to investigate'. Focus group discussion is a method within this broad category of interview techniques (ibid.). The main difference between the group and focus format is that in the latter participants are more explicitly encouraged to talk to one another, as opposed to each person answering questions in turn (Kitzinger and Barbour cited in May, 2001). Patton (1990, p.335) defines a focus group discussion as: 'an interview with a small group of people on a specific topic...' In contrast to other authors Patton underlines the fact that: 'The focus group interview is, indeed, an interview. It is not a discussion. It is not a problem solving session. It is not a decision making group. It is an interview' (ibid.). My study involved the use of a focus group discussion. I used this method when I sought to elicit the views of students towards the use of a VLE. Each of the two groups I interviewed consisted of three students. These students were all from school C, a school that had the opportunity to teach a few VLE lessons before taking a decision to abandon them. I decided to make use of this method in line with the observation made by Hennink et al. (2011, p. 136) who consider that, '[t]he interactive nature of data collection found in a group discussion enables this method to generate more insights on the research issues than a series of in-depth interviews with the same number of participants'. This view is also echoed by Flick (2002, p.113) who argues that group interviews, '...stimulate [interviewees] and support them in remembering events, and that they can lead beyond the answers of the single interviewee'. I had an interview guide (see appendix 9) which served basically as a checklist not a rigid format of questions. I was flexible to restructure the order of questions and to follow topics as they were spontaneously raised by the participants. With the consent of the participants, the focus group discussions were audio recorded using a digital voice recorder. This enabled me to focus on the questions and to make observations of other different forms of communication like body language. The interview recordings were subsequently transcribed ensuring anonymity of participants. The participants were given numbers, for example, student 1, student 2, etc., hence in my writing in the primary data chapter, I will refer to student number not their real names. It is important though to realise that I was interested in understanding the views held by the groups of students and not the individual-level information.

3.7 Data Analysis

Qualitative and quantitative data analysis tools were used for analysing qualitative data (generated through interviews) and quantitative data (generated through use of a questionnaire) respectively. I will start to talk about analysis of the interview data followed by a look at the analysis of student questionnaires.

3.7.1 Analysis of interviews

After transcribing the interviews I analysed the data using 'thematic analysis'. 'Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data' (Braun and Clarke, 2006, p.79). The interview guides helped me to identify some of the themes I used in my analysis of data but there are also some themes that emerged during the interviews that were not captured in the original interview questions. Ritchie and Spencer (2002,p.309) argue that: 'qualitative data analysis is essentially about detection and the tasks of defining, categorising, theorising, explaining, exploring and mapping are fundamental to the analyst's role'. I found this task to be a time consuming one as Lofland and Lofland (1984) hinted when they said you need roughly two to five times as much time for processing and ordering the data as the time you needed to record it. Each interview transcript was analysed and written up as a case study in its own right (Smith, 1995) in the data presentation chapter. I presented a discussion of themes across cases in a separate chapter, the discussion. This was an attempt to ensure the integrity of the data as representing the perceptions and experiences of the individual teachers or students before attempting to look for broader generalisations across the groups.

Common themes started to emerge from the case studies data and I identified these as key themes. From the Midshire VLE project I interviewed teachers and students. For the teachers, the following key themes were identified:

- Adoption of the VLE project
- Teacher preparedness for the VLE lessons
- Challenges faced by the teacher using VLE lessons
- Impact of using a VLE on teacher's perception of teaching and assessment of science
- Failure of the VLE project

On the other hand, the following key themes were identified from the students' interviews:

- Attitude towards use of computers in lessons
- Attitude towards VLE lessons
- Home access of VLE lessons
- Why the VLE lessons were abandoned

I also analysed interviews of participants beyond the Midshire County who were using the VLE successfully. The key themes that emerged from those interviews are as summarised below:

- Adoption of a VLE in the organisation/school
- Ways in which the VLE was being used in the organisation/school
- Home access to broadband
- Technical support system in the organisation/school
- Students' attitude towards the use of a VLE
- Teachers' attitude towards the use of a VLE
- Reasons behind the success story of VLE usage in the organisation/school
- Problems and challenges of using a VLE
- Advice to other Departments wishing to start using a VLE

I also analysed interviews of the teachers who were using EVS and the following key themes were identified:

- ➢ Adoption of the EVS
- ➢ Learning to use the EVS

- Different ways of using the EVS in the classroom
- Students' attitude towards use of EVS
- Problems and challenges of using the EVS
- Impact of the use of EVS on teachers' attitude and perspectives about teaching.

The common key themes were used as a basis for the discussion bridging across the case study participants presented in a separate discussion chapter and that attempted to map the outcomes to the research questions.

3.7.2 Analysis of questionnaires

I used a questionnaire for some teachers to whom I could not manage to administer face-to-face interviews. Their questionnaires had open-ended questions so they generated qualitative data that were analysed using the same themes as those shown above for the teacher interviews.

On the other hand, I used a questionnaire with 22 closed-ended questions and 3 open-ended questions to elicit views of students who were using EVS in their learning. The three open-ended questions generated qualitative data that was analysed qualitatively using a thematic approach. The closed-ended questions were analysed using MS Excel making it possible to make graphical and tabular representation of data. All the 150 students were treated as a single group. The questions were analysed using the following themes:

- Impact of clickers on student participation in class
- Knowledge retention
- Ease of use of clickers
- Students' attitude towards the use of clickers
- What students appreciate about using clickers
- What students dislike about use of clickers in science lessons

In the discussion chapter the identified themes will be used to discuss the relevant research questions.

3.8 Participants of the study

This research study was carried out with some secondary schools in Midshire, Miltonshire and Milkshire Counties. In Midshire, the concerned schools were trying out the use of a VLE in the teaching and assessment of science with the support of their LA with a view to ascertaining ways of improving students' academic performance. The original plan for the Midshire VLE Project was that each school would have two groups of science students which can be either year 10 or year 11, a science teacher, an IT technician and a science HOD taking part in the study. In addition to these, the Midshire LA science consultant and IT technician were also part of the study. However, the VLE project ran into difficulties and most of the participants who were anticipated to participate in the study did not do so. However, it is worth pointing out that when some of the participants failed to continue on the project, the researcher ended up engaging participants from other places outside the Midshire County. A detailed account of this is provided in chapter 4.

For the EVSs project, participants were drawn from schools in two Counties, one school from Milkshire County and two schools from Miltonshire County. Some teachers in the science Department from these schools were using the innovative technology in their lessons. I, therefore, included the teachers who were using the EVS in my study as well as students from their classes.

3.8.1 Research sampling

I used purposive sampling in my study. This was in consonance with what Creswell (2007, p.125) explains: '...purposive sampling is used in qualitative research. This means that the inquirer selects individuals and sites for study because they can purposefully inform an understanding of the research problem and central phenomenon in the study'. According to Creswell (ibid., p.126), 'researchers can sample at the site level, at the event or process level, and at the participant level'. I could only work with schools that were using an innovative instructional technology, either a VLE or an EVS in the teaching and assessment of science because this was the main focus of my study. I was interested to find out how the new innovative technologies were being used and their impact on the teachers and the students. Therefore, to begin with I had to sample schools that satisfied the criterion. Secondly, within the schools, I was interested in working with teachers who were using the technology with their students in the classroom. It therefore meant that purposive sampling technique was the plausible option for me.

3.8.2 Ethical considerations

This research study was carried out in light of the ethical principles of the University of Sheffield's Code of Practice on Research Ethics which are in conformity with the British Educational Research Association (BERA) ethical guidelines. BERA (2004, p.5) considers that, 'all educational research should be conducted within an ethic of respect for the person, knowledge, democratic values, the quality of educational research and academic freedom'. The guidelines set out by the association are framed under the following headings: responsibilities to participants, responsibilities to sponsors of research and responsibilities to the community of educational researchers (BERA, 2004). Based on these guidelines I made important ethical considerations in my study focused on the application of principles including seeking permission and informed consent, voluntary participation, anonymity and confidentiality and minimisation of harm. These principles will be discussed in the subsequent section paying particular attention to how they were applied in the context of my study.

Seeking permission to conduct the study

Permission to carry out the study was sought and granted by the University of Sheffield through the Department of Educational Studies ethical review committee (see appendix 10).

Informed consent

According to Hennink, et al. (2011, p. 63), 'individuals should be provided with sufficient information about the research, in a format that is comprehensible to them, and make a voluntary decision to participate in a research study'. This view is echoed by Newby (2010, p.357) when he asserts that: '...consent is more than a signature on a form. We must be sure that people understand in what (and on what basis) they are participating'. In tandem with these important observations, I made sure that all my participants were informed about the nature and the purpose of my study. I prepared a detailed information sheet and a participant consent form and these were given to participants before engaging in the study. For instance, when I visited a school to conduct an interview with a teacher, I always made sure that the interviewee was given time to go through the participant information sheet and the consent form before embarking on the interview. I also clarified any questions they had to make sure that they were fully aware of what involvement in the study entailed before they agreed to participate. In the case of students, although the teacher consented on their behalf I made sure that either the teacher or myself explained to them fully what the study was all about and the implications of their participation making it explicit that participation was solely on a voluntary basis. After being given the information the students had the right to choose whether they wanted to participate or not in the study. Participants were kept informed about the nature and the purpose of the research throughout the research process.

Voluntary participation (avoiding coercion)

In the participant consent forms I stated clearly that participation in the study was voluntary. Participants had the right to refuse participation without negative consequences. When I conducted interviews, I also asked the participants if they wanted to be recorded or not. If anyone of the participants was unwilling to be recorded I was prepared to proceed without recording in which case I was going to rely heavily on notes rather than recording. All my participants agreed to be recorded. I explained to them that I would destroy all the recordings when the study was complete. In addition to this all participants were informed and reassured that it was within their right to withdraw from the research for any or no reason, and at any time.

Maintaining anonymity and confidentiality

As a researcher it was my responsibility to protect the identity of my research participants and to ensure that all data records were kept confidential at all times (Hennink, et al. 2011). In terms of ensuring anonymity, I made use of pseudonyms for the participants, schools and Counties in my study. I also informed the participants that the research information was to be analysed and reported anonymously. Hennink, et al. (2011, p.71) argue that, 'in qualitative research, it is difficult to assure complete confidentiality because researchers report the study findings and ... quotations are often included in these reports'. However, 'although complete confidentiality cannot be ensured...qualitative researchers can restrict who listens to the recording of the interviews...' Assurance was given to the participants that no other third party could have access to the recorded data apart from my research Supervisor and/or Examiners without the participant's written consent. Any recorded data were to be destroyed after completion of the study.

Minimization of harm

Although the influence of bioethics means that harm is most often thought of in physical terms, it also includes physical, psychological, social and economic damage (ESRC, 2005). Israel and Hay (2006, p.96) argue that: '...in social sciences, research harm is generally more likely to involve psychological distress, discomfort, social disadvantage, invasion of privacy or infringement of rights than physical injury'. During the conduct of my study, I was aware that my research participants could conceive the idea of being under investigation and hence subject themselves to working under pressure which can be stressful. I made sure these participants understood the purpose of the study and emphasis was put on ensuring that they were not going to be implicated in any way in the study.

Final note

In addition to the above ethical principles, as a researcher working in a new environment, with a different culture, I relied a lot on support from my Supervisor. I sought clarification on cultural issues I thought would impact on my work as a researcher. It was important for me to establish how to build good relationships with the participants. I had to learn the language to use when communicating either by phone or through emails to ensure that I maintain good relationships with the participants, necessary for the successful conduct of the research study. Researchers are encouraged to be 'culturally sensitive when conducting qualitative research in other cultures'. (Hennink et al., 2011, p.62).

The following chapter focuses on data presentation and analysis.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter contains data generated through the use of different tools, used with different groups of participants involved in the study of two new technologies: Virtual Learning Environments (VLEs) and Electronic Voting Systems (EVSs). Most of the data are generated through the use of semi-structured interviews and each interview data will be presented separately as argued by Smith (1995, p.9) when he says 'a single respondent's transcript may be written up as a case study in its own right'. An attempt is made to use common categories in the presentation of the data whenever it is considered possible to do so, however, I must emphasise that I did not prioritise this because I worked with individuals who held different positions and so in the majority of cases I raised slightly different questions with each individual especially with the VLE project. The chapter represents my attempt to construct meaning from the data I generated from the different individuals involved in the study. The study sought to find out the impact of using new technologies on teachers' perceptions about the teaching and assessment of science as well as to assess the impact of using the new technologies on the students' perceptions and views about science and its impact on their academic performance. Initially, the study was focussed on the use of VLEs only, however, the VLE project ran into difficulty a few months after it was started and it was impossible to stick to the original plan. I decided to include the study of another innovative technology, the EVSs. The following research questions evolved and were pursued in the study:

5. What are the circumstances which led to the adoption of the innovative technologies by the participating teachers?
6. Can the innovations help to change teacher ideas about the teaching and assessment of science?

7. What are the students' perceptions of the value of using the innovative technologies in the teaching and assessment of science?
8. Are there observable indications that the use of the new technologies in the teaching and assessment of science helps to improve student's academic performance/achievement or views about science?

In the following section I will present the data generated from the VLEs project followed by the data from the EVSs project.

4.2. Data from the VLEs project

Before I focus on the presentation of the interview data I will start by presenting data related with the origin and implementation challenges of the VLE project. I have decided to do this to enable the reader to have a good grasp of the interview data that will be presented in the subsequent section.

4.2.1. VLEs project in context

November 2008

The idea to try out an innovative project in some schools was picked up some time in October 2008 by the Midshire[5] LA. Our Department at University was approached by the LA officials to see if any research student would be interested to study the implementation of an innovative project in the teaching and assessment of science. I got interested with the idea and through my supervisor a meeting between the staff from Midshire LA and myself was set up on the on the 13th of November 2008. The meeting was hosted by the LA in Midshire. Two people represented the LA and these were the Head of Improvement (11-19) and the Mathematics Consultant who stood in for the Science Consultant. It was at this meeting that we discussed the possibility of my involvement in a collaborative research project in Science Education. The LA indicated its desire to help a group of schools in one of the districts in their County that had problems with a view to improving results and encouraging

[5] Pseudonym used.

networking among schools. The Head of Improvement was prepared to give financial support of £1000 to each school that was prepared to try out any innovative project to improve the teaching and learning of science. She also promised to contact schools for possible involvement in the project. I was happy with the arrangement and agreed to be the principal researcher on the project. The research component was going to satisfy my PhD study requirements and at the same time, it was going to provide useful feedback to the LA regarding the implementation of the project. The project was conceived within the framework of the National Challenge Scheme (see www.dcsf.gov.uk/national challenge/) introduced by the Labour Government in the same year (2008).

January 2009

The Head of Improvement convened a meeting at one of the schools in Midshire on the 13th of January 2009 where she invited Heads of Science Departments (HODs) from four schools that had shown interest to participate on the research project. My Supervisor and myself were also in attendance at the meeting to clarify our interests in the project and elaborate the nature of any collaborative work with them. Apologies were extended for the Science Consultant in the County who could not make it to the meeting on that day because of other work related commitments. At this meeting the Head of Improvement invited HODs to discuss and agree on any project of their choice that could subsequently be implemented in their schools. It was interesting to note that at the beginning each school came up with a different theme as follows:

School A: 'How science works'

School B: Small group work

School C: Use of a VLE for developing science

School D: High level thinking skills

After spending some time debating on the convenient project, the HODs agreed to combine two themes suggested by School C and School D. The theme agreed with a 'big question' was 'Can VLEs stimulate High Order Thinking Skills?' It meant from this meeting all the schools were now going to work towards the implementation of the VLEs project. The Head of Improvement was going to provide financial support to each school. This money was meant to help the schools to provide cover when needed as teachers were to be freed to work on the development of the VLE resources. It was agreed that for a start the schools were going to identify one unit of Edexcel GCSE in Biology and teach it using a VLE. The unit could be taught either to students in year 10 or year 11. Each school was going to contribute in producing the resources for the unit. In addition to the financial support the LA was also going to request involvement from the IT Consultant and the Science Consultant who were both housed at the LA offices. From here, it was agreed that schools would meet with me to discuss the fine details of how the research aspect of the project was going to be conducted.

February 2009

A meeting was convened on the 24th of February 2009 in Midshire. This time each school was represented by two people, the HOD for Science and a science teacher. One of the schools (School B) was absent at the meeting, that is, did not sent any representatives. No apologies were received. I was in attendance to observe the developments. It is worth mentioning that prior to this meeting the HODs had gathered with their teachers in their respective Departments and had agreed to work on a particular topic 'Behaviour in Humans and other Animals'. During this particular meeting the schools divided the unit into four sections and distributed tasks for each school to develop resources for their section and then share the material with other schools. Regarding how the research was to be conducted each school was going to teach two groups of either Y10 or Y11 students and I was going to evaluate the impact of the intervention. While the other two schools present were comfortable with the use of an experimental design involving the use of a control group, one of the

HODs from the other school argued against the use of control groups as he said 'all students should benefit from the project'. I agreed with his view and I was happy to involve all the groups and avoid using control groups in my study which of course was to be mainly a qualitative study.

March 2009

One of the teachers from school C which was taking a leading role in the project, volunteered to teach the first VLE lesson on the 19th of March 2009. On this day, science teachers from all the four schools who were involved in the project, the IT Consultant and the Science Consultant and myself were in attendance. The first VLE lesson was taught to a Y11 group which had 29 students while we all observed them working on their own. At the end of the lesson I administered a questionnaire to the students to elicit their views on what they thought about using a VLE in a science lesson. The responses that were given by the students were analysed immediately and it emerged that most of the students were happy and satisfied with the use of the VLE. We had a review meeting after the lesson and all the teachers unanimously agreed that the project was a viable one and should therefore be implemented in all the participating schools. The science Consultant had his own reservations about the utility of the intervention and indicated that he was keen to know whether this intervention would improve attainment levels of the pupils. To him, this was going to be the fundamental criterion for judging the success of the project. However, as a researcher, I was interested not only in the impact of the project on students' attainment levels but also on other issues as I have indicated earlier on in this chapter. At the end of the meeting teachers encouraged each other to finalise the preparation of teaching resources and share with each other so that the whole unit could be taught through a VLE. Judging from the enthusiasm of the teachers at the meeting there was no reason to cast any shadow of doubt on the success of the project, however, some more work still needed to be done. The next meeting was scheduled for 18 June 2009. It was agreed that every school was to bring all their resources to that meeting to ensure that each school had the full set of teaching material for the unit in the following academic year (2009/2010).

Postponement of meetings

Meetings to discuss and take forward the VLE project work were constantly postponed for various reasons and this was a major setback to the progress of the project. I will use extracts of some of the mails that I received from teachers regarding cancellation of scheduled meetings.

The first meeting was scheduled on the 18th of June, however, a week before the date I received a mail from one teacher who was coordinating the meeting with the following message:

> Unfortunately I am going to have to cancel the meeting on Thursday 18th June; this is due to us having a Y5 day in school. Can I suggest an alternative date of the Tuesday 7th July? Hope to hear from you soon (email dated 11/06/2009).

Similar messages continued to reach my mail box. For instance the meeting scheduled for the 7th of July was also cancelled.

> Sorry to mess everyone's diaries up, but I cannot get cover for the meeting on the 7th-it is our sports day in addition I am struggling to designate an entire day so can only suggest an afternoon slot on Tuesday 14th July. Please let me know if this is convenient for everyone. Thanks (email dated 30/06/2009).

Ultimately, we could not hold the meeting on the 14th of July and that meant the only possibility was to be in the next academic year. Another email was circulated with the following message:

> Gladstone [sic], I had planned to have a meeting before the end of term. Unfortunately no other members of the group can make it due to end of term commitments like sports day and field trips. Can I now suggest that we meet in September (email dated 13/07/2009)?

Staff turnover appears to have been one of the issues that affected the progress of this project and this was not only taking place at school level but even at the LA. On the 28th of September I received an email from the LA informing me that there was a new Science Consultant who was going to take over the coordination and supervision of the VLE project. It looks like this new Science Consultant did not get all the necessary information about the project as she actually had to ask me for names of schools participating on the project and the contact persons for each school. Part of her email message to me read:

> I'd like to help by following up on those schools and personnel who were getting involved last year for you but do not have contact names available here. Please could you let me know which particular schools were involved and the name of the key contact you are working with (email dated 28/09/2009).

The new Science Consultant, however, showed keen interest to see the project going forward and one of the things she did first was to call for a meeting of all the parties involved. She felt it would be valuable for all participants to meet together to bring each other up to speed on progress regarding the implementation of the VLE project.

November 2009

A meeting was arranged for the 19th of November 2009 and was hosted by school C in Midshire. A week before the meeting we received an apology from school D, they were not able to send any representative to the meeting because the teacher who was involved on the project was ill and off work for a long term. The meeting was conducted; representatives from two schools (school A and school C) were present including the new Science Consultant and myself. At this meeting I was the only person who had been on the project from the beginning, the rest had joined at a later stage so I took time to give a reprise of the project aim and objectives before discussing the way forward for the project with the whole group. The two teachers who were present had managed to prepare some resources for the VLE lessons, however, these needed to be uploaded on the VLE and the expertise was lacking. Support was needed to upload the lessons on the VLE. Further funding was also needed to support further teacher release thereby enabling them to work on the development of more VLE lesson resources. The Science Consultant was going to handle all these issues. It was also agreed that the teacher from school C was going to start teaching the VLE lessons on the 22nd of February 2010 as she would have 8 lessons ready by that date. The course of action was mapped out clearly as shown in the table 4 below, the new consultant was geared to provide leadership and steer the project forward.

TABLE 4: PLANNED SCHEDULE FOR ACHIEVING DATA FOR THE MIDSHIRE VLE PROJECT

Date	Activity
19.11.2009	• Learning episodes written and if possible uploaded to VLE
01.02.2010	• All learning episodes uploaded (including School A and School C) ready for teaching beginning 22.02.2010 • Researcher to provide initial surveys for pupils (60 colour copies)
w/c 08.02.2010	• Diagnostic surveys used by students and passed to the researcher • The researcher to analyse and provide results to teacher in school C • Lessons delivered • Lesson observation by the researcher-possible timings Monday P2,4 Tuesday P1.
w/c 15.03.2010	• When teaching completed, diagnostic survey 2 completed by pupils • Surveys returned to the researcher by 26.03.2010
w/c 12.04.2010	• Interviews with teachers at School C re teacher reflections and implementation , learner feedback • Possible use of Mock B3 outcomes as indicator of outcomes.
30.06.2010	• Review/ Evaluation meeting-9.30am

The schedule of activities was well defined, however, this was not everything needed for the project, the people involved needed to fulfil the designated tasks.

February 2010

During the early days of the month of February the Science Consultant sent an email reminding all teachers to submit the resources they had produced to enable one of the teachers (at school C) to prepare to teach her lessons as planned. Her email read as follows:

> The teacher from school C is aiming to [teach] the B3 unit on Behaviour after half term and is now in desperate need of having the resources that you committed to producing last year, ready for uploading to the VLE system. Please, please can you forward the materials as soon as possible to the teacher (or myself if it's as easy) so that we keep our commitment to supporting this project. Please phone me as soon as possible if there are problems with meeting this request (email dated 05/02/2010).

Despite this effort, two of the schools (school B and school D) did not respond. It became clear that there were not enough resources to teach the whole topic using the VLE. School A and school C brought their resources together and these made up the first eight lessons of the topic. I took the questionnaires for the diagnostic survey 1 to school C in preparation for the launch of the VLE lessons. The VLE lessons were supposed to be launched on the 22nd of February. On that day I went to the school, however, the VLE lessons were not launched as per plan, the teacher was off sick. I managed to administer the diagnostic survey with the help of the teaching assistant who was covering for the science teacher. I then waited for the teacher to inform me of the new dates when she was going to start delivering the VLE lessons. Despite several prompts through the phone and the email the teacher did not come back to me at all. I raised my concern with the Science Consultant who was the coordinator of the project; she was also unaware of what was happening in the school. She, however, managed to send an email to the teacher and forwarded a copy to me. It read as follows:

> Hi Yasmin[6], Just wondered how you were doing with your 'Virtual' B3! Did you manage to get the uploading done by John[7]? How has the teaching been going?

It appears the teacher was very busy and took long time to respond to the mail. We only managed to hear from her on the 28th of April when she sent an email to me copied to the Science Consultant for her information. Part of it read as follows:

> With respect to the VLE distance learning project, after two weeks I am afraid we abandoned it as the majority of students were excessively complaining and after taking feedback in the form of a questionnaire, bearing in mind target grades and progress I felt that for the best of the majority of the students it would be better to go back to regular teaching of lessons.
>
> Whilst I firmly believe the project has applications, perhaps better suited to the BTEC style learning I don't think it supported the hitting of the top grades in its current form. Perhaps with time and resources to extend and further develop a bigger range of resources this could be better achieved (email dated 28/04/2010).

This signified the end of the VLEs project in all the four schools in Midshire because this teacher was from the only school (School C) that had shown commitment to achieve the goal of the project yet it was giving up too. I made arrangements to conduct interviews with the teacher, students and the LA staff.

[6] Pseudonym used.
[7] Pseudonym used.

4.2.2 The VLEs interviews

Failure of the VLEs project to take root in any of the four schools resulted in some changes to my original research plan. It became clear to me that the VLEs project was not going to allow me to generate data to answer my research questions adequately. For instance, although I still managed to generate some data to answer research questions one to three, it was impossible to pursue research question four. Instead, I had to focus on the implementation challenges of the innovation. In addition to this, I also decided to study the use of another new technology, that is, EVSs. Following below is the interview data generated from the VLEs project.

The interview context

The interview extracts presented in this chapter are from the individual interviews conducted with the Science Consultant from the LA, science teacher from School C and students from School C who had the chance to experience a few VLE lessons. They were conducted after the final participating school, school C, had abandoned the project. I will also include extracts from interviews that I conducted with individuals from beyond Midshire LA, who are from institutions where VLE was being used successfully. All interviews were held in quiet rooms where there were no disturbances from other people and where participants felt comfortable. I used a digital voice recorder to record all the interviews after getting participants' consent. Each participant was provided with an information sheet where the nature of the study was clarified. It was also made explicit that participation was to be voluntary and participants were free to withdraw from the study at any point when they felt the need to do so. I also made it clear to them that the information they were to provide was to be treated confidentially and all recordings would be destroyed at the end of the study.

In instances where the respondent gave an extended response that could serve as a standalone illustration, I have preferred to privilege the individual's voice and used just the individual's response, isolated from the conversational prompts. However, where there was an interchange between the respondent and me, rather than an extended response from the individual, I have selected extracts which include both my conversational prompts or questions and the individual's responses.

The text

In recognition that 'the syntax of verbal speech is not as controlled, orderly, or grammatically correct as conventional written prose' (Poland, 1995, p.298), I have made judgements about eliminating the features of the response which interfere with readability. For example, where there is unnecessary repetition or unfinished sentences, I chose to eliminate these provided the meaning of what was said remained unaltered.

Finally, I have been selective about extracts from the interview data I have displayed in order to condense the chapter into manageable proportions. The text is also supplemented with descriptions of aspects related to the institutions' context, in order to aid the reader in understanding the context. It is my aim to reduce and display the data which illustrate the perspective of each individual respondent within each of the categories specific to the research questions so that the reader, in parallel with me, is able to trace the trajectory of my analysis.

4.2.3. Interview data of teachers, students and other individuals on the Midshire VLE project.

Science Consultant: Sandra Wallas[8] (SW)

Interview context

On 22 July 2010 I held an interview with Sandra who worked as the Science Consultant at the LA. The interview was conducted at their premises; we used one of the conference rooms which offered a very quiet and comfortable

[8] Pseudonym used.

environment. The atmosphere was very conducive for a good conversation. As we began chatting I chose to ask simple questions like what her job involved and what was happening in the schools in general before I moved my discussion to focus on the VLE project in particular. This was a deliberate effort to make her feel comfortable and create an atmosphere which would facilitate discussion of issues of interest revolving around the adoption of VLE as an innovative project for some of their schools in the County. Sandra took time to explain to me the nature of her job which involved working with and supporting subject leaders in science across the County with their professional development. She happens to have a very tight schedule as she is the only science consultant working with 45 schools in the County. I was very happy to have an opportunity to talk to her in a relaxed atmosphere. I felt she was the best person to talk to because she was directly involved with the VLE project that was being tried out in the schools. Although she was not involved from the inception of the project, at this point she was the one who assumed a leading role in terms of coordinating and monitoring the progress of the project in all the participating schools.

Why VLE project was adopted

Regarding the circumstances which led to the adoption of the VLE in the participating schools in the County Sandra made it clear to me that the Head of their Department, that is, the School Improvement Services for 11-19, is the one who picked up on the idea that a project on VLEs could help move the use of these forward in a group of schools in a particular District in the County. I still wanted to know more about this, for instance, it was of interest for me to establish where the Head of Department got the initial idea from, was it the influence of any Government Policy or it was merely her brainchild just to make sure schools in her County are keeping pace with the technological developments elsewhere around the country. I went on to seek clarification:

'was the promotion of this technology in the schools in line with any Government policy?' (GC-34)[9]

> I don't know...I certainly think within the schools there would be and there has been in the County over the last years a definite intention to have VLEs because it's new technology and it sounds dismissive to say and why not but I am not being dismissive...I think it was just generally in line with the monies that had been received and you know, and the policy of the last Government to promote new technologies which I think schools were just taking the opportunity to respond to that (SW-35).

According to Sandra, the Head of Department appointed someone who was the science consultant before she took over to oversee the development of the project in the schools. This person got a job elsewhere and left after a year. When this happened Sandra was then asked to take over the responsibility to coordinate the project. She indicated that the schools in the chosen district might have been identified purposefully. The area is considered to be a deprived one so the idea of adopting the use of a VLE was seen as a way of promoting or enabling the schools to work together. She lacked confidence as she reflected on questions I raised because as she put it in her own words, she was not involved right from the beginning of the project and apparently no one took time to explain everything in detail to her as she began to work on the project. At one point she said 'I think that could have been one of the points, I have to be clear that these are my opinions on the basis of the information I have been able to glean from the original set up since I wasn't there at the original set up meetings'(SW-20). It was noticeable on a number of occasions that she lacked confidence in the way she answered the questions I raised; however, this was still useful detail to me as a researcher on the project.

Identification of participating schools on the project

[9] The code at the end of each excerpt refers to the initials of the first name and surname of either the interviewer or the participant's pseudonym. The number refers to the text place in the transcript.

A total of four schools were identified for the project and I wanted to know why the four schools were chosen. '...were the four schools of similar characteristics, were they all considered to have deprivation?'(GC-21) In response to these questions, Sandra explained that:

> The schools draw their cohorts from the same region, therefore, they have similar cohorts and similar issues including how they challenge aspiration, how they come across with higher expectations of their students and how they develop the more able students and so it might have been seen as a possible way of developing those (SW-22).

I enquired about the possibility of finding more information to show that these schools were similar as she was suggesting and she immediately referred me to the league tables available on the Department For Education (DFE) website. The tables below taken from the DFE website present some interesting comparative information on the four schools under study.

TABLE 5: BACKGROUND OF THE SCHOOLS

School	Total number of pupils (all ages)	Pupils with SEN			
		With statements or supported at school Action Plus		Supported at school Action	
		Number	%	Number	%
A	1204	76	6.3	163	13.5
B	1598	102	6.4	620	38.8
C	739	35	4.7	123	16.6
D	1581	111	7.0	278	17.6

Source: adapted from DFE website, Secondary School (GCSE & equivalent) Performance Tables (2010)

As can be seen from Table 5 above, three of the schools had high student population and all had pupils with Special Educational Needs (SEN).

TABLE 6: ABSENCE STATISTICS

	State-funded mainstream schools only		
Institution Name	Overall absence	Unauthorised absence	Persistent absence
Local Authority Average	6.8%	1.9%	4.1%
England (State-funded schools only	6.9%	1.4%	4.6%
England (All schools)	6.9%	1.4%	4.6%
A	7.6%	1.2%	3.6%
B	8.6%	2.6%	6.7%
C	8.5%	2.2%	4.7%
D	6.7%	1.8%	3.6%

Source: adapted from DFE website, Secondary School (GCSE & equivalent) Performance Tables (2010)

All the four schools faced absenteeism problem. The above Table 6 shows that three of the schools were above the LA average as well as State-funded schools and all schools in England, in terms of overall absence. The fourth school was slightly below the LA and national averages.

TABLE 7: YEAR ON COMPARISON OF RESULTS

School	% of pupils at the end of key stage 4 achieving 5+ A*-C (and equivalent) including English and Maths GCSEs.				
	2006	2007	2008	2009	2010
Local Authority Average	40.1%	41.7%	43.3%	47.2%	51.4%
England (state funded schools only)	44.0%	45.8%	48.2%	50.7%	55.2%
England (all schools)	45.6%	46.3%	47.6%	49.8%	53.4%
A	39%	45%	43%	44%	55%
B	18%	19%	29%	26%	31%
C	20%	33%	41%	32%	42%
D	31%	34%	30%	42%	41%

Source: adapted from DFE website, Secondary School (GCSE & equivalent) Performance Tables (2010)

Table 7 above shows that all the four schools under study were underachieving schools. Their pass rates were below national averages and with the exception of school A, the rest of the schools had pass rates below the LA averages from 2006 to 2010. Similar results can be seen in Table 8 below where the percentages of pupils achieving in 2010 are shown.

TABLE 8: KEY STAGE 4 RESULTS

Institution Name	% of Pupils achieving in 2010				
	Level 2 (5+ A*-C (or equivalent) including English and Maths.	A*-C GCSE in English and Maths	English and Maths skills at level 2	2 grades A*-C in science.	Average total point score per pupil.
Local Authority Average	51.4	51.6	57.1	75.8	456.2
England (State – funded schools only.	55.2	55.4	59.4	61.6	449.4
England (all schools)	53.4	53.8	57.4	60.2	438.5
School A	55	55	64	68	561.4
School B	31	31	39	55	482.2
School C	42	42	52	70	409.9
School D	41	41	45	42	420.9

Source: adapted from DFE website, Secondary School (GCSE & equivalent) Performance Tables (2010)

I also enquired about whether improvement of school results was an issue when the project was started and this is what I got from SW:

> Er, it would, now again this is my extrapolation backwards since I wasn't there on the original set up but of the four schools there would be one school which would have been very clearly in need of some support to

> raise outcomes for pupils at GCSE, the other three were possibly around the same, they were getting around the same outcomes but these wouldn't have been higher than the National averages...(SW-28)

She further clarified that all four schools were below National average outcomes for 5 A*-C (see table 8 above). 'So do they fall under national challenge schools?'(GC-32). I noted that she was not very sure about which schools were falling under the category as shown in her response below:

> Now, some of them would, now, who falls under the national challenge schools? I don't want to give you the names, I just want to think how many are they, I think one of them would be. I don't think the other three are, no one of the four would but in general because they are all in that same region they all have got same issues to deal with (SW-33)

<u>VLEs project support system</u>

It was of interest to me to establish the kind of support that was earmarked for these schools after a decision was made to implement the VLEs project. Sandra provided the following information:

> Right, again this is something I got by hearsay because I have not seen it in writing, but my understanding is that there was to be one of us, that was my colleague, was there as sort of a facilitator support on the project, I guess that the original intention would be that he would be able to help with the networking of staff but also I think the Head of Department invested funding into the schools I think it was a thousand pounds in each school in order to, you know, release teachers to... provide cover and or funding for whatever was needed for them to be involved, participate in the project (SW-39).

I also sought to find out whether there was any involvement of the LA IT Consultant in the project but Sandra made it clear to me that there was no IT consultancy involved in the project at all. She pointed out that nobody had said anything about this to her and hence was inclined to think that no such support ever existed on the project. There was no IT support on the project and at times schools relied on their own IT Departments when they had technical problems. I raised the following question to Sandra 'I understand the schools might have come across some technical problems, how did they manage to handle those problems?'(GC-42) In response to this question Sandra highlighted the following:

> Now again that's a very good question and that's a question worth following up because the only times I have heard them [referring to teachers in schools] talk about that this year when I have been involved were not necessarily very positive and I know that one particular school which I won't name but that school had a difficulty because the resources that they were trying to generate for the project had actually gone to the IT Technician [in the school] but were misled that's the only way I can say it...they actually did service it but quite late and that made it very difficult for the school that was really pushing on providing resources in the lessons, made it a bit of a last minute rush, so I would, I don't know how you will put this but my own observation of it is that there wasn't really any obvious IT support which might have been a good idea (SW-43).

Coordination and monitoring of progress in schools

It seemed to me that there was nothing set up in terms of monitoring the progress of the project in schools so I went on to ask about this. 'So from the point of view of the County, of the authorities here, how was the progress in the schools supposed to be monitored... on the evolution of the project?' (GC-46) This is what Sandra had to say: '...I don't know... I don't know, the only thing I know about is when I picked it up I felt that especially from the first meeting that we had together at [school name provided] that it clearly did need a bit more of a steer than...'(SW-47) and she did not complete the sentence. She emphasised the need to provide effective leadership in any project of that type which she felt would be critical to keep people focussed and joined together as indicated below:

> It could be a reflection of my own style with any of these things but I would see it as quite important that when you are pulling people together from different schools and with different expectance on the thing to make sure that it stays joined up... so I think that was something which was unfortunate from the outset and if perhaps there had been a stronger steer from the outset we might be talking, we may have overcome problems more quickly (SW-49)

<u>Failure of the VLE project</u>

As I was talking to Sandra the VLE project had actually stopped in all the schools that were meant to be implementing it so I also took the opportunity to explore some of the reasons why this project had failed to take root in the schools. 'What do you think contributed to the failure of this project to take root in the participating schools because I understand the information I have is no school is implementing it now?'(GC-56)

> No, because (name of teacher supplied) is going to...[Name of teacher supplied] is gonna come out in a slightly different way, isn't she? I don't think she wants to drop the idea because I think of all the places her school are [sic] the school that understands that there is a learning issue here and I know that's clear in [Name of teacher supplied]'s mind because he is the senior leader now who was the one you would have met I think at the [place name supplied] meeting last year but of course he is the one who has not been directly related with involvement in it so what do I think contributed to its... that it didn't take off and not in the place where we wanted it to be , well I think, just my personal point of view, so I am not speaking on behalf of the LA here, eh I think it was er...when you set up projects like this if you do not, if you are not able to secure ownership that the participants become owners of what they gonna be doing I think you are...it becomes very difficult to keep

> generating and keep the motivation going. If people come to it because they are being asked to but it hasn't been their original agenda whatever you are doing, whatever you are into, I think it becomes a really difficult thing to keep momentum on. Er...I think again the fact that during the first year there wasn't a timeline schedule, now we gonna be doing this by this date, so and so is gonna be checking this, individual responsibilities identified that would help to move the project forward and will give everybody, you know, some responsibility accountability, I think that was missing... (SW-57).

When asked whether she thought staff turnover at both the LA and in schools could have been one of the contributing factors to the failure of the project Sandra had this to say:

> Well again, again that's another thing, I don't think staff turnover as such has been an issue, I am trying to think, I am thinking through the staff in those Departments and people who will have been identified as being involved in the project are all there still but again, maybe that's another aspect that will be really key is the identification of the staff, of the key players and if you are not doing...and without the sort of briefing paper that says this is what this sort of person needs to be able to do to identify the staff becomes an issue of say oh you don't seem to be doing much you gonna have to go or you know much or most about VLE or ICT so we will send you whereas you might be asking the question who is the good teacher who knows about learning, yeah, because that's the key bit and the use of the VLE we can make sure that somebody sits budding with you...well I am just thinking through it now in my head Gladson, that could have been an alternative way of doing it, talk about it, I think the identification of the original people who were going to do it could have had more (SW-67).

The future of VLE in schools

Realising that the project was no longer taking place yet the LA had invested some funding in it, I enquired about the way forward from the LA perspective. Unfortunately, Sandra could not provide an answer to that as she was to consult with her line manager first, 'that's the question I can't answer for you because I haven't asked [name of line manager supplied] how she feels about it' (SW-71). Although she could not provide answers concerning the way forward with regards to the development of VLE initiatives in the County Sandra was also quick to point out that they were not very sure about how their work was going to be like and whether the new Government was going to adopt the same stance as the previous Government on the promotion of new technologies in schools:

> You see, we crossed a certain line now, now there has been a change of Government with a different emphasis, the wording of the LA is not quality assurance, critical friend schools, all those sorts of words but also we used to read "provide support for development" but now it's "commission support" so the LA no longer really has the function of supporting schools so the sort of people like myself aren't within the landscape, the advisory side of it is still in place but the advisors will decide oh, they go out to so and so or encourage this school to work with this school and obviously the Coalition Government's policy is for schools themselves to take on their own development so unless there will be schools that were going to set themselves that we want to develop our VLE and we will work with this school, these are the schools, I don't think we would take the initiative, the initiative wouldn't come from us. It's unlikely to come from us (SW-81).

She opted not to continue with the discussion of the impact of changes of Government but made it clear that her role, for instance, was going to be abolished under the new system which means the LA was now going to relate differently with schools. The future of VLE is, therefore, unpredictable given the significant changes in Government policy. Schools now have the full responsibility to decide what they want to introduce and will also decide where to get advice from, the LA will no longer take the initiative on anything.

<u>**Interview with a science teacher from school C:**</u> **Yasmin Williamson (YW)**[10]

On the 24th of June 2010 I had an opportunity to interview a science teacher from School C which was the school taking a leading role in the implementation of the VLE project. School C is an 11-18 Comprehensive school which has been in existence since September 2003 and moved into a brand new building in March 2007. The school is now operating as a Specialist Sports College since September 2009.They are using a VLE called Frog. Yasmin tried her best to implement the VLE project with her two year 11 groups focusing on the teaching of one particular topic namely 'Behaviour in humans and other animals'.

<u>**Interview Context**</u>

This interview was held during a lunch hour break at the school. Prior to the interview date, the teacher made necessary arrangements within the school which included securing one of the conference rooms for the interview session. The room was perfect and an ideal place for the interview as it was free from interruptions from other staff members or students in the school during the interview session. It is worth noting that Yasmin was not on the project from the beginning, she only got involved a few months later after the previous teacher was promoted to the position of HOD which made it difficult for her to continue on the VLE project. The interview was held after a couple of months of working together with Yasmin on the project so she was very comfortable talking to me. Before embarking on the interview session I went through the ethical review forms with her and she signed all the necessary documents for me. I felt that Yasmin was the best person to talk to in the school because she

[10] Pseudonym used.

was now in charge of the VLE project and her hands-on experience with its implementation was of significant importance as she was likely to provide answers to some of my research questions. Following below is a detailed account of the discussion I had with this science teacher.

Teacher preparedness for VLE lessons

Since Yasmin had some practical experience with the use of a VLE in her teaching engagements I began the interview by eliciting her views on how comfortable she was using this piece of technology in her science lessons. I anticipated that she might have had problems with some technical aspects of the VLE. However, in her response I gathered that she was quite comfortable and happy with the use of the technology although she lamented on the limited time at her disposal to prepare the resources for the VLE lessons. This is well illustrated in the response below:

> Yeah, I am comfortable with that. No technical aspects...no problems with that, actually them [the students] using it was fine, preparing the lessons using a VLE was a bit difficult, that was a new skill and a bit tricky so that's something I could have done actually with a little bit more time to actually look at it because what I was finding is other people were preparing my lessons for me which then I could just let the kids log on and have a go with it...that bit I didn't like so much (YW-6, 8).

Yasmin was not happy with the idea of having her students work on their own using materials prepared by other teachers. It is important to clarify that there were four schools involved in this project so each school had to prepare resources for a specific part of the unit and so Yasmin makes reference to this in the above quotation. She felt that it could have been better if she had prepared all the resources for her VLE lessons. It appears that she was not happy with the way some of the material was prepared. I went on to ask if there was anything that she felt could have been done differently with the VLE lessons. The following response captures her thoughts about it:

If I could I would like to go and have a look at the way they were actually written [the resources] and make them a lot more tighter [sic] because what I think is there was a lot of...it was too blurry, the students weren't getting clearer definitions, there weren't getting clearer explanations and this is why I ended up roaming around the classroom explaining things individually and I think that was due to the way the Power Points were structured, oh sorry, we have got Power Points on video clips, they were all structured together, sometimes you would have video clips and for some reason it wouldn't work through to the VLE so that was causing issues, so it's all about making sure that if those lessons are going to work at all they must be a lot tighter and to do that requires a significant amount of time to write them in a different way and institute them so that students can access them without our input and that's where I see the challenge really, that's where I felt inadequately prepared really (YW-12).

There was no proper in-service training offered to the participating teachers prior to using the VLE lessons. I raised the issue of in-service training with Yasmin to find out whether she felt the need for training at any point during the implementation of the VLE project. Regarding this she said:

Yes...I think that's where I fell down really because there were too many of us doing so many things, you know, several people were writing it, none of whom were teaching it, I had not influenced writing it but I was teaching it, it all just needed a lot more time together, we needed some time to actually sit down as a group to say this is what we are teaching, this is the approach, this is how we gonna do it and then move forward so that we are 100% sure of what we are doing, how we are doing it and why and I think also because different lessons had been written by different teachers they were all in a slightly different style and they were all slightly different from mine which is confusing for the students who would have worked with me for the past 3 years and they did not understand really where we are going with this but there is nothing

> wrong with that, I like it because it makes them think in a different way, eh...but also it was quite hard for me to get my head around what they wanted to do and some of the lessons were a little quite basic for the high ability group, there wasn't a structure there, I think if they were actually thought through a little more carefully incorporating assessment for learning and the objectives a lot more tightly I can definitely see applications for it and students have got to know that this task is worth this grade and this task is worth this grade so that they can see they are doing things and how far they have got to go throughout the lesson and maybe that would motivate them a little bit more, that's for that group of students who are highly motivated by grades (YW-28).

From her response, although she did not allude directly to in-service training, a number of factors which did not help in the implementation of the VLE project were highlighted above and these could possibly have been dealt with had these teachers received some form of in-service training.

<u>Student engagement in VLE lessons</u>

One of the issues I wanted to ascertain was how effective the VLE lessons could be in terms of facilitating student engagement. For instance, if students are having a VLE lesson, is there anything that can distract their attention stopping them from doing what they ought to do in a lesson? According to Yasmin:

> Because of the way they were written it was a bit of a long struggle to get through them, it was quite awful, they might be presented with lots of text, they may be presented with a video which said answer those questions and I think they were finding it quite batty, and we are doing this, then doing this and then doing this, there were children who wouldn't see the overall flow of the lesson and what they were to get out of the lesson even if they had all the data in front of them. It was all about the assessment of the work as well I was working out how I could assess what they learn from that lesson and actually making sure that

> they got as far enough through. There was no distraction by talking but I don't feel that they got as much out of the lessons this way as they had doing it with a regular teacher (YW-14).

From the above response I did not get anything on how, for instance, they deal with the problem of internet. I thought this could be a potential problem as students could easily be diverted and end up looking at some websites not linked at all with the lesson. I decided to ask a direct question about it 'did the students have access to internet and wouldn't you find some of them working on You Tube instead of focusing on their lesson' (GC-15). Yasmin claimed that internet was not a problem at all with her students. I asked how she had managed to instil that kind of discipline in her students and this is what she said:

> I don't say I did but the sort of students we have in those classes are very focused and they know what they want and they want to do it well, it's very unusual to get all 36 to be like that and they did just get on and work through. In that way so there weren't distracted by internet which was a bit of a surprise to me as well (YW-20).

The above quotes indicate that Yasmin felt that the VLE was not in itself a barrier to effective student engagement. For instance, students were able to do their work without being disrupted by access to internet. She, however, contends that the quality of the learning material on the VLE is critical in terms of enabling students to see the overall flow of the lesson.

Challenges faced by the teacher using VLE lessons

I also enquired about the challenges that the teacher faced while using the VLE lessons. She highlighted the following:

> I think the challenge for me was to know where the students were and the major challenge with this was with assessment and progress and knowing how to deal with their progress throughout the lesson and

> overall...The main one was assessment and progress and hitting most top grades, making sure they are hitting most top grades (YW-22)

Although the teacher was keen to adopt this innovative way of teaching and assessment of science she also lacked technical expertise, for instance she indicated to me that she did not know how to upload resources on the VLE. The other teachers in her Department including the Head of Department were very supportive of the idea of trying anything new that could help students develop their independence; however, no one could provide the much needed technical help. I felt that for such an innovation to move forward successfully there was need for some kind of technical support. I, therefore, enquired whether they got any support from the IT Department in the school or from the IT Consultant from the LA. Regarding support from school, YW categorically stated that this was not provided at all. She also made it clear that there was no technical support offered from the LA.

It was interesting to establish the response of students to this innovative way of learning. I went on to ask the teacher for her views regarding students' response to the whole idea of using a VLE in their science lessons. The following response was given: 'some loved it, some did love it...but quite a significant majority didn't like it. And like I said it was interesting, it was the higher level students who didn't like it and it was the "c" grades who loved it' (YW-40). If the majority of the students did not like this way of learning science, this obviously was one of the big challenges faced by the teacher. I was prompted to find out why the majority of the students were against the use of the technology and Yasmin explained clearly:

> The ones who didn't like it were quite vocal about not liking it as they came and said we are not going to have this again and ... they were just bored for following through text and they felt that they were just sat working all lesson...I can't quite explain what they said, they just didn't get any stimulation from it, they were just doing it for the sake of it not for the love of it and I think it

> comes to that discussion element so maybe, you know, it needs that with the triple group you can make the tasks like that but you still have got a few elements for discussion in there as well...so when we are using the computers for research and stuff like that to support the learning I can see applications for it there with the triple group...(YW-42).

From what I was able to glean from the above quotes, it appears that the teacher found it difficult to assess students' progress during the lesson and was not sure if the VLE lesson was helping students to hit top grades. Lack of technical expertise was also militating against the effective use of the VLE as the teacher could not upload VLE resources on her own and could not get the needed technical support from either her Department, IT technicians or the LA. Although some students loved the VLE lessons, the majority were unhappy as they seemed to lack stimulation from the way the VLE lessons were designed.

The impact of using a VLE on the teacher's perceptions of teaching and assessment of science

Although Yasmin had used the VLE only for a short time I asked her to reflect on the impact that the use of a VLE had on her approach to teaching and assessment of science. 'So did you have to make any changes in your approach to teaching as a result of using a VLE?'(GC-23) She commented:

> Totally different approach because the main thing with using the VLE is to try and do it in a way that I thought we did, instead of coming in and doing the starter and discussing it, me teaching them doing some sort of consolidation task summarising and at the end assessing my task, that's how normal lessons would go with this group, instead they were coming on to the computer room, logging on and working on their own throughout the lesson with no real chance to share their ideas or consolidate so instead of me explaining things once because they were struggling I had to explain things 30 times as I went around the room to support them (YW-24).

> I don't feel like I was doing much at all. I was definitely a facilitator rather than a teacher and I mean...but I teach my lessons in that way anyway, I always empower them to do their own work but this was too much on them, not enough explanations, I didn't make which is why the hands were going up all the time (YW-26)

The above quotes indicate that Yasmin felt that in VLE lessons she was not teaching in the way she is used to in non-VLE lessons. Although she continued operating in her role as a facilitator, she felt forced to do this on an individual rather than group level. I asked her to compare her use of a VLE and the conventional approach to teaching and assessment more generally. Regarding this she had this to say:

> I think so [VLE better than the conventional approach] as I said I have done something similar now with BTEC group, I haven't got skills at the moment to make that and upload it to the VLE that's something I need to learn. There is no reason why I couldn't do that and they actually love it because they go on to the computers, they log on and they work through all their tasks and I direct them through the tasks and they know what they are doing and I think it's just a different way in which their work is assessed and they have just done really well, they love it. I am being the facilitator but it's better to do that...I find it better to do that with the BTEC group than with the GCSE group, I can't quite tell you why that is, it might be something to do with me not feeling so pressured to achieve those top grades because I know it's, I can just say about this and I will get them the required grades rather than actually to learn something to reproduce in an exam situation so that's maybe the distinction why it works for the BTEC and not for the triple kids...but I definitely see a lot of potential with it, it's just now a case of fitting it in the right place (YW-30).

From her response I read that Yasmin was not dismissive of the idea of using a VLE, in fact, she is using VLE lessons with the BTEC group but found it difficult to continue using VLE lessons with the higher attaining triple science group. She raised an important idea pertaining to the impact of exams on innovative projects. Realising that she might have been forced to abandon the VLE lessons because it was not helping students to hit top grades in exams I went on to ask 'Do you feel if we had nothing like examinations you could have continued using the VLE?' (GC-51).

> No. Still no, because that reason of a group that didn't want to, I will be too worried of the long term impact of switching so many students off when I have got 60 to 70% of students who were bored. I can't continue, especially if I have got good natured, well behaved students who want to succeed, to keep forcing them to do things that they really don't like, I think that will be unfair but again that comes down to the sorts of tasks that we were doing there and we could improve on that to make them better (YW-52)

Turning back to the VLE lessons she conducted, she felt that the problems they faced were related to the way they had prepared their lessons.

> I think the way we wrote it and the way it was put together put those weaknesses in and I think it just needs somebody to have the product, to sit down and one person take responsibility for, who has got the skills, who knows what they want, who has got a vision for it rather than several people doing it on top of everything else that they have to do, I think some of it looks rushed to get there (YW-34).

What does the teacher think about the applications of the VLE in the science curriculum? Is it possible to teach all topics in the science curriculum using a VLE? I raised this question with Yasmin and she expressed the following thoughts about it:

> Er, now you have to forgive me because I have not taught either physics or chemistry for a while but I can see that a lot will be possible with sufficient interactive replications of experiments and stuff like that,

> however, I think to do it like that will be deskilling children, deskilling students if they're thinking of going into industry they need the application, I mean a lot of those who enjoy science enjoy it for the practicals, for the active learning, for the discussion and I think if you sit them in front of the computer that will turn them off, that will be my opinion (YW-42)

I asked the teacher to reflect on the positive aspects of having virtual practical lessons especially looking at the cost side of things where students can practise more on the computer than using the chemicals in the lab environment. She had this to say:

> They can, they could do that and some would like that. I can imagine some girls would like that because they don't like doing the practicals, but I think science is one of these subjects where you need to actually roll up your sleeves to getting up to doing it, and I think, unless you are doing that there are lots of these skills in science that are going to be lost, it's gonna switch a lot of kids off because like if I have got my bottom group in Y9, my set 4 who are not very academic but who are actually brilliant when doing practicals, and they love it and for that reason they enjoy coming to science, if I said to them you are going to do it interactive on the computer, they will drop you on your table whatever they could access, you know, er, and I think it's about gaining that balance right. I think there is applications for it and I think it will be very good for the non-attenders or for students who are catching up or students who are doing resits or anything like that, there are definite applications for that and I think it's important that you keep the actual practicals in there (YW-46).

Yasmin was agreeable to the idea of having virtual practical sessions but at the same time she had her reservations about them as she felt students should engage with real practical activities to develop skills that cannot be developed by virtual practicals. She also felt that some kids who enjoy doing actual practicals are likely to be put off if these are to be substituted by virtual practicals.

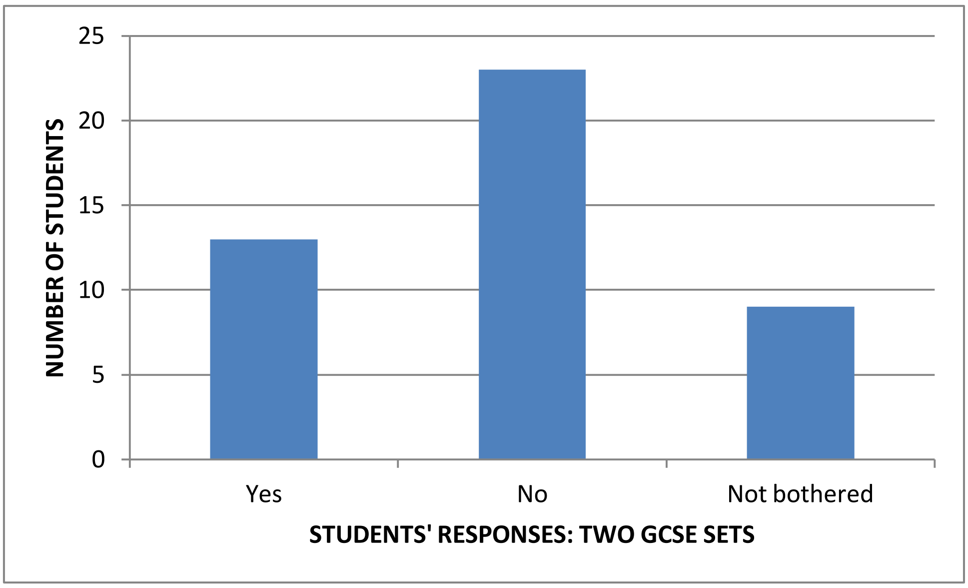
Failure of the VLE project

As indicated earlier on, the VLE had been abandoned by the time this interview session with Yasmin was conducted. Although she had hinted in some responses to some previous questions why the VLE failed to take root in her science lessons, I went on to seek clarification on this. Regarding the reasons why she finally decided to abandon the VLE lessons with her groups,

> I did that after surveying the students, they moaned at me several lessons on trial and they were saying 'do we have to do this again next time' at which point I gave them a questionnaire and asked them to indicate their choice: if you want to continue, Yes; if you don't, No; if you don't mind, Don't know; this gave me some feedback and upon counting them more didn't want to continue than did and at that point I just abandoned it (YW-48).

Students were asked to give their views about the following statement 'I like this way of learning'. Slightly more than half the number of students voted against the use of VLE lessons, that is, 23 students out of 45, as shown in the figure 5 below:

Figure 5: Students' views about the use of VLEs



I decided to conduct some interviews with the students further to explore their thoughts and feelings about using the VLE. Details of the interviews will be presented later in this chapter.

Future of the VLE

It appeared to me that the way the VLE lessons were being implemented was not smooth; there were problems as indicated by both the teacher and the students. Now that this project had been abandoned I was interested to know how the use of the VLE could be improved for possible continuation at some point. Yasmin highlighted the following:

> I think it comes down to having a wide range of activities, more opportunities for blogs, eh or online discussions or maybe through the use of the cameras they can film each other doing things... I don't know...it needs to be more interactive, it needs I think the best thing to do is actually to ask the students how they would want it to be improved and what suggestions they have got because they know more about technology, they may have some good ideas, I think there need to be more videos, more examples of practicals in there, more research to really have them work out, I think it will be a case of having a bigger range of different learning styles integrated into it somehow...quite how we should do that I mean I can see ways in which we should do that (YW-54)

When she talked about creating more activities for the students I thought that would create more work for the teacher, however, she had a different view about this as shown in her comments:

> You see, we do that anyway, it will be a case of learning how to do it on there and once it's there, that's fine, but it's trying and seeing its effects on to students and different students can respond in different ways, like I said for the BTEC students, it works incredibly well and with the triple students it will work well for some of the time and I can see its

> applications for using it in part of the module, this is an independent piece of work, this is how you gonna have to do it and building on to that more research and maybe...do instil more interaction in that maybe (YW-56).

Clearly, despite her disappointing first experience of using a VLE in class, Yasmin remained open to further attempts and had some optimism about the contribution a better designed VLE might be able to make.

Views from a science teacher at school A: Rose Adams (RA)[11]

School A is located within the Midshire County and is a comprehensive co-educational day secondary school. It is a Specialist school for Science and Mathematics with an inclusive policy. From the school website, their vision is to help young people to be enterprising, creative, able to use new technologies and to think independently in a rapidly changing society. Maybe this explains in part why the Science Department in this school was willing to embrace the innovative VLE project which is the object of my study.

One of the science teachers from this school showed keen interest in the VLE project. As soon as her HOD brought up the idea after making contact with the LA, she picked it up and participated actively in the designing of the VLE resources together with teachers from the other schools in the project. However, she also abandoned the project before it reached the final stage of its development. Realising that she had some experience with the VLE lessons I thought it was a good idea to interview her to elicit her views regarding the efficacy of this innovative way of teaching and learning, as well as the problems that led to its failure to get institutionalised in her Department. I made several attempts to arrange a face to face interview with the teacher, however, on all occasions it was difficult to find a time when she could be available for a discussion. Ultimately, she opted that I send her the interview questions so she could answer and email the responses to me. This was a great relief to me because I really wanted to get her views, so I sent her a questionnaire with

[11] Pseudonym used

open ended questions for her to answer. Although she answered all the questions I gave her, in some cases her answers were too brief and it is regrettable that I could not probe her further for more details; neither could I seek any clarification on any of the issues she raised. The questions I gave her covered the following aspects: teacher preparedness for VLE lessons, challenges faced by the teacher using VLE lessons and the reasons for the failure of the VLE project to take root. Her views will be discussed under the above sub-headings in the subsequent section but I will first look at how this project was adopted in the first place.

Adoption of the VLE Project

I was keen to establish the reasons why the Science Department embraced the innovative VLE project and how this teacher, in particular, got involved in the project. She highlighted that the VLE project was adopted to alleviate the problem of time limitations: 'We have previously had five, 50 minute lessons per week to cover all of the separate science GCSE course, which leads to rushing and not being able to spend much lesson time covering the units' (RA-2). She also indicated that, apart from her HOD, she was also encouraged to participate in the project by a teacher from a neighbouring school, school C, who was also keen to try out the innovative project.

Teacher Preparedness for the VLE lessons

I also enquired whether she felt adequately prepared to use a VLE in her teaching by the time she started working on the project. In response to this question she explained, 'Yes. We have had quite a bit of training on using the VLE and general ICT skills in school through INSET' (RA-6). 'Did you at any point feel the need for in-service training in the use of a VLE? If so, what areas do you feel you needed more training?'(GC-7) Her response to this question indicated that she had some issues that needed ironing out once she started working on the VLE project: 'the only issues that arose were when animations would have been useful. This would have involved creating SCORM packages which I am currently not capable of doing. But I am confident when using the

VLE for uploading, creating links, etc.' (RA-8) Could this have been one of the reasons why she aborted the project? The question is, was she able to get the help when she needed it?

Challenges faced by the teacher using VLE lessons

One of the questions of interest with the teachers who were trying out this innovative teaching and learning project was focused on the impact of the VLE on their way of teaching. I asked 'Did the attempt to use a VLE present any new challenges in your role as a teacher? If so, can you identify any particular challenges faced' (GC-9). Rose admitted that the VLE posed some challenges to her as she highlighted in her response: 'The only concern I had was letting go some element of control over delivering the material and be reliant on the pupils to actually spend a good amount of time doing the work set on the VLE' (RA-10). I asked her to identify any problems that they may have faced in the way in which the VLE was being implemented in her school. She felt that, 'the only issue is that not all pupils have access to a computer and the internet at home and so there is the issue that using the VLE to set homework and deliver lessons outside of school may not be totally inclusive' (RA-12). On the other hand, the teacher mentioned that the VLE lessons were helpful but insisted that they should not substitute the teacher: 'It is useful for pupils to use if they need more support in a particular area when working at home, however, I think it would be inappropriate for pupils to be encouraged to become reliant on the information on a VLE rather than the expertise of teaching staff' (RA-14).

Why the VLE project was abandoned

I asked the teacher why she decided to abandon the VLE project. 'The nature of the separate science groups that I taught this year meant that I was not confident they would actually spend the time necessary working through the information on the VLE, my concern was that I would have to re-teach it all anyway' (RA-18). The impact of examinations can be detected in her response. It appears she could not afford to let students go it alone on the VLE and go for the examination. She needed to be sure that all the content was addressed thoroughly in preparation for the examinations.

When asked to give any other thoughts regarding the use of VLE lessons, she had this to say: 'using a VLE as a medium to deliver the content of courses will only work for pupils who have the motivation and self discipline to use it properly. For these pupils it will in the future be an excellent resource, and I am sure will help them to get better grades' (RA-22).

The teacher provided useful feedback regarding her experiences with the VLE project. She maintained that the use of a VLE has got some benefits; however, she cautioned against seeing it as a substitute for a teacher. From her view, a VLE can be used to complement the work of the teaching staff, not as a standalone strategy. She noted that some pupils do not have computer and internet facilities at their homes so it is difficult to uphold the principle of inclusive education if these were to be used.

4.2.4. Interviews with students

On the 24th of June 2010 I visited school C in the Midshire County to conduct some interviews with students who had participated in VLE lessons. I made prior arrangements with the science teacher to enable me to have access to her students during the science lessons and she agreed. She was then helping students with revision as they were about to write their GCSE examinations. I had a warm welcome from the teacher who then took me to her lesson to meet the students. She introduced me to the students highlighting the purpose of my visit to the school on that particular day. The students were familiar to me; they had seen me before when we started working on the implementation of the VLE project in the school. Apart from the fact that the students remembered me from previous meetings, I think the presence of their class teacher was very helpful in terms of encouraging good behaviour and stimulating the interest to be interviewed. We connected with each other very well during the introductions and when the teacher asked for volunteers who wanted to take part in the interviews there was an overwhelming response. With the help of the teacher I managed to select eight students for the interviews. Two of them were interviewed individually and the other six were divided into two groups of three each and group interviews were held. One group consisted of students who liked VLE lessons and the other group consisted of students who were against VLE lessons. Using her knowledge of the students, the teacher helped me to identify students who were capable of articulating their views clearly but participation was solely on voluntary basis. Although the teacher consented on behalf of the students, I also clarified all ethical issues with them ensuring that no one felt coerced to participate.

Interview context

A room was set aside for all my interviews with the students where no interruptions were experienced. The teacher was releasing the students in turns to come and have a chat with me. Everything was done in a very orderly manner. I did my best to create a friendly atmosphere for the students to ensure that they could share their views freely. I dressed casually, no tie as I wanted to look different from their teachers, hence I had to look very informal and this helped to create an atmosphere that encouraged students' participation. One other thing, I used simple language that was easy for them to understand, avoiding complex technical terms throughout my discussions with them.

Interview with Timothy White (TW)[12]

Timothy volunteered to speak in favour of the VLE lessons. My discussion with him touched on the following aspects: attitude towards the use of computers in science lessons, attitude towards the VLE lessons, comparison of the effectiveness of VLE and conventional lessons, home access of VLE lessons, reasons for the abandonment of the VLE lessons and his perspectives of the ways in which VLE lessons could be improved.

[12] Pseudonym used

Attitude towards use of computers in science lessons

I started the conversation with Timothy asking him to tell me how he felt about the use of computers in science lessons. It was clear from his response that he had a positive view pertaining to the use of computers in general in science lessons. He said: 'Well, I enjoy it because I am more of a computer person...I like teaching myself using computers' (TW-2). He was also quick to mention that some of his classmates were against use of computers in lessons as they were too dependent on the teacher. He also indicated that he enjoyed using computers in other subjects as well, not only in science.

Attitude towards the VLE lessons

Timothy really liked the VLE lessons as he considered himself to be an independent learner: 'I prefer working as an individual myself' (TW-26). He demonstrated that his interest in science is actually increased by the use of a VLE. In one of his responses he indicated that his performance was boosted by the use of a VLE: 'for physics I have done a lot of exam papers on the VLE that got me top grades because I was interested in it and I researched stuff'(TW-8). To probe his attitude towards VLE lessons further, I asked him: 'if one of your friends was to make a choice between a VLE module and a traditional module like a teacher led lesson what sort of advice would you give them?' (GC-15) To this, he stated categorically that he would advise the friend to pursue a VLE module. He showed enthusiasm and a lot of interest to try some VLE lessons with some science topics apart from the one they tried in biology. 'Physics, I would love to, chemistry I need to brush off so that would do me good I think' (TW-41). Commenting on one of the reasons he preferred VLE lessons over the teacher led sessions he said, 'well, If I didn't understand something I could go on to Google and search whereas with the teacher maybe I put my hand up and ask and other people will be doing the same so they end up saying things you already know and it's pretty pointless' (TW-22). From his view point, science lessons are 'less interesting' when they are led by the teacher compared to VLE lessons, 'because she is talking in the front about stuff going on like that' (TW-30).

Home access of VLE lessons

When I enquired about the access of VLE lessons from home Timothy revealed that access of these lessons was not a problem at all 'Oh yes! Actually if I didn't complete some work I did it at home as homework and finished it' (TW-36). I also wanted to know whether they were able to engage in some discussions using chat rooms with colleagues or the teacher and he indicated that this facility did not exist on their VLE. Responding to the question on whether the teacher provided enough guidance on how to use the VLE lessons he said, 'I am gonna say no, because basically we got given just a set of instructions and she just said do it' (TW-38). I wondered whether this could have been one of the reasons why many students were put off by these VLE lessons. Also, if this was actually what the teacher did, could it have been a reflection of the teacher's lack of familiarity and therefore lack of confidence with operation of the VLE? This, in turn, would reflect a need for further professional development in advance of the adoption of a VLE in class.

Why VLE lessons were abandoned

According to Timothy, VLE lessons were abandoned because apparently the majority of the students did not like this new way of learning. It was unfortunate that although he liked the VLE lessons he was found in the minority group, as he clearly articulated: 'Well, I wasn't up for abandoning it but everyone else in the class really liked teacher based learning so I don't know what the reasoning was probably because they just wanted to be taught directly not to teach themselves' (TW-50). Although he really liked the VLE lessons, he also indicated that there are some aspects of the VLE that did not go down well with him, for instance, he was not pleased with the absence of interactive features such as chat rooms, the lack of clear guidelines from the teacher on how to use the VLE lessons and lack of a variety of activities. When asked about how the VLE could be improved he said the following 'more interactivity instead of just writing things down in a word document, you need really to press buttons and have a look at some quizzes I think' (TW-44).

Interview with Hannah Knowles (HK)[13]

My discussion with Hannah was centred on the same issues I discussed with Timothy. However, I managed to have a good exchange with her regarding the teacher-student interaction in VLE lessons and this will be captured separately from the other four subtitles identified in the interview with Timothy.

Attitude towards use of computers in science lessons

We started the conversation by greeting each other and I also took the opportunity to thank her for choosing to participate in my study. This was intended to set the tempo and create a relaxing atmosphere for her. My first question was intended to elicit her general feeling about the use of computers in different subjects in general and science, in particular. She indicated that in some cases she prefers to work with a computer, however, there are certain times when she feels like working without a computer: '...I prefer it but sometimes I prefer to write but there are other lessons where I prefer to be with a computer, like English I prefer to be writing myself but for everything else I would rather be in [sic] a computer because it's easier' (HK-4). She feels that computers are also a good idea in science lessons. 'Yeah, it will be a lot easier [in science] because everything is in one place' (HK-6).

Attitude towards the VLE lessons

'So what did you think about the VLE lessons that you had?'(GC-7) 'I liked them but like it was too easy for everybody to mess about in there because the teacher helps for everyone to concentrate but with all the screens it was like difficult for her to keep everyone on track, it's hard for her to see every computer screen' (HK-8). Although Hannah enjoyed the VLE lessons she also had her reservations about them. For instance, when asked whether she found the VLE lessons to be useful she said, 'sometimes yeah! But there are times

[13] Pseudonym used

when it was like too difficult to find everything, like a lot of messing about to find what I needed' (HK-10). She further commented that it was a long route for them to open the files on the VLE. To establish more information regarding her general attitude towards the VLE lessons I asked if she would recommend a VLE module to a friend. 'Ok, so from your experience, suppose a friend of yours has to make a choice between a VLE module and a teacher-led module, what sort of advice would you give to your friend?' (GC-13) In response to this she said, 'the VLE one because it's more independent and you think for yourself more and there is just more independence...' (HK-14). She made it clear to me that she preferred learning as an individual than being led by the teacher and for this reason she really liked the VLE lessons. I was interested to find out why she was so much against teacher-led lessons so I went on to ask 'what are the disadvantages of being led by the teacher?' (GC-17) This is what she said: 'just that, if she [the teacher] is telling you something that you already know, you begin to lose interest in what she is saying and like by the time she is telling you something you don't know you have lost completely interest so you are not fully there with her, you might be somewhere else' (HK-18). She also indicated that she thought VLE lessons can prepare her for exams better than teacher-led lessons because 'if you're doing it yourself you tend to remember, it will be there, it's already stuck in your mind if you happen to find it independently' (HK-22). Although the VLE had been stopped by the time the interview was conducted she felt that if they were offered a second chance, she would go for them. She was happy to learn more science topics using the VLE and commented that she had found it very useful to learn the topic 'Human and other animals behaviour' using the VLE. She said that use of a VLE had also made her enjoy science more. I asked her whether she understood the concepts better using a VLE than a teacher-led lesson and this is what she had to say: 'I think I understood more when I was in the VLE, it was easier to understand because it was like written at the back of mind, instead of...people interpreting things differently, so I was getting more than the teacher's interpretation of what it was' (HK-51).

Home access of VLE lessons

One of the issues discussed with Hannah was accessibility of VLE lessons from home. Hannah was one of the few students in the school who were not privileged to own a computer and have internet access at home. This is what she had to say: 'No, I don't have a computer, just have to make use of it at school' (HK-26). I also got interested to know whether the school was providing her with enough time to work independently on the computer and she was quite positive about that: the school was offering a good opportunity for her to do her work. I asked her about the clarity of the guidelines provided by the teacher and she said that, '...she was helpful but there are things we had to find out for ourselves because I don't think they were totally informed, they [the teachers] weren't overly sure of what they were doing' (HK-30). She indicated that she did not have any technical problems with the VLE although she felt that it was hard work to open different files to get the work done. Some facilities like chat room were not available. When I asked whether she had used a chat room or not, she was very quick to say 'No, not really, no' (HK-34). This confirmed what Timothy indicated to me about the non-availability of a chat room on the VLE. Without a chat room how do the students interact with each other and the teacher during the lesson? Lack of dynamic interactivity during the VLE lessons might as well have been one of the reasons why most students found these lessons less interesting than the non-VLE lessons.

Teacher-student interaction in VLE lessons.

I was interested to know what the teacher-student interaction was like during the VLE lessons. I therefore asked, 'What did you do when you had a question that troubled you?' (GC-35) 'I tend to email the teacher' (HK-36). She further elaborated that the teacher responded to her emails. I was keen to know whether the kind of communication she had with the teacher was in any way better compared to what transpired in the conventional lessons. She did not provide a direct answer but from what she said it appears that she enjoyed more the interactions she had with the teacher using VLE lessons. She said 'I emailed the teacher and could get back to me directly instead of like messing about, so it was like interesting' (HK-42). Now if Hannah sounded so positive about the VLE lessons, my other question was, why were these lessons abandoned?

Why VLE lessons were abandoned?

'What would you say is the main reason for abandoning these VLE lessons?' (GC-57) She gave a clear answer to my question: 'a lot of people weren't doing what they were supposed to be doing, just playing games and messing about and Miss was like getting quite annoyed by that and she said would you like to come back here, and those who were like not doing anything chose not to'(HK-58). I asked her to comment on what she thought needs to be done in future regarding the problem she cited and she was quick to say, 'Blocking the games!'She felt that if games were blocked then students would easily concentrate on their work.

Conversations with Timothy and Hannah yielded useful information regarding their perceptions about VLE lessons. It was evident from their responses that they both enjoyed the VLE lessons and also felt that the lessons were beneficial to them. Although they were happy with their first experience with the VLE lessons, they also felt that these lessons could be improved in different ways including the provision of clear guidelines by the teacher, use of a variety of activities and making it more interactive by having facilities such as a chat room on the VLE. It also emerged that home access to a computer and internet facilities is an important factor to consider as some students like Hannah cannot access VLE lessons from home. This calls for teachers to make necessary arrangements within the school to ensure that students who cannot access VLE lessons from home are provided with adequate facilities and time to do their work at school.

4.2.5. Focus group discussions

As indicated before, I conducted two focus group discussions with students. Following below is a summary of the discussions I had with the two groups. Each group will be discussed separately and the students shall be identified by numbers not pseudonyms. In each case, I started by greeting the students and highlighting the purpose of the discussion, making explicit how we were going to handle the discussions. I did my best to ensure that each student was given a fair chance to share their views by asking them by name for their different opinions. With the consent of the students, I used a digital voice recorder to record the discussions. This way, I was able to conduct the focus group discussions on my own as I was able to focus on asking questions without getting worried about taking down notes.

Focus group 1

Attitude towards use of computers in teaching-learning situations

I started by asking for their general feeling regarding the use of computers in teaching and learning situations. The first two students gave the following answers: 'it's easy to use' (Student 1) and, 'I preferred it, I thought it was easier,I preferred being on my own, going through the steps on my own, you know...' (Student 2). I realised that the two students were already making reference to the VLE lessons and not responding to the question I raised and had to make a clarification about this. Having made the clarification, student 1 decided to make a new contribution and said, 'they are easier to use as well and you can buy yourself software instead of just listening to teachers all the time, you get bored by that easily while with computers you can...'. Before he completed the sentence, the other student interrupted saying 'Yeah!' (Student 2) showing complete agreement with his colleague. I was struck by this and so decided to ask 'do you mean to say teachers are boring?' (GC) At first, they all laughed and then one student commented, 'well not all of them!' (Student 3).The same student went on to say, 'the computers are good but still I find the computers can still be boring...'. Student 1 interrupted saying something that appeared to complete student 3's view; he added, 'after a lot of use of them in sessions'. Another student echoed, 'It's good to make a change from the normal routine' (Student 2). In a way, all the students were in favour of using computers and within the group it was also discernible that some felt that if the computers were used in excess then they could be boring as well.

Attitude towards the VLE lessons

Focusing on the VLE lessons I went on to ask, '...and you have had an experience with computers in a special way, I understand you have used VLE lessons...What do you think about the VLE lessons...?' (GC). 'I realised that I preferred them unlike everyone else said that they didn't like them but I am one that preferred it because in your own time you can go through the tasks, I find it easier, I would rather do it by myself than trying to keep up with the class' (Student 2).

Another student went on to say, 'Yes, I like the lessons in VLE, they are easy to use, all class don't have to do same amount of work at the same time, you just have to go at your own pace, you know, I find it easier' (Student 1). Initially, the third student did not want to say much citing that he had only one VLE lesson; however, I managed to persuade him to share his experiences from that one encounter he had with the VLE lessons. He went on to say 'I quite enjoyed that one' (Student 3). I enquired what led them to enjoy VLE lessons more than the teacher-led lessons. I got the following reactions: '...I like having step by step what we have got to do and then you just tick it off as you go through it and then I prefer it because you are like learning yourself, you read it and you can read it over as many times as you want whereas if you are in a classroom if everyone else understands and you don't it will be different' (Student 2). Student 1 was in agreement with student 2's view and student 3 had this to say: 'It's more involving and it's more interactive and it's more hands on rather than just writing or reading from a textbook'. To probe further their attitude towards the VLE lessons I also asked the following question 'if a friend of yours was to make a choice between a VLE module and a teacher-led module what sort of advice would you give?' In response to this question, student 2 chose to be very cautious as he said 'Er, I see what kind of learning he likes because it depends on what you like really isn't it? I think it's more individual thing because some people in my class didn't like it, they preferred being taught by the teacher whereas I preferred this one so...' I asked him to elaborate why he preferred VLE lessons instead of teacher-led lessons and this is what he said 'er, because sometimes when you get taught by the teacher I get behind, I don't quickly always ask whereas with your own time management when you are on your own business...' (Student 2). In support of the VLE lessons, student 1 said he would ask the friend to try out the VLE module: 'I would say give it a try even if you don't see much life in it'. However, contrary to this, student 3 said 'I think you learn more from a teacher than from a computer'. Although, in the previous questions she was very positive about VLE lessons, this time she chose to differ from the other colleagues. She liked the VLE but still felt that you learn more from the teachers. All the students were happy to continue using the VLE in lessons and were willing to try other topics as well apart from the one they studied in biology. They felt that the VLE lessons were good especially for revision purposes and thought that using a VLE could prepare them better for exams. Apart from this, there was also a feeling among the students that exposure to VLE lessons was good as it prepared them for University experience. This was clearly articulated by student 2 when he said 'you know when you go to University and stuff, you know you don't do computers, do you? If you weren't doing it at school you won't get used to it, if you use it at school when you go to University it will be different and stuff like that'.

Home access of VLE lessons

I wanted to find out whether access of VLE lessons from home was an issue with these students. All the three students indicated that they had computers and internet at home; hence, they could access the VLE lessons easily. When asked how they dealt with problems they encountered during the VLE lessons that they could not solve on their own different answers were given. For instance, student 2 said 'our teacher was always in the room [classroom] so we could ask'. 'Or could even scroll internet as well to find it,' (Student 1). To add to this, student 2 yelled 'Google!' Student 1 reiterated 'because the teacher is busy you could look on internet for like questions, oh not the questions but like guide or answer'. Student 3 had this to say, 'or I can always ask the person next to me'. I noticed that the other two students were thinking of a situation where they are working on a VLE lesson in a classroom, yet, problems could arise while working alone at home or in the library. I asked whether they had a chance to enter into a chat room with either their friends or the teacher on the VLE to discuss some of their concerns regarding the topic they were learning. This facility was not available for them so they did not have a chance to explore it.

Why VLE lessons were abandoned

This group of students was quite positive about the use of a VLE. I took the opportunity to ask for their views regarding why this piece of technology was abandoned in their science lessons. "So regarding the previous topic that you were trying to use the VLE what would you say was the main reason for abandoning it' GC). Student 1 stated that 'because everyone like talking about it in class, everyone else agreed to the idea of working in a classroom'. According to student 2 the VLE lessons were abandoned because 'we were a minority, there was just like a few of us that liked it and no one else preferred it in a classroom'. Student 3 shared the same view with the other two. I asked them to reflect on what could be done to improve the VLE lessons in future to ensure that they are more helpful to students. One student chose to say 'make them more enjoyable' (Student 3). When I realised that they were not keen to share their views, I decided to restructure my question. I went on to ask a more direct question 'what did you miss most when you used the VLE lessons?' (GC) This seemed to help their participation; student 2 went on to say 'talking, and having discussions and stuff like that'. On the other hand, student 1 suggested the following 'we can have chat rooms where we can discuss'. Making reference to chat rooms I went on to ask 'can chat rooms really substitute the direct relationships that you can have in a classroom situation?' (GC) All the three students were in unanimous agreement in their response to this question, they all said ‘No’. One student tried to explain the difference ‘you can’t really like, er...you are probably not sure of what you would like to say, you can’t bother typing it or whether you want to store it...’(Student 2). I gathered that it is difficult to express yourself as some actions cannot readily be transmitted to the other person by typing.

Focus group 2

I had the opportunity to talk to a group of students who were very dismissive of the idea of having VLE lessons. All of them were girls, however, it should not be interpreted that only girls were against VLE lessons as some boys also disliked the VLE lessons. I will refer to these students as student 4, 5 and 6 to distinguish them from group one participants. The discussion took place a few minutes before break time and because of this, I went straight into the discussion of the reasons why these students chose to abandon the VLE lessons. Other issues, for instance, attitude towards VLE lessons could be discerned as they were implicit in their response to the question on why they disliked VLE lessons.

Why VLE lessons were abandoned

I started talking to this group of students by saying ‘...I understand you didn’t quite like the VLE while it was being tried out in the school...’ (GC). All of them shouted at the same time ‘No!’ I then proceeded to invite them to share with me the reasons why they were so much against the VLE lessons. Student 4 went on to say: **‘**It’s just boring sat on the computer all the time and like you don’t get any help from the teacher, they just expect you to look at the screen and then read it yourself. So they are not teaching it, you are just teaching it to yourself and you can even copy it wrong so it’s not like very helpful at all’. I interrupted this student and sought some clarification from her, ‘so you enjoy listening to the teacher?’ (GC) In response to this she added, ‘yeah, yeah! I feel like the teacher has like to explain it instead of just sitting and staring at the computer screen teaching yourself' (Student 4). Student 5 reiterated some of the issues raised by student 4 but also chose to talk of her own weakness as a student: 'yeah! Very distracted and get centred on something else because it gets so boring just trying to learn it and you can't get anywhere when someone is not there to help you...'. The sixth student also mentioned the issue of losing focus and ending up pursuing other things online. She posited that 'because I get sidetracked by You Tube because we don't get any videos to watch but then we look at other videos as well on You Tube'. Her response pointed to a weakness in the way the VLE lessons were written. It appears that there was too much text and no videos were used to keep the students motivated and interested. I made a follow up on this and asked, 'so suppose we put some videos and enable you to watch some of them; for example, you were studying animal behaviour, you preferred to have access to videos of animals...would you like the VLE lessons more?' (GC) Student 4 and 5 both said 'No' and student 6 said, 'I have got to see it myself. I would like to go on a trip and see it instead of just watching it on a video; you would like to see it yourself'. The other two students all agreed with her view and simply said 'Yeah!' Realising that the other students were in favour of what she was saying, student 6 went on to suggest a trip to the zoo for the effective learning of a topic in biology such as the one they were trying to learn using the VLE lessons 'Human and other animals behaviour'.

I got interested to find out what these students thought about the whole idea of learning things by themselves. To what extent were they willing to embrace the idea of independent learning? I put forward two questions to the group: 'What do you think about the idea of learning things by yourself without the teacher? Don't you think the VLE helps you to achieve that?' (GC) Student 5 had this to say: 'Not really, I think it depends what kind of a person you are because if you are independent then fair enough you can learn by yourself, if you wanted like depend on others you need help, and then it's not the best way to learn'. In pursuit of her idea I quizzed the following: 'But the VLE can provide, for example, chat rooms where you could chat with friends and obviously discuss some useful ideas about the topic that you are studying, would you be happy to use such a facility if made available on a VLE?' (GC) Student 4 was prompted to react and she went on to say 'they will get it wrong anyway, they don't know what they are talking about really, do they?' She felt that even though students could chat in chat rooms their discussions can be misguided and not something to rely on. Student 5 argued, 'sometimes it's like completely both things, you could talk to your friends in chat rooms but if they don't know, then you are stuck there'. Student 6 who had remained quiet on this issue came up and said, 'yeah!' showing support to the views forwarded by student 5.

I was also keen to find out if the mailing facility had been any better, could students have emailed any problems to the teacher on the VLE. 'I understand you could also email your questions to the teacher and get some feedback, isn't it? Did you try to use that facility as well?' (GC) Student 6 decided to continue reflecting on the previous question and instead of responding to the new question went on to say, 'when we talk to our friends, the conversation will change and suddenly we talk about something irrelevant because we are teenagers!' [and she laughed]. Student 5 decided to respond to the question about emailing the teacher for help and said, 'if you email the teacher they will probably never email you back...'. It sounded as if she was just imagining what could happen but had never tried this in practice so I quizzed her 'did you try this?' She revealed the following 'yeah, just emailed the teacher and never emailed me back!' (Student 5). If ever this is true then students could have found it a daunting task working on their own on the VLE with no one to seek help or clarification from.

The ideas that came from the students were quite enlightening. Lastly, I decided to ask each one of them what they considered to be the main reason for abandoning the VLE lessons. Student 4 clearly articulated her reason for disliking the VLE lessons in the following response: 'I just can't concentrate on it, I just lose my concentration'. Student 5 cited the following reason: 'I don't like typing'. Student 6 echoed the same view as student 4 and in addition to this said that, 'I prefer being taught by the teacher because she can explain it more'.

Home access of VLE lessons

Student 4 and 6 had access to a computer and internet at home while student 5 had no computer at home at the time they had to do the VLE lessons. When asked about access to a computer and internet at home she indicated the following: 'I broke my computer so I have to go down to my mum's boyfriend so that makes it even harder!'

Attitude towards use of computers in teaching-learning situations

Talking to these students I realised that they were not using computers in other subjects in the same way they were to use them in science VLE lessons. While they did not like to continue with the VLE lessons, on the other hand, they continued to use computers especially for revision purposes in preparation for examinations. Commenting on the effectiveness of computers for revision purposes, student 5 said 'that's quite useful really because it tells you whether you are right or not [referring to question paper]'. So examination papers on a VLE might be good, but VLE lessons were not a pleasant idea to all of the students.

Summary

It was fruitful to talk to the students to elicit their views regarding VLE lessons. I managed to get some very interesting ideas from two groups of students, that is, those who liked the VLE lessons and those who disliked the VLE lessons. Students who liked the VLE lessons characterised themselves as independent learners, hence, they felt that the VLE lessons enabled them to learn things by themselves. On the other hand, students who had negative feelings about the VLE lessons voiced that they prefer being taught by the teacher as they tend to learn more through this way.

4.2.6. Interviews with teachers & educational staff beyond the Midshire VLE project

Interview with Edna Zara[14](EZ)

On the 21st of July 2010 I set off on a journey of more than 200 miles from the University of Sheffield towards a school in the Southern region of England where I was to interview a Head of Department for Science on issues pertaining to 'the use of new technologies in science education'. Through networking I had been given the name of this school as being a centre of good practice in the country in terms of using a VLE. Through informal contacts my supervisor got in touch with a Head teacher in Sheffield who was a member of the BECTA[15] Leading Leaders Network and she provided him with names of three schools which were considered to be successful with the implementation of a VLE. I discussed with my supervisor and thought it was going to be helpful if I could visit such schools to find out what makes the VLE work, yet in the Midshire county, the four schools who were implementing it had all given up the project. I contacted two of the three schools and they both agreed to share their experiences with me so I started by visiting the school in the South of the country. I was keen to know what was making the school successful. Although I was going to discuss the success story of the school as a whole I was particularly interested in understanding the success story of the use of a VLE in the teaching and assessment of science. This explains why I made contact and arranged to meet and discuss with the leader of science education in the school. The school is a co-educational comprehensive for young people aged 11-16.

The interview context

[14] Pseudonym used

[15] British Educational Communications and Technology Agency (BECTA), under Labour Government, this used to be the Government agency leading the national drive to ensure the effective and innovative use of technology throughout learning.

The interview was conducted in the office of the Head of Department (HOD) which was a quiet and comfortable environment. The interviewee was familiar with the settings since it was her own office and this made her feel very comfortable during the interview. When I arrived at the school the interviewee came to pick me up from the reception area. The science Department building is a short walk from the reception and I took advantage of this to have a casual chat with the interviewee. This also helped to create a friendly atmosphere which was needed for a good conversation during the interview. It was a very busy time as the schools were closing for summer on the following day. The interviewee was very busy attending to some administrative issues on that day. Actually she had tried to cancel our meeting a day before and I had to plead with her to accommodate me in her tight schedule. She agreed but she made it clear to me that I was only going to be able to talk to her after 4pm when her other school business was done. I accepted this, so when I arrived at the school an hour earlier I was left on my own in the office while the HOD and her teachers conducted a meeting. I was logged on to one of the computers to have a look at the VLE in use in the school. I was quite happy with this arrangement for it helped me to navigate through the VLE and see how it was being used in the Department. Some of the questions I had were answered before I discussed with the HOD. I realised for instance that the VLE was being used for home study not for teaching in the classroom. This was very helpful for it meant some of the questions on my interview guide were to be left out during the interview as they were only relevant for a situation where a VLE was used for the purposes of teaching in the classroom. I gained the impression of confidence in the HOD's attitude towards the VLE because of her willingness to let me see their work on my own.

The interview started at 4.15pm and lasted for 40 minutes. After that I returned to Sheffield and proceeded to transcribe the interview. I did not include annotations about voice stress, accent, paralinguistic features, precise duration of pauses, or signalling of instances of conversation overlap. I will make use of some of the extracts from the interview as I write about my findings. The name of the school remains anonymous for confidentiality purposes and I will use a pseudonym, Edna Zara, for the name of the participant in light of the ethical principles informing the conduct of this study. Analysis of the responses to the questions raised and discussed during the interview is given below.

Adoption of a VLE in the school/Science Department

Regarding the circumstances which led to the adoption of the VLE in the Department, Edna made it clear that this was the brainchild of the Head teacher: 'it was the whole school initiative, it was our former Head teacher about 7 or 8 years ago, he introduced the idea of a VLE, it was the whole school and every Department was asked to set up' (EZ-6)[16]. I tried to find out whether the Head teacher had picked the idea from the LA or whether they had received some special funding for this particular innovation, however, emphasis was placed on the Head teacher's own drive towards new technologies as can be gleaned from Edna's response:

> He was very much looking around the school and computers; he was very much..., in my opinion, ahead of his time, looking for his own ideas, I don't think he got this from the LA; I don't think so because they started using Moodle about 5 or 6 years ago (EZ-10)
>
> He might have picked it up...but he was really driven by new technologies initiative (EZ-12).

The school is using a VLE which is an open source called the Moodle. It appears that no consultations were made with the teachers when it was purchased; it was the Head teacher's decision: '...the Moodle was picked by the Head teacher, no idea wherever he got this from' (EZ-48). According to Edna, the Head teacher saw that the VLE would be a good learning platform for the children and so he went on to encourage all the Departments within the school to embrace the innovative technology. Considering the extent to which the VLE

[16] The code at the end of each excerpt refers to the initials of the first name and surname of the participant's pseudonym. The number refers to the text place in the transcript.

is used, every Department uses VLE including the school library. Every teacher in the school has been required to use the VLE in one way or another.

Ways in which the VLE was being used in the school/science Department

When the VLE was first introduced in the school teachers thought it was meant for them to share resources among themselves and this had nothing to do with the students. Edna made it clear

that the Head teacher had a different idea:

> I think he [the Head teacher) saw that it would be a good learning platform for the children, I think he was misunderstood, we thought it was more for teachers to share resources and then we soon realised that this was not the right way of using it, it was actually a learning platform which we share with the pupils (EZ-18 &20)

I was interested to find out how the VLE was being used in the school so I went on to ask Edna and she explained the following: 'Y7 and Y8 can access home study; basically the home study is in the form of homework projects. We don't have to give them any sheets... they go on to the VLE and they download it from there' (EZ-54). She showed me how the homework projects are organised and how the students access them on the VLE. She further explained to me that the VLE was being used differently for the different age groups.

> One thing which has turned out to be easier was organising Y7 and Y8 in terms of homework and communication with them. At the beginning they were quite eager, and it was easier with the forum. For the KS4, it is easier with sharing of resources- that is, revision resources...Y10 and Y11 are more interactive, share exam papers (EZ-86).

> So I say to them you have to do...exam paper, you don't have to print it or download it. I know it's a boring way of using it but they are really going for it (EZ-88).

As she was trying to open up some files to show me how the students use the VLE for revision purposes, the file she wanted to show me failed to download. At that point she lamented about her lack of competence with the computers but in the process she indicated that only two of her twenty-five teachers in the Department were comfortable with IT: '...there are two teachers of mine who can do this; unfortunately they are moving on to another school! So I have to find somebody else who is enthusiastic to take things up' (EZ-92).

I also wanted to know whether they had tried to use the VLE as a substitute for the teacher in the classroom and I got a big 'no' to that. She reiterated that basically the school and the science Department in particular were using the VLE for the purposes of home study not as a platform for teaching purposes in classroom situations: 'For home study yes! So if they want to go on, say if we do the forces topic they will go on to the VLE and do more on that. So it's an extension of what is done in the classroom...' (EZ-79). She argued that the approach they use in teaching science does not allow them to leave the students on their own; teachers should be there to facilitate the process. She added that 'I think the problem is we teach using a scientific enquiry approach. Pupils need to find answers...and that approach is only possible if the teacher is there as a facilitator...' (EZ-79). Edna could not see how a teacher could be substituted from the classroom with any piece of technology: 'I can't see how this can be possible but I would like to see a school that has put it up!'(EZ-80)

She explained that they use the VLE for coursework activities and also in times of crisis:

> We also use it when we have snow days, when school's closed down; we used it to give work to the kids. That was a creative use! We put on the VLE website a message like 'Y11 I want you to go on to the VLE and do that!' And that was very good (EZ-101).

I quizzed her on whether they used the VLE to plan for cover lessons and she indicated that this was a possibility but they had not done as such. They were also using the VLE to assess students using quizzes. I was also interested to find out how they were dealing with less independent students in their Department. In her response she acknowledged that less independent students were a problem but not only with the VLE '...the less independent students are the ones who if you give them a sheet of homework they will not bring it back neither but at least I can turn back and say you just have to go to the VLE...' (EZ-68). She argued that instead of these students being put off completely by the VLE, the VLE actually encourages them to become more independent.

Home access to broadband

Do all students have access to broadband at home and what does the school do in the event that some students do not have access to a broadband at home? Edna indicated that most of the students in the school have access to a broadband at home; however, there are some students who had no access to a broadband at home. This echoes the situation reflected in the national statistics for internet and broadband access in households. In Great Britain, the Office for National Statistics (ONS) reveals that in 2011, 77 percent of households had internet access (ONS, 2011). 'Broadband has almost entirely replaced dial-up internet connection, with 93% internet connected households using broadband compared with 84% in 2007' (ibid., p.5). Although this is a high percentage of internet connection in the country, it is also evident that there is a big proportion of people who do not have access to internet. This is well articulated by the ONS (2011, p.5): 'despite the growth in household internet connections over recent years, there were still 5.7 million households which were without an internet connection'. This highlights the need for schools to think of ways of fostering inclusivity when they make use of new technologies. Regarding the response of her school to the issue of how they deal with students with no access to broadband at home, Edna elaborated that 'if students cannot access the broadband from home because of different circumstances...we have a duty to support them' (EZ-63). When asked how the teachers find out about those who do not have access to broadband at home she explained:

> They will come up to you so you will say, anybody who has got any problems with accessing it from home come and see me at the end of the lesson and then if you have let's say low ability class you would put the VLE up and show them how to get there and write instructions on how to get there... (EZ-65)

She indicated that there can be a wide range of reactions to downloading materials from the VLE:

> It is quite a big thing for them. Some of them will have never ever downloaded anything from a website before because they might not have computers at home and some of them will look at it and say, "Oh! I have seen something better than this" (EZ-66).

She did not deny the difficulty they face when they have to work with a whole range of children; they have children from deprived background and middle class background and 'so it's difficult to cater for everybody' (EZ-66). For those students with no access to broadband at home Edna indicated that the school is very supportive: 'the library is very supportive and we have lots of computers in the school and we use IT classroom as well. There is an enormous amount of computer facilities in the school' (EZ-131). Although the facilities do exist in the school, I wondered about the time for the students to use the VLE. Edna told me that students use the facilities either 'before school or during break time' (EZ-133). When asked whether the time was enough for the students, she explained the following:

> For children to download the resources it will be enough...they can go to the library before school, there is a system to support them...students with special needs can even go to special needs support Department for learning but there will always be children who will not do that and they will come and say I haven't done the homework because I could not access...sometimes I allow them to come in the Department and log on my computer to do it (EZ-135)

Technical support system in the school

Teachers get the needed technical support within the school for effective use of the VLE. Despite not having been consulted, it appears that the teachers were given very good induction on how to use the VLE.

> We had lots of INSET at that point, how to upload information, how to set up quizzes, how to set up questionnaires, forums...we has [sic] many CPDs across the school...then we had time in the Department to set up our own and then also sharing of good practice...(EZ-34).

This seems to contradict Edna's earlier declaration that only two of her Department staff were IT competent. It appears that the teachers had received adequate training to use the VLE; however, it might be that they lacked confidence with the use of the technology in their classrooms. Edna was evidently reasonably IT competent herself. She kept opening files and moving from one page to the other explaining how the learning platform works and how they are using it in the Department. Apart from the initial training, teachers have got massive support from the IT programmers employed in the school. The school has got a team of six IT programmers who offer training to the teachers and all the other technical support they need to use the technology properly. The school also helps other schools to set up their own VLEs. It was interesting to note that although the teachers received training at the beginning the implementation of the innovation was not without problems. From my conversation with Edna I learnt that the project stopped two years after its implementation following complete loss of data: '...but two years into the project we lost everything because of something [technical problem)... they basically backed it up but the back up of the backup was lost...and that was a big shock' (EZ-28). It was indeed a big disaster! According to Edna, had this not happened probably today the use of VLE could have reached some greater heights compared to where they stand now:

> Actually, I have to be honest about this; it took about a year after this to pick up again. I think if we hadn't lost it at that point people would have

> been much more motivated, it was quite a big shock because there was so much stuff on there (EZ-30)

When asked whether someone came from outside to give them some training, Edna said ‘No...IT guys do the job, our own’ (EZ-36). When she said this I sought clarification as to whether the IT Department in the school was involved. Edna clarified that it was the IT programmers and not the IT Department in the school which was responsible for providing technical support to all the teachers:

> Not IT Department, but IT programmers, they are not teachers. We have about 6 or 7 sitting just above us [she was pointing to the IT programmers’ office]. This is all done by our IT guys so I can register a class on here and it’s all done, they have done everything (EZ-38).

The IT programmers are constantly improving the features and the affordances of the VLE. When I talked to Edna she indicated that they were going to launch e portfolio in September that year ‘where students will be able to store their work and we will be able to put work there...’ (EZ- 40).

<u>Students’ attitude towards use of a VLE</u>

I sought to elicit Edna’s thoughts on how the students were responding to the use of the innovative technology in the classroom. Edna shared the following views:

> They like it but I’m not sure if they actually enjoy it. KS3 students like it more, Y7 and Y8 than Y10 and Y11 because I think by the time they get into Y10 and Y11 they have seen stuff on the web which is just more than what VLE can offer. I think Y7 especially like it at the beginning because some of them are allowed for the first time to go on to internet at home. They like the forums and also we have quizzes... (EZ-70)

From the way the VLE is rolled out in the school, there is no way any student can choose to avoid using it. Every Department including the school library uses a VLE. When I asked Edna to comment on the attitude of students towards the

VLE she did not take time to think about a suitable answer, she simply said 'I think students' attitudes towards VLE are positive' (EZ-178).

Teachers' attitude towards the use of a VLE

Teachers' attitude towards the use of new technologies is an important aspect of my study so I went on to elicit some information regarding how teachers in Edna's Department were responding to the use of a VLE. According to Edna all the teachers in the school are expected to use the VLE in one way or another in their teaching and assessment of the subject: '...there are certain things that teachers have to do through VLE' (EZ-96). I asked Edna whether the teachers in her Department were equally enthusiastic about the use of the VLE. Responding to this she indicated the following: 'no, some more and some less...'(EZ-94). She showed me some of the work that some teachers were doing with the VLE, 'somebody has written that and students can download them at home. It's quite a nice way of sharing resources...there are lots of stuff here, students can sit at home and work...' (EZ-97).

Edna showed a lot of passion for the VLE, she was very positive about its use which she felt was of great benefit to the children. She indicated that they use the curriculum time to work on the VLE material with her teachers. This was very interesting and I went on to ask whether teachers have any incentives which encourage them to use such innovative technologies. Edna took a few seconds to think about the best way to answer the question and went on to say, 'Well, the children!' (EZ-149) As she looked at me she went on to say, 'I see where you are coming from but when you see that children are enjoying and getting more engaged and improving their results then...' (EZ-151). It was very clear that these teachers were motivated to use the VLE because it was benefitting their students. When I asked her about how their results compared with other local schools, she indicated that their school was '...one of the best in [the County]' (EZ-153).

Reasons behind the success story of VLE usage in the school

The use of VLE in this school had received national recognition so I went on to ask Edna to share with me some of the reasons why they were so successful with the use of the VLE. She gave me a lengthy answer to this:

> The thing is staff has got good training but parents are trained as well. Every year at the beginning we have Y7 parents, they are invited, not all of them come in but it's usually a large number of parents who attend. It helps because then when a child has an issue they can help.
>
> You cannot deliver the science lessons you want to without students going onto the VLE... for instance, when we are teaching cells, the project which they have to do supports the teaching so they have to get the information off here [demonstrates] and there is lots of other things for them.
>
> Library is on here, so it's not just science which makes it successful, there are so many other things which they [students] can access from here. So, that's for the library resources centre [pointing at the VLE], opening times and book awards. These kinds of things I think make it alive, make it successful! (EZ-83)

Edna felt that one of the reasons for their success could have been the fact that the VLE was rolled out to all Departments within the school and all teachers are required to assist: 'if it was just the science Department putting loads of stuff and making it more interactive, I don't think it could work. It needs to be the kind of thing coming from every teacher in the school' (EZ-84).

Problems and challenges of using a VLE

During my conversation with Edna I also felt the need to establish any problems and/or challenges they might have faced with the use of a VLE in the Department. Edna reflected on the way the VLE was designed and felt that it could have been better if each teacher had a section for each class on the VLE:

> I think you would really love to have a section on each class as we wanted originally so that my class would have its own section on VLE so

> that as they log in they will have access to my work, say, like you would have written on the smart board...so they could look at them and so they would not have the need to write their own notes (EZ-105)

The other problem she cited was the internet. Edna indicated that although there are many ways of controlling it, it still constituted a problem in the sense that students can access anything on Google: '...they can go on to anything but of course instead of going on to You Tube, for example, they can be limited on that' (EZ-141). One of the major challenges she cited was that of keeping the VLE material refreshed and updated '...I think one problem is to keep up to date and for the children they see so much these days so these kinds of things are static and limiting possibly...'(EZ-165).

Advice to other Departments wishing to start using a VLE

I took the opportunity to ask Edna to share some advice on the best way to introduce and use a VLE in a Department or a school.

> I think you need to get the staff on board. You need to have training of the staff first, they need to be confident in using it...there are some activities in the schemes of work which send the teacher to the VLE and if the teacher doesn't use it or get the kids to use it, then the whole package doesn't work (EZ-120)

Reflecting on the importance of leadership she explained the following 'I think the HOD should have the first training session because if the HOD is not using it, nobody else will use it' (EZ-126). The other important issue that Edna raised was that of ensuring that students' voice is listened to. Students in Edna's school can post their views regarding the use of VLEs on the platform and they actually make suggestions about what they want to see on the VLE and this feedback is made use of by the teachers (EZ-124). From her own experience Edna had this to say 'if you put more on it they don't like it because at the beginning we put lots of stuff and they didn't access it so we learnt...put just a few but good!'(EZ-97) She also mentioned the need to have the senior management team on board and the participation of other Departments in promoting the usage of the innovation, highlighting that 'if all the other bits weren't there like the library, and all the other things out there, science on its own wouldn't be that familiar' (EZ-165). The school management promotes the use of the VLE in all the Departments so the students are not hearing of a VLE in science Department alone. Edna emphasised that 'if you only have one Department using it, it doesn't work' (EZ-167). One other thing that Edna talked about was the need to have a well defined system within the school clarifying the minimum standards each Department is expected to achieve through the VLE and the existence of a monitoring system. She explained:

> It's always like we have standards so our school...every year there is an audit so you will be told you are not meeting the minimum standards or you are meeting the minimum standards of your VLE...that's also coming from our senior management team as well (EZ-171)

When she mentioned the involvement of the senior management in the equation I could not conceal my surprise and when she realised this, she added the following:

> Yes, it needs to work from the top to the bottom and it also needs to be manageable and if you have just ridiculous expectations that you need to do this and this and this it will not have enough time but if you have minimum standards, can have minimum standards for each lesson and will also have minimum standards for VLE.

Lastly but not the least, she reiterated the need to train the teachers adequately citing that 'if a teacher doesn't know how to use a VLE they may not like it' (EZ-176).

Interview with Peter Steward (PS)[17]

[17] Pseudonym used.

In an effort to have a broader understanding of how the new technologies are being used in the schools to support teaching and learning, on the 19th of October 2010, I visited another school in the south of Midshire County which, like Edna's school, was also recommended by BECTA as a centre of good practice. I made prior arrangements to hold a discussion with Peter who is the Assistant Head teacher for e-learning in the school. The main purpose of my visit to this school was to find out how the school had managed to adopt and achieve a successful use of the VLE. The school is a specialist college for humanities and music. It is a mixed Voluntary Aided Church of England Comprehensive school. In 2007 they moved into all new accommodation which consists of impressive buildings. In 2007 their OFSTED report said that they were at least good in all aspects of their work and were outstanding in some aspects. They were expecting me at the school and when I got there I was provided with lunch which I took in the company of Peter. I took the opportunity to learn more about the school and had an excellent chance to familiarise myself with the interviewee.

Interview context

Peter had made necessary arrangements in the school including booking a venue for the interview session. The interview was conducted in an office where we had no disruptions from other staff members or students. There was a desk computer in the room and Peter logged into the VLE and used this to show me the features of the VLE and how they were using the VLE in the school during our discussion. I found the teacher very sociable and ready to provide information. He had a lot of interest in ICT and had some research experience in the same field. I started by explaining the nature of my study and he formally agreed to be interviewed by signing the consent forms. As the interview began, I remember addressing the interviewee by his surname but he was quick to tell me that he was quite comfortable being called by his first name. My cultural baggage was with me again here! We laughed this off and went on to focus on the business of the day.

Adoption of a VLE and how it is being used in the school

To begin with, I was interested to establish when the VLE was first introduced in the school. I learnt that they had started using the VLE called Kaleidos in 2007. Kaleidos is not an open source which means any changes they have to make to it can only be done in consultation with the manufacturers. I was told that the idea to introduce the VLE was a vision of the school's Executive Head Teacher.

> ...so it was his vision, basically when I joined this school which was in 2006, we were on the other side, a very old site, a dump, really unhappy place...while we were there this school was built, so a lot of decisions were taken, for example, the decision for adopting a learning platform were made before I got here. However, we were an RM[18] school in the old building and because we had a strong partnership with an RM school it made sense to be an RM school in this building and we have continued to be a strong partner with the RM school. By the way, we are classed as an RM pioneer school (PS-40)

I sought clarification about what RM was all about and he explained to me that RM was an acronym for Research Machines and this was the company responsible for manufacturing the VLE brand they were using in the school. He explained that, 'the Executive Head Teacher, the Head Teacher, the IT team knew the RM system, they liked it, they enjoyed it and they kept it and rolled it out here...' (PS-46). In addition to this Peter also told me that his arrival in the school also contributed in terms of moving the idea of using new technologies further.

> Now when I came if you take something like the Visualiser they only planned to have 3 or 4 Visualisers...now when I arrived I started to demonstrate how these Visualisers could be used in terms of student presentations, teacher assessment, and videoing work. For example, we had a fine art teacher who started to demonstrate to his class all his

[18] RM, to be clarified in the subsequent paragraph.

> drawing techniques and everything via the Visualiser and now students could see clearly what's going on and they got it and this had an impact in art lessons...based on demonstrations like that they made the decision to invest and put one Visualiser in every classroom where they thought it was needed... (PS-46)

It was evident from this that Peter was open to the use of new technology in his teaching. How was the VLE used in school?

> We used it basically as a portal, gateway to information so we could upload staff bulletins, student bulletins, we would transfer messages to each other via the learning platform, would have news items that would appear to promote what's going on around the school and the portal also allowed us to create certain things we call interest spaces, so for example, in PE we have got football clubs or dance clubs, whatever, then the learning platform can be used to promote resources and the timetable of when those things will be on, and we also used as links to external websites as well so that students had access to sites for revision purposes, for example, for all the research requirements (PS-4).

He chose to refer to the VLE introduced in 2007 as version 1 because this was later replaced by a new version. He cited problems of broadband speed which he said was caused by the fact that they did not have fibre optic broad band and were just using coaxial cable based ones with lower speeds or bandwidth. He indicated that they began to use the VLE properly in 2008 after introducing a version 2 of the previous one.

> ...our released version 2 is better than version 1. Once we got used to it we were able to do exactly what we had done before but since then we have been able to take a lot of the areas much further. I will give you some examples of what we have done: one innovative thing that we have done that I haven't seen elsewhere is, we track what students do in terms of extended opportunities, so on our learning platform we have created a form that students can log in and fill in so they can tell us what

> they do in school and what they do out of school such as [inaudible] lessons or they can play the flute and they update that over a period of time. They get the opportunity to update it twice per year so that we can get a track of what they are engaging with outside the school because research tells that if they are engaging outside lesson time it has great impact on their academic achievement. We have done wonders tracking students' performance that way (PS-8, 10)

He went on to elaborate on the uses of VLE in the teaching and learning engagements citing an example of how they managed to utilise the VLE in Food Technology.

> In food technology, we have classes that come in and access a lap top computer in the same environment that they are about to cook in and they use the VLE to download the instructions, they watch a health and safety video about how to conduct themselves in that particular session, they follow the instructions they are issued via the VLE, prepare their ingredients, they mix it together and cook, they download the documents so that they can evaluate the work that they have done, and they are evaluating how everything they performed has gone based on while its cooking, so all this technology is being used in the food room environment at the same time all the cooking is being done. This is during a double lesson by the way because you need all the time to do it and yet, it has proved successful, done over a wireless network, students have really enjoyed it, it's a different way of delivering a lesson (PS-14)

I learnt that the VLE was being used for teaching lessons and also for some homework assignments. He lamented that the VLE was inconsistently rolled out across the school; however, they were still doing their best to foster independent learning:

> It's not consistently rolled out across the school as I would like, again you could pin- point complexity of use for some staff members or the internet speed for other issues but homework can be set via the VLE and

> can be sent back to the teacher via the VLE as well, can be electronically marked and grades can be awarded to the students with some commentary to help those students improve that work, it reinforces something that we are trying to get going here, that is, the notion of the independent learner, you know, it doesn't matter what school I have been to, students will always take the least path of resistance and if they can be spoon fed the information then they will take the easy route, but what we are trying to encourage is a bit more independence so the VLE helps us with that (PS-21).

In this school a lot of Departments are using the VLE with the exception of PE and Mathematics Departments. I enquired whether there are any special reasons for the two Departments not taking up the use of a VLE. Referring to the PE Department Peter explained the following:

> No special reasons other than that the content of their courses don't align itself to a great deal of VLE activity. The other reason is we have four houses in our school and every head of house is a PE teacher so I think their time is actually squeezed between actually teaching PE and the use of new technology, I would love to do more with them but actually don't have time and they don't have any more teachers to support them either... (PS- 27)

The Mathematics Department was not using the VLE for issuing homework and the reason for that is they use 'Mymaths.co.uk' which according to Peter has: '...better resources, works in exactly the same way so they can submit homework and send it back via a different system which is fine by me because they are using new technologies and they are still learning and it's a fairly cheap product to buy' (PS-27). In ICT they have set up an interest space including a wiki facility on the VLE for an English readers group. Peter explained how the group works and by so doing elaborated different ways of using the VLE in the school:

> ... students in a class become members of the English Readers group and then they have a book that they are going to review. Instead of reviewing it by standing up inside the classroom and saying whatever they think, they go on a discussion thread on a VLE or they go on a Wiki and write their comments on the wiki and that all works fine (PS-29)

Home access to broadband

It was of interest for me to establish whether all students had access to broadband at home or not. In the event that some do not have broadband at home what does the school do to help such students? I gathered that the school had conducted a survey and found out that 98% of the students had broadband at home. For the two percent who did not have access to broadband at home, Peter explained what the school does to help them:

We open up early in the morning; we have got an Early Bird Breakfast club for students who would like to do some work, we have two late sessions a week on a Tuesday and Thursday where we have arranged for the buses to come back again and pick up late students who have stayed behind and working late. In some special cases we have got some spare laptops and we lease those out. There is not many cases where we do that but we have leased out some where the parents sign up a contract to abide by our terms, and if we don't lease a laptop out we have promoted BECTA Home access...there is a page on our website that describes BECTA Home access idea which is Government funded as well. There is always an opportunity, you know, this school is open until, its doors lock up at 9pm. As long as there is a member of staff they often let students work (PS-37)

Technical support system in the school

I wanted to know how teachers deal with the problems they face while using the new technologies. I asked 'Are the teachers getting support from the IT Department or from some IT technicians within the school (GC-59)?'

> I think we all help, the way it works is this, every Wednesday afternoon the school finishes early for students at 2.30pm, that leaves everybody with an hour a week to do some preparation or some CPD based activity for professional development. We have in sessions on a Tuesday and a Thursday night, we call it our Twilight programme, staff are required to do some 4 hours of extra training in something, it doesn't have to be a new technology but we do an awful lot of sessions. If they do their four hours then they get days off in lieu, instead of having an inset and coming to school they have that day off work so Christmas holidays could be a day longer or in the summer we break up a day earlier. That's a nice thing for staff to do and they don't want to see that thing go. We use a cascaded training model, you know, if you take the learning platform how it has gone, we take what we call ICT champions from the Departments and we train them and they take it back to their Departments in that Wednesday staff development slot and they cascade that training to others (PS-60).

The ICT champions from the Departments are chosen on a voluntary basis. Each Department has got either one or two people who volunteer to become ICT champions. Apart from this, for Departments that would need extra help like the PE who need more technological help, Peter takes control of that, as he elaborated, 'so on top of a programme of support my role in the free time that I have got apart from teaching, sorting out systems or helping other schools I then go to the Departments and support them either in a live situation or do another training or something of that sort' (PS-68). It was interesting to note that 'everybody helps everybody' in this school and as Peter puts it: 'that's the secret to success' (PSM-70).

Students' attitude towards use of a VLE

I was also interested to know how the school introduced their students to the idea of using a VLE as they join the school and whether parents were also involved in the project.

> Well, the Head teacher doesn't want to use the VLE to engage with parents...he has got his own reasons to do that, I mean it's not statutory to do that and he is not giving me the green light to turn it on so that parents can access the attendance details or attainment level, behaviour credits, things like that...
>
> ...in terms of engaging with students what I have had to do is I have to leave it to the classroom teacher, the only way I support them in doing that is that I provide him with a guide, the students have a set of instructions to enable them to see how to use it, the guidelines are pretty much the same for different areas, I just change the heading for the subject areas, I just make a screen chart of relevance to each subject area...so I kind of support them that way (PS-82)

I enquired about how the students were responding to the VLE and Peter expressed the following views:

> Oh yes! They are happy! The students love the technologies that they have got access to but like all students they have their other side...not all students but we are trying to change the idea of homework now, in this day and age with all the social networking and more than 120 TV channels, the idea of homework every week isn't an idea that's actually working... (PS-88)

Peter went on to explain the changes they are making in terms of homework highlighting that in one of his subjects, ICT, teachers are now giving homework which is like a big project that is half termly based. So, instead of giving homework on a weekly basis, students only submit a single project every half term. According to Peter, this way of handling the homework is proving to be 'incredibly successful'.

Teachers' attitudes towards the use of a VLE

I sought to understand whether it was easy to get all teachers using the VLE for the first time in the school:

> No. We had some teachers who argued that this doesn't add value to the education I am providing I would rather do things the way I do...I have to point this out, this school already had a system, a system called learning resources in the old building that staff were already using...we have developed the e mail culture here. So when we kicked this thing off we have all these competing things and guess which was the fastest to use: email attachments! So there are still teachers who say this is faster so I'm going to stick to my email attachments thank you very much... (PS-77)

Peter also highlighted that he was finding it difficult to educate some of his teachers, especially, those aged over 50, to enable them to appreciate that the learning platform was much more efficient compared to the emailing system they were used to. However, on a general note, he was happy to point out that the VLE had found a lot of usage with most teachers in the school.

Reasons behind the success story of VLE usage in the school

Apart from being the Assistant Head teacher for e-learning, a job that involves coordinating everything to do with ICT in the school, Peter also teaches ICT and computing and a bit of Maths. Listening to everything he was telling me I could pick out some important issues that explain why the school is considered to be a centre of good practice in terms of using new technologies. I gave him a direct question on that 'What makes you stand out as a school with the use of these new technologies?'(GC-32)

> ...we have a wonderful environment in which to work...here you don't just see pockets of ICT, it is embedded throughout the entire school and as you will read later [he gave me some copies of the school newsletters to read], the staff can't work without the IT now. (PS-33)
>
> I think it's because we engage students, we give students the new technology and the opportunity to interact, we give students the

> opportunity to work individually or in groups, we give them control and they like it, they enjoy it... (PS-48)

He also indicated that at their school they are always trying something new: 'another area where we are successful, I think is that we don't just take what we have and pat ourselves on the back and say well done; we always look for an opportunity to do something else' (PS-58).

Problems and challenges of using a VLE

I learnt that the use of the VLE in this school was not free from problems. Peter lamented about the slowness of the broadband in use in the school: 'I just wish that the broadband could be much faster...' (PS-50). Some of the ideas he has got cannot take off; for instance, he pointed out that the idea of recording a lesson and then uploading it on to the learning platform for students to play back has not been possible for him to implement. In addition to this he also indicated that due to lack of time it was difficult for him to come to grips with all the features of the VLE: 'it is giving us a tough time to work with it and do more with it. We only get three frees a week and it's not enough time...' (PS-75). He also cited some difficulties including technical problems pointing out that they had not been able to register any new students on the VLE that particular year because the provider of the VLE had not sorted out a certain technical problem. I also learnt that the other big challenge was that of getting all the senior management members on board, to support the implementation of the new technology

Advice to other Departments wishing to start using a VLE

I asked Peter if he could give advice to other schools that might be considering taking up new technologies such as the VLE for the first time. He gave very insightful ideas:

> If you have got a school doing this for the first time... your leadership group at the top of the school has got to be seen to be actively engaging with the new technology that you want to use, if it comes top-down then

> you will see the culture in the school of using new technologies growing...(PS-94)

He emphasised the need to have the entire leadership of the school behind the product pointing out that their full participation would ensure that the product is used consistently throughout the school. He also recommended schools to use BECTA's self review framework which he considered to be 'a road map for [someone] to embed new technology and e –learning across the school' (PS-98).

Summary

It was very useful to visit this school and to interview Peter. He provided helpful information regarding the adoption and use of the VLE and other technologies in their school. The VLE is used differently; some teachers use it for home study while others use it as a teaching resource, for example, in food technology. The Leadership of the school plays an important role in implementing new innovative projects. If some of the senior management team members do not put their weight behind the innovation, it is difficult for it to be used consistently across the school. Most of the teachers were using the VLE; however, some of the teachers were reluctant to adopt the new technology. Students were happy with the VLE; however, some of them were not too impressed with the idea of doing homework too frequently, leading some of the teachers, like in ICT, to change the way of using homework. The majority of the students had broadband access from home and the few students who did not have access to broadband at home were provided with necessary support by the school. The use of the VLE is affected by the slowness of the broadband, making it difficult for different classes to use it at the same time. For those who want to use the VLE for the first, it is important to enlist the full support of the leadership team in the school and to utilise the guidelines provided by BECTA.

Interview with Sally Kennedy (SK)[19]

During the course of my study, I had a unique opportunity to interview Sally from Singapore regarding her use of a VLE. A meeting with her was made possible through arrangements made by my Supervisor. Sally was supervised by my Supervisor during her PhD studies at the University of Sheffield a few years ago. In September 2010, Sally visited UK on a holiday and decided to pass through the University and it was on this occasion that my Supervisor managed to arrange a meeting between her and myself. At the time the interview was conducted, she worked as an Assistant Director of the Learning Academy at a Polytechnic in Singapore where she had successfully implemented the use of a VLE across the polytechnic. The Learning Academy provides an intensive teacher education programme to all the lecturing staff at the polytechnic. Among other things, they promote the use of new technologies by the lecturers in their teaching. The Polytechnic offers Diploma courses recognised locally and overseas. Its student population stands at over 15000 and it has got about 1000 staff members. My supervisor and myself agreed that an interview with Sally would provide some useful insights into some of the issues I was looking at in my own study; hence, I took the opportunity to interview her. The interview lasted for thirty-five minutes.

The interview context

The interview took place in one of the teaching rooms in our Department at the University of Sheffield. Sally was familiar with the place, it was a quiet environment and there were no disturbances from other students or members of staff. I explained the nature of my study to her and she participated voluntarily. I requested to record the conversation and again she had no problems with that. Realising that Sally was neither a science teacher nor was working at a secondary school, I had to leave out some of the questions on the interview guide which were meant for science teachers based in secondary schools. Following below is a summary of the issues we discussed.

[19] Pseudonym used.

Adoption and use of the VLE at the Polytechnic

As we started our conversation I noticed that Sally referred to the VLE as Learning Management System (LMS). As she was explaining her role at the polytechnic she said 'My job title is Assistant Director of the Learning Academy and basically what I am in charge of doing is implementing polytechnic-wide a new system, what you call a VLE and what I call an LMS, Learning Management System...' (SK-4). The VLE is used by all students and staff at the polytechnic. She further elaborated that,

> Initially the polytechnic started with a small version, what we called the Departmental version which catered for 2000 students so different pockets within the institution would use this VLE but it was not institutionalised...the use grew up and that initial system was not capable of supporting many students, 15000 students, so my Department proposed that we get a new system that is capable of supporting the whole institution...3 or 4 years ago (SK-6)

It was interesting to note that once they decided to get a new system they conducted a survey to find out whether staff would be interested to use the VLE or not before it was purchased. According to Sally '...the concern was because it's a large amount of money and if they buy it and no one wants to use it then it's not worthwhile' (SK-10). I also learnt that the use of technology such as the VLE is widespread in Singapore and that currently there is a programme to have the whole country wireless (SK-12). Sally pointed out that 'there is a very big push from the Government to be technologically advanced as a nation' (SK-14).

She explained that the VLE they have got in their institution was placed on an open tender and they chose the one they could afford. They purchased Blackboard with some additional features to it to meet their needs and so the product they have is called Learning Objects. According to Sally '...it supports blogs, wikis, podcasts...we wanted the web 2.0 tools as part of the Blackboard, it is actually an extra part that we demanded to meet the needs of the users'

(SK-26). She added that this VLE is not an open source and the choice was based on their policy which stipulated that they had to purchase an official commercial product (SK-32). The system was launched institution wide in April 2010 and by the time I was talking to her she actually indicated that some of the technical aspects were still in progress: '...we are now in what we call phase two of the project...in October we will launch the automation of some of the backend processes so as a technical project it's still ongoing' (SK-46).

Sally is not a technical person at all; however, she explained that she got involved in this project by her immense interest in using technology, 'I am not a technical person but I was quite interested in using technology as part of my staff development...' (SK-41).

Staff development and technical support for the teaching staff at the polytechnic

I was interested to know whether the teaching staff were staff developed or not before using the new technology. Sally explained that staff development was provided in two tiers. Her Department which is responsible for staff developing the rest of the teaching staff, received staff development from the vendor and in turn, they staff developed the rest of the teaching staff in the institution. She made it clear that the vendor offered '...predominantly the backend systems training, administration and service...not so much the user training because [her] Department handles that...' (SK-36). She also indicated that in their institution anything about basic logging, how to use windows, how to use word, is not done for staff or students because everybody comes in equipped with those skills. They train their staff to use the VLE for assessment of students; however, it remains the lecturers' choice as to whether they want to use it or not for that purpose.

Collaboration with schools

According to Sally, polytechnics often have some projects with either primary or secondary schools. Although she was working in neither primary nor secondary school settings, I was interested to know from her experience what the situation regarding use of new technologies was like in primary and secondary schools in Singapore. Referring to the students' exposure to new technologies she said, '...they start very early in primary school. There is a large investment in technology in the whole school system and there are some other projects, for example, one called Future Schools...' (SK-16). According to Sally, the Future schools project is aimed at promoting the use of advanced innovative technologies in schools. Schools identify projects they are interested in and they work together with a technology company to develop them for subsequent use in their schools (SK-18). Citing an example of collaborative work between the polytechnic and the schools, Sally indicated that her Department helped one secondary school to use a VLE to support problem based learning (SK-78). She highlighted that they maintain links with secondary schools because their students come from these schools; however, the links were not very strong.

Teachers and the new technologies

I also asked Sally for her opinion regarding the issue of whether the teacher can be substituted from the classroom by the new technologies. She said:

> No. I think the answer is no. I firmly believe that a good teacher cannot be replaced. A good teacher can use a lot of resources to help them be a good teacher or better teacher but I don't see how technology could replace the skills of a good teacher. Maybe it's possible in a hundred years time when technology is so advanced ...I don't know but then to me you will need technology that is the same as the human mind and the human mind of the teacher which I personally believe is impossible. So for that reason it's the human mind inside the teacher that can never be replaced by technology (SK-86)

She emphasised that the teacher should always be there to drive the technology, highlighting that with a VLE the teacher can be present physically or in an online environment. Commenting on how a VLE was being used at the polytechnic she indicated that lecturers were using the VLE in four different ways depending on the nature of their subjects.

> One is fully online so that means the student is not coming to face to face classes. The other one is what I call blended learning greater than 50% so that would mean that more than 50% of their time, official allocated time is done online and then the rest might be face to face sessions, and the other category is blended learning less than 50%, and the final category is supplementary learning, so you put up lots of information, resources and things like that but actually they still come to face to face...
>
> I think there are many different ways of using it and I don't think that we need to stipulate how they use it, it depends what's appropriate for the subject, for the students, you also need to know the aims of the subject, all these sorts of things, so if it suits the aims of the subject to have the teacher in there at the same time they are doing things online to me I will have no problem with that... (SK-96)

I took the opportunity to find out whether Sally had come across some teachers who were very negative towards the use of these new technologies. She expressed the following: 'Oh yes! There are definitely people like that, there are people who are very keen and will try anything and try all the new things, there are people who will reluctantly, ok I must do something, I think there is always that kind of variety' (SK-54). I asked for some of the reasons why staff do not want to take up these new technologies. Turning to the views of their staff, she expressed that '...a major concern from the staff in our institution is time' (SK-56). She elaborated on this saying:

> This is the most common argument from lecturers as to why they don't like using it, so it's a pragmatic issue and alongside that is where management seem to think that face to face teaching takes the same amount of time as online teaching but the lecturers will be saying that online teaching takes longer. But part of that is due to them perhaps

> sometimes not knowing how to adjust what they do, so they will translate what they do in a face to face environment, they will do exactly the same online and so they spend a very very long time responding individually to a discussion post, for example, so we do quite a bit of work with lecturers on how to be more efficient but still get good learning and not compromise learning (SK-58)

I also enquired whether the teaching staff conduct any research to find out the views of their students pertaining to the use of the VLE. Sally explained that most staff conduct satisfaction surveys at the end of a course and there was no framework for investigating this systematically. She commented that no research was carried out even with face to face learning in the institution.

Students' views and access to broadband

Commenting on the access to broadband by the students, Sally made it clear that in Singapore they do not have broadband access problems like the situation presents in other countries. '...in Singapore we don't face those kinds of issues...if students come from a poor socio-economic status [and] they don't have a broadband at home, the polytechnic has got 24 hour access labs...most students have a laptop [and] they have wireless in various places on campus...' (SK-68). Reflecting on students' views regarding their experience with the VLE she indicated that students valued a lot their interaction with fellow colleagues in an online environment and that they felt that these interactions enabled them to learn more. She came to these conclusions from the results of a preliminary analysis of a survey conducted at the polytechnic in 2010.

Advice to other Departments wishing to start using a VLE

During my discussion with Sally I asked her for advice that could help people contemplating using new technologies such as the VLE for the first time. She pointed out two critical things for the success of the project: the presence of the technical team and the teacher. She emphasised the need to have technical expertise to provide guidance and support citing that: ' these [technologies] cost money so the technical people are absolutely critical because in a way it's a technical infrastructure project, the use is for pedagogy but the actual object is technical, so you need to work closely with them' (SK-110). I asked her whether an institution needed to employ its own technicians. In her response she reiterated the importance of people with technical expertise but she also hinted that they should work hand in glove with people who are interested in pedagogy because:

> Technical people often want to set up systems that are not pedagogically friendly so you need to bridge between those two...the other key aspect is the change management...how do you get lecturers [to use] technology not for the sake of using technology but because it helps teaching and learning...it's important not to forget that at the end of the day it's the teaching and learning that is important and the VLE is in a way infrastructure or a resource that supports that, it should never be the other way round...it should be always, this is what I want to do, this is what I want my students to learn and ok this tool will help me do that (SK-84)

According to Sally, teachers should not be driven by the technology but they should be in control, using it when it is convenient and helpful to achieve the needed results.

Summary

The conversation I held with Sally yielded useful information regarding how a VLE can be adopted and used effectively in an institution. Among other things, she highlighted the importance of consulting with staff to see whether they will be interested to use the technology before it is purchased, the need to provide training and technical support to staff and to encourage the collaboration between technical experts and people with interest in pedagogy. Although she appreciates the significant role played by technology, she emphasised that teachers should not be driven by technology, technology should be used to support teaching and learning.

Primary data on the use of VLEs: concluding comments

In this section of the data chapter I have reported on six interviews with a range of education professionals involved in the use of VLEs in teaching, two interviews and two focus group discussions with students who have had experience of using a VLE as a learning resource. I will synthesise this data and discuss my critical understanding of it in the Discussion chapter. Before that, in the following section I will present data that I generated on the use of another new technology in education: Electronic Voting Systems, or EVSs.

4.3. Electronic Voting Systems in context

When I realised that most of the schools I was working with on the VLEs project in the Midshire County were no longer committed to the original plan, as explained in the preceding section, I discussed with my Supervisor the possibility of broadening the focus of my study. We agreed to take on board, in addition to the VLEs, another innovative technology in use in some secondary schools, which is the EVS. A few Departments in some schools have adopted the use of this technology. I had an opportunity to interview teachers from four secondary schools, who were using this technology in their teaching. In addition to this, I also had an opportunity to administer a questionnaire to elicit the views of students who were using the EVS in their learning. In the subsequent section I will focus firstly on the interview data from teachers and lastly I will present data from the students.

4.3.1. Interview data of teachers using EVSs

TEACHER: JOSEPH MARTIN (JM)[20]

Joseph is a Biology/Science teacher at school F located in Milkshire County. The school is an 11-18 Comprehensive school and it has a specialist Science and Mathematics status. It is larger than most secondary schools. The great

[20] Pseudonym used.

majority of students come from white British backgrounds. Only a small number of students are from minority ethnic background and there are no students with English as an additional language. The percentage of students with special educational needs and/ or disabilities is below national average. The school has a Healthy school award. According to the OFSTED report (2009), the school's science specialist status has made a significant contribution to the good curriculum and teaching and there is some impressive teaching of science within the school. I visited the school on the 15^{th} of July 2010 to conduct an interview with Joseph and two other teachers from the same Department.

Interview Context

I arrived at the school in the morning and Joseph invited me to observe him teaching one of his Y10 groups using the EVS in the second period. During the third period Joseph was free so I had an opportunity to interview him. The interview took place in one of the science labs in the school with no interruptions from other teachers or students. I needed a quiet environment to enable us to concentrate on our discussions and also to ensure that the interviewee could speak freely on all the issues of interest to me regarding the use of the EVS. Although I had spoken to Joseph over the phone and through email correspondence, I took time to explain the nature of my study before embarking on the interview. With his consent I proceeded to record the interview using a digital voice recorder. This made it possible for me to focus on the interview itself, following on topics that were arising spontaneously and also observing the body language of the interviewee. Following below is a presentation of the issues we discussed.

Adoption of the EVS

The idea to use the EVS was brought up by the previous HOD of Science. Joseph explained that the HOD '...bought the apparatus and then showed [them] how it worked and then made [him] think it was a very useful way of teaching and testing and [he] started using it...'(JM-4). The technology was not purchased to solve any particular problem in the Department but as Joseph elaborated it was thought that '...it is very versatile [and] could be used for any teaching situation' (JM-6). The EVS was purchased some four years ago and some of the teachers, like Joseph, started to use it from that time. Joseph pointed out that some of his colleagues in the Department have not yet started using the EVS and he singled out time as being one of the major constraints '...actually, several of my colleagues don't use it, it's because they haven't got round to find time to get on top of it'(JM-12). Joseph uses the EVS with all his classes ranging from year 7 to 'A Level'.

Learning to use the EVS

I was interested to know if the teachers in the Department had been given some training on the use of the EVS. It emerged that the HOD held an induction session with the teachers which was very brief as indicated by Joseph: ' it was just one Department meeting, he just demonstrated to us how to do it which took him up to 20 minutes and then it was up to us to engage with the stuff and actually teach ourselves...' (JM-18)

Different ways of using the EVS in the classroom

I went on to ask Joseph how he was using the EVS in his lessons. I realised that there are so many different ways in which the EVS was being used. He explained the following:

> ...sometimes I use them as a starter when I am introducing a topic to find out how much the students already know, sometimes I use it as a starter to test the students on how much they remember from the previous lesson, sometimes I give it at the beginning of the lesson and I then teach the lesson then I give them exactly the same test as a plenary, sometimes I do it as an activity just to keep them thinking...so I might use it in the middle of the lesson...I often use it as a follow up for homework, instead of marking their books I just give them a voting test and that immediately tells me whether they have got out of their homework what I wanted them to get out of it...(JM-24)

It was also of interest to me to establish whether the teacher had assessed the impact that the EVS had on knowledge retention. In response to this he explained to me how he attempts to measure knowledge retention:

> ...I give them a quiz in a particular topic and then as it comes to an end I will give them as revision and consolidation...the same quizzes I gave them in the same unit a couple of weeks before and I will show them the scores in the initial one and the subsequent one and demonstrate to them whether they have forgotten the work or they know the work a lot better because they have been doing some learning... (JM-28)

After he explained how he measured knowledge retention, I asked him to comment on the effectiveness of the EVS in terms of helping students to retain knowledge. He was very confident that students tend to retain more knowledge when using the EVS compared to the other conventional ways of teaching and learning. However, he did not have any substantial evidence to prove this assertion but alluded to the fact that the EVS, '... gives them immediate feedback so they get immediate insight into their misconceptions, mistakes that they are making and gaps in their knowledge...so it does [contribute to more knowledge retention] because I think as a teaching tool it's effective'(JM-30). He explained that the system allows him to save every test that he gives to his classes making it possible for him to: '...compare the same class when they do a test on one occasion and do another test on a different occasion or you can look at one test and compare how well one class did compared to another class so you can have a feel of how well different classes are performing on a particular unit' (JM-32).

I also enquired whether the use of EVS was something planned well in advance of the lesson or it was something that could happen spontaneously. Joseph explained clearly that the lessons could be planned or spontaneous: 'usually they are planned in advance, the only time that happens spontaneously is if students request to have a particular test or I suddenly think that oh, hang on!

I thought you knew all this and it seems to me that you have forgotten it so let's refresh it...' (JM-38).

Still on the ways in which the EVS was being used, I went on to ask if the teacher was promoting peer instruction through the use of EVS. The teacher was familiar with the concept of peer instruction, however, he indicated that he was not using the EVS for that 'I don't use it [EVS] specifically for that but just to the extent that I do allow them when they are stuck on a question to discuss it amongst each other and so you will find a particular student explaining to another student...' (JM-49). To sustain the conversation, I took time to explain to him how some teachers use the EVS to facilitate peer instruction. After that he went on to say ' I suppose I do that but informally because I allow them to speak to each other but I don't tell them that they must but I don't stop them doing it' (JM-53).

The other thing I enquired about was 'wait time', I was interested to know how much time the teacher gives the students to work out the answer to a question before they can make their submissions. I learnt that the software has got a time counter which the teacher can set. This is what Joseph said, '...the software has got a counter on it; I sometimes put them under pressure either because there is time constraint in a lesson...or because I just want to put them under pressure usually because they have had the quiz before...'(JM-57).

I also quizzed the teacher on whether he thinks the EVS is helpful in terms of developing critical thinking skills of the students. Joseph was very positive about the contribution that the EVS could make, however, he was critical and pointed out that the capacity of the EVS to develop such skills was dependent on the way the teachers would design the questions. He highlighted that,

> ...if you design the questions carefully it does...my A level students thought it was gonna be really easy, 'ah, you just press the button!'...but if you put a thought into it you can make the questions very challenging and put little pitfalls in the way you design the questions and it will be interesting for you to speak to the A level students because I think they

> would agree that the questions do force them to think things through very carefully and does challenge them to think critically (JM-65)

So Joseph is convinced that the EVS, if well used, can contribute to the development of critical thinking skills. He emphasised that 'the skill is in designing the question the right way' (JM-67). From what he said it emerged clearly that the teacher had an important role to play. I made the following comment 'So it depends on how skilful the teacher is and on the teacher's creativity?' (GC-68) Joseph added:

> Well it's partly how skilful the teacher is and how well the teacher knows the topic in the sense of the teacher knowing what kinds of questions are asked in the exam, for example, what the common misconceptions and pitfalls are but it also depends on the class and I often find that when I have prepared a quiz for one class it's not appropriate for another class and it's not just linked to the ability, it's linked to the specific issues with the particular class...so it's much more powerful when you link the quiz to specific issues that have come up with the specific group and the students recognise that as well and it makes them engage more...say if there was a discussion which went down a certain way and there were some interesting points and you give them a quiz in the next lesson which specifically refers to that discussion that really links the students and makes them engage more...(JM-69)

I was interested to establish whether the teacher could point out some indicators useful to show the impact of using the EVS on students' academic performance. The teacher's views were as follows:

> Well, I can't think of any objective measurements that we have made but I just know from all the things that I have just said, you know, the students' enthusiasm and the students' engagement, so in terms of the learning I personally subjectively believe that it does enhance the learning enormously...if somebody was to come and say we're gonna do away with it my main objection which would be entirely objective...is the

> way that it could increase my work load because for me to assess my students as rapidly and as effectively without using the technology will be many more hours of work for me...(JM-71)

Judging from the above extract, Joseph acknowledges that it is difficult to show the impact of the technology on students' academic performance in an objective way; however, he believes that the technology is very useful for students' effective learning. He also sees the benefits of the technology, it saves a lot of time for him.

Students' attitude towards the use of EVS

Although I was going to talk to the students directly, I also felt that the teacher could also shed some light on how students were responding to the use of the EVS in their science lessons. Joseph highlighted the following:

> They love them! Every class I have ever taught have loved doing it. One of the main massive advantage of it is that...every individual is participating as opposed to giving them a quiz where students put their hands up and then one student answers the question, every student answers the question...and that's one of the things they like about it because it's boring when there is a teacher doing a question and answer session and one student is answering at a time, it's much more fun when every student has a go (JM-40)

Joseph also elaborated that the EVS helps to generate discussion and puts pressure on students to answer the questions:

> ...they can't just sit there and not get involved so as well as the force to participation being enjoyable it also forces them to engage with the topic and that sometimes takes the form of them looking in the textbook...or asking the person next to them...they are learning by discussing so the big advantage is that it forces the students to engage...which they enjoy! (JM-42)

He also explained further that the use of EVS improves the students' attentiveness in a lesson as they all try to have a good mark:

> They are all very attentive when we do the quiz and they know that their score is something that [they will] see, I don't normally show their scores to the whole class because I know that some students [will be] embarrassed if they have done poorly but they know that at the end of it I will be looking at the score and if they have done really badly, I will at some point say, for example, James can you stay behind, can you just look at this, why did you perform so badly? It pressures so they know they have to do their best (JM-45)

Joseph uses the EVS with all his classes and according to him the level of enthusiasm is the same with all the groups of students he teaches ranging from Y7 to A Level students. However, he pointed out that in some classes there are some lower attaining students who are less secure with the EVS. He pointed out that in such classes '...there is less discussion, there is just copying and looking at what button the person sitting next to them has pressed and just copying which I often point out to them as a rather flawed strategy because the person sitting next to [them] might be wrong' (JM-63).

Problems and challenges of using the EVS

I was also interested to find out whether Joseph had faced any problems and/ or challenges when he started using the EVS. This is what he said:

> The software is very badly designed, it's not user friendly, it's not too obvious how to set up the quizzes and to look at the responses. The software is designed to do many different things but it's so daunting to work out how to do it, both how to set things up and how to look at the results...I just use it in quite a narrow way...(JM-14)

It was not evident that the Department had any contact with the vendor for any technical assistance. The HOD just bought it online. On the other hand, the same HOD who had inducted others on how to use the technology was no longer in the school. Joseph indicated that if ever they are going to buy a new voting system, the software will be a major consideration. The other issue he raised was that of time constraints, most of the colleagues in the Department were not using the technology because they did not find time to learn how to use it in their lessons (JM-12).

<u>Impact of the use of EVS on the teacher's attitude and perspectives about teaching</u>

One of the issues I sought to find out was how the technology was impacting on the teacher's perspectives about teaching. I wanted to know if the use of EVS was leading to some changes in the way the teacher views and carries out his teaching assignments. I went on to ask Joseph whether the use of the technology had changed anything for him and this is what he said:

> Nothing radical but all the advantages of using the voting pads just reinforced stuff that I believed and felt about before...all students love using it which is a huge factor, if students want to do it you have won half the battle...they love it, they never get tired of it...and then one other advantage is it reduces my marking load enormously because it gives me immediate feedback (JM-20)

He was very positive about the EVS and from his response one can glean that he was very happy with the idea of getting immediate feedback which reduced the amount of his work load. He further explained:

> ...because you get that instant feedback which allows you to not only see how individual students have done...so you can pick out individuals struggling with a topic, it also allows you to see which areas of the topic you have just taught the whole class is struggling with and it gives students instant feedback on what the correct answer is so as opposed to giving a piece of work taking it home for marking and giving it back to them in two days time they may not see where they went wrong, within seconds they see where they went wrong, so there is just such a huge list of advantages of using it so all the stuff that I was already aware of

> by using these voting pads it just demonstrated to me how important they are (JM-22)

Joseph explained how the EVS had helped to simplify his job:

> So when my line manager asks me for the students' books and test marks to see how well I am marking and assessing students' performance I just print off all the tests that students have done using the voting pads...at the end of the year students will have done at least 30 tests with me and I can just say here is [sic] the test marks and it does show very clearly, there is no other way that you can generate as much assessment as easily and quickly in my opinion (JM-73)

From the above extract, it can be seen that the teacher was quite content with the technology which was making it possible for him to achieve his goals without requiring extra time.

Teacher: Janet Nisbet (JN)[21]

Janet was one of the teachers who were using the EVS in their science classrooms at school F, the same school as Joseph, in the Milkshire County and she also agreed to participate in my study. Through email and telephone conversations we managed to fix a date for an interview of the 15th of July 2010.

Interview context

The interview was conducted on a normal school day. Janet was busy teaching on that day and I only managed to sit down with her during one of her free periods. We used one of the science labs in the school for the interview and I recorded the interview using a digital voice recorder.

Adoption of the EVS

[21] Pseudonym used.

Janet started using the EVS four years ago when she joined the school as a trainee teacher. During her teaching placement she saw one of the science teachers using the technology and she got interested to try it out in her own lessons: '...I was having some of his lessons and he had just got the software for use in science and so we were using it, I was using it in his lessons with him' (JN-2). The teacher was kind enough to induct her on the use of the technology and she went on to use it in her own science lessons as she expressed, '... I could see how it can be used without having to find out for myself, he showed me how it could be used and so this gave me confidence to get on and have a go with my own class' (JN-6). I asked Janet to explain what exactly attracted her to want to use the EVS and she said the following:

> It provides very quick assessment straight away and you get it without you having done any marking, you get feedback on how well all the pupils are doing in the class...you can analyse the results in so many different ways like [you can] see who has responded to each question in a particular way...the students get feedback straight away as to whether they got it right or wrong, it's done anonymously so they feel safe using it because it doesn't come up with their names or anything like that so if they make a mistake then you know about it and they know about it but none of the others in the class do...they just love it (JN-8)

Janet was motivated to use the technology because on one hand, she was able to get instant feedback which helped her to assess her students' understanding in a lesson and on the other hand, she also realised that the students enjoyed using the technology.

Learning to use the EVS

Janet got inducted on the use of the EVS by another teacher in the Department. She worked with her mentor for some time before she started using the EVS on her own. Upon completion of her initial teacher education course she secured a job in the same school and this helped her to continue to use the technology.

Different ways of using the EVS in the classroom

Janet teaches science/biology to classes ranging from y7 to y12 and she uses the EVS with all groups. When I asked her how often she used the EVS in her lessons, she said,

> It varies because I used them quite a lot with my y10 classes because I had made all the quizzes, the bit that takes time is typing them out and once you get them all typed out you are fine you can use them with all your classes but because that takes a bit of time it tended to be that I was using them with y10 quite a lot but not with the other year groups and then every now and then with y9, y7 and y8, so probably a couple of times a week at least but with different classes (JN-10)

As she explained in the above quotation, her use of the EVS depended on the availability of the resources. Classes with more resources available tend to have more opportunities to use the EVS in their lessons. I wondered whether she would use the EVS in all lessons if she had the resources available so I went on to ask and she said

> I think if they were used in all lessons then pupils would get bored of them and they wouldn't get as excited with them, it depends as well because it takes a little bit of time to set up and for the kids to collect their clickers, it would work differently if they had their own it could be done very quickly but because you have to share it out between teachers and organise who is taking it for the first half, the second half...it's a bit of a timing issue (JN-12)

Janet indicated that sharing of the EVS among teachers was an issue; one teacher cannot use the EVS in all his/her lessons because other teachers also want a chance to use them. I did not have a chance to observe her using the EVS so I was interested to find out how she used them in a lesson. She explained that when she uses the EVS in a lesson she usually uses them at the beginning or at the end:

> ...I have done it both at the beginning and at the end with the same questions so they have a go with them at the start of the lesson and I teach the lesson and then see how well they do in their responses at the end. Sometimes I do that but usually it's either to see what they remember from the previous lesson or to see what they have learnt out in the lesson they have just had (JN-16)

I sought to find out whether in her opinion clickers were helpful in terms of promoting knowledge retention in her students. She expressed the following:

> It is a bit but particularly what I have done in the past is if there is a question that they keep getting wrong or lots of them got wrong I will include it in the next lot of questions just to see if they can remember what the right answer was from it and so we have another go there and then I do it again and have another go, so that sometimes helps and they go oh we had this question before! I say yeah but can you remember what the answer was? So it does seem to help and if they particularly know that we are going to have a quiz on it, you say, here you need to learn these key terms I'm gonna quiz you on them in the next lesson and they tend more likely to revise them because they know that it is coming (JN-18)

Janet also uses the EVS to promote peer instruction. She told me how she achieves this during the lesson:

> Quite often I find I'm kind of an intermediary in that, I will say... who got this one right and then they will give me the answer and then I will say can you explain to everybody why this is the right answer or I will say who got it wrong...can you figure out why you got it wrong, explain to people what's wrong about the answer you chose, so I do that to some extent... (JN-24)

I was interested to know if Janet was using the EVS in some group work activities. She told me that she had never used the EVS in that way, however, she was keen to try it out at some point as indicated in her response: 'I haven't, I know that some people have...it's just because of the time it takes, I haven't learnt how to do that, I haven't had a go with it but it's something that I will be interested to do...' (JN-26).

I asked her to reflect on whether the EVS was helpful in terms of developing students' critical thinking skills and she posited that this was dependent on the way the questions were designed:

> I think it depends on the way the questions are written, if it's just straight fact questions like what is the product of this...I don't think that would help particularly to be critical but when you put on answers that make them think 'why, they all look right to me, so which one is actually the correct one?' they start thinking about the accuracy of the answer and they start getting to think critically (JN-28)

Janet explained that such types of questions are hard to write and she tends to use them with y10 and y12 students, 'I try to do that fairly often but they are the hard ones to write, I do it more with the y10 and y12 than I would with the lower school, the lower school tends to use...straight forward, quite closed questions whereas when I use it with y10 I try to trick them a bit more ...so that they can think a bit more' (JN-30).

She mentioned that the system has got a time counter which can be altered to give students different wait time depending on the nature of the question. On the other hand, she also pointed out some important issues that teachers should be aware of when using the time counter:

> ...sometimes it might take them a while to answer but that's just because they are chatting to a friend and they haven't realised that we have moved on to a new question so it wouldn't necessarily be that they can't do it, it's just that they are not paying attention or it might be that some questions are very long and some questions are quite short to read and so the reading can take time rather than anything else (JN-37)

According to Janet the teacher has to be alert to make sure that the students are using the EVS appropriately.

Students' attitude towards the use of EVS

One of the reasons which led Janet to adopt the use of the EVS was that she realised that students were enjoying it. I went on to ask her to comment on the level of motivation of the students regarding the use of the EVS and she expressed the following:

> I would probably say when we started using them all of them loved them, now I will say it's probably about 80%, most of them really enjoy them, it's only a couple who say 'Ah, do we have to do that again?' But then they always get involved even if they say that to start with, they get involved I would say (JN-31)

She teaches students from y7 to y12, so from what she says in the above quotation, it indicates that all her students spread across the different year groups enjoy the use of the technology in their lessons.

Problems and challenges of using the EVS

Janet pointed out time constraint as being a factor militating against the effective use of the EVS. The teacher has to find enough time to prepare the questions and the quizzes for each year group which will make the use of the EVS productive. This is usually unavailable. The EVS they were using only allowed them to make use of multiple choice questions and according to Janet they would not use the EVS in all lessons because,

> it's a multiple choice question, you don't necessarily find out what they [students] actually think because you have given them the options so I think we need some open dialogue with them as well so they have a chance to show you what they know and what they think without you having to predict what answers they would put...(JN-14)

Janet felt that the EVS was quite limiting in terms of the types of questions it allowed the teacher to design, hence it was necessary to have some lessons without the EVS.

Impact of the use of EVS on the teacher's attitude and perspectives about teaching

One other important thing that I wanted to establish was the impact the technology was having on the teacher in terms of attitude and perspectives about teaching. Janet was very positive about the use of EVS in her science lessons. I asked her whether she had changed anything in terms of the way she teaches as a result of using the EVS and she expressed the following:

> Yes, I think so because it made me realise how important it is to include all the pupils in activities, I think it's quite tempting to ask questions and ask for hands up and then get one person's answer to that question but the clickers enable you to find out what all of the class [members] are thinking and what they are all doing and, therefore, you can plan your lessons to suit everybody better rather than just asking a couple of kids at a time so definitely in that sense so even if I'm not using the clickers now I do more to do with whole class participation either using the white board or using the cards, things like that so that you get a full picture of where all pupils are (JN-33)

The EVS has also facilitated the use of class-wide discussions. She uses the feedback she gets from the EVS to generate some discussions according to her explanation:

> From there it comes up with a text with the correct answer so it shows them which one was the correct answer and then it shows you how many pupils have answered each of the options so I always look and say well done to those who got that right and then I go through why the answers were right or wrong so I get them to explain what's wrong with the answers they put... (JN-20)

The EVS helps her to play her role as a facilitator during the lesson while students actively participate in knowledge construction individually and through peer instruction.

HOD Science: Simon Nathan (SN)[22]

Simon is the HOD of science at school F, same school as Joseph and Janet, in the Milkshire County. He was not using the EVS as such; however, I found it necessary to include him in my study as I felt he would provide some useful information regarding how the Department supported the use of new technologies among its teaching staff. I, therefore, made arrangements to meet with him in person and discuss some issues related to the way they were using the EVS in their Department. On the 15th of July 2010 when I visited the school, he was one of the teachers on my interview list and he actually spared some time to discuss with me.

Interview context

Simon is a busy person in the school, having to deal with Departmental administrative issues and teaching responsibilities. However, in support of my research work, he agreed to take part in the study and spared some time that morning to sit down and discuss with me. The interview took place during his free period immediately after break time. During break time we had tea in the staff room together with Simon and had some casual conversations and this helped to set the tone for the interview. The interview took place in one of the science labs which offered a quiet and convenient environment for the discussions. Simon was very relaxed and we managed to have a friendly conversation. He agreed to be recorded; hence I went on to record the interview session using a digital voice recorder. Following below is a presentation of the issues we discussed pertaining to the use of EVS in his Department. The issues are presented under specific categories for clarity purposes.

[22] Pseudonym used

Adoption of the EVS

I started my conversation with Simon by inviting him to reflect on how the EVS was introduced in the Department. He explained that the use of the EVS was the brainchild of the previous HOD:

> ...originally, it was the previous HOD who went to a Trade Fair, an Educational Show and saw the clickers in use and we thought what a great idea to get children involved in this idea of voting for something...like 'who wants to be a millionaire', very game showish, so we thought it was very relevant to the kids, they quite enjoy that, so that's how we got started (SN-4)

The innovation was brought to the Department four years ago. Teachers were introduced to it and according to Simon no one was coerced to start using the technology. After enquiring about whether a Departmental policy was defined to oblige teachers to use the EVS in their lessons, Simon highlighted the following: 'We have had training, we have left it open to people but everybody has been trained on its use...it has been left to people to use it as they see fit, there is no Departmental policy to it' (SN-14). He also made it clear that teachers are introduced and encouraged to use such new technologies during Departmental meetings '...we tend to launch them [new technologies] at special Departmental meetings and get people involved that way. I never force people to do anything, I usually rely on my Department, they will see the benefits and they will take it up appropriately...' (SN-26).

Teachers' attitude towards the introduction of the innovative project

I asked him about the teachers' reaction towards the idea of using the newly adopted piece of technology by the Department and he went on to say,

> Some teachers were very receptive to it...everybody thought it was a good idea but the time to learn the system, the software, the initial software was and still is to some extent a little bit tricky to manage and get into so the amount of time we need to spend to learn how to use the

> system is quite intensive, we feel that probably limited its use in some ways (SN-10)

I wanted to find out if the uptake of the innovation was dependent on the age of the teacher but without ruling this out, Simon brought up some other factors he considered to be influential as shown in his response:

> I think some of it is down to style of teaching as well...some teachers who are a bit more interactive than others have embraced it more...there are some youngsters within [the Department] that I think tend to be coming through and have a broader sort of base to work from anyway...they have been encouraged to be less didactic and so yes they have embraced it (SN-12)

Apart from age differences among teachers, the use of EVS is also being influenced by the teachers' styles of teaching.

<u>Teacher development and provision of technical support</u>

Understanding the importance of professional development and technical support, I went on to ask Simon what the situation was like in his Department. He mentioned that everyone was trained when the innovation was brought into the Department. However, I asked him whether they have regular professional development sessions for new teachers joining the Department. He expressed that since four years ago when the innovation was introduced in the Department they 'haven't had refresher training' and agreed that this was one of the areas they had neglected by adding that, '...perhaps we ought to [have provided some regular professional development]' (SN-16). When asked if teachers had cited any problems with the use of the technology, he said, 'just difficulties operating the software and getting it do what at times...' (SN-18). I also wanted to know whether the IT Department in the school was providing any technical help to the teachers using EVS. The answer to this was a categorical 'No' (SN-20). I further queried the reasons for their non-involvement by asking: 'is it because they don't know how to use it or it's because they don't want to get involved?' (GC-21) Simon responded to this question saying, 'I think it's a bit of both, to be honest I think they don't know how to use it and they don't want to get involved' (SN-22).

Monitoring and evaluation of the EVS

As a Department I was also interested to establish if they have a way of evaluating the use of the EVS by their teachers. To this end, I asked Simon if they had carried out any staff surveys on the use of the EVS and he indicated that, 'no, formally no. We discuss things informally; we have not done anything formally on their use or to insist on their use or anything like that' (SN-28). I asked him to reflect on some of the common views of the teachers that he had gathered informally pertaining to the use of the EVS. He elaborated the following:

> The common views of the teachers is [sic] that it's brilliant stuff, once you get your PowerPoint and your questions sorted out and you get them loaded in the right format it's very useful. The set up time, the initial getting it sorted and getting all your questions together is the lengthy bit and the complexity of the software sometimes is not the most user friendly software, at least the version we are using isn't, that's the only thing really. Other than that as far as the actual use of the system within the school people think it's a very positive thing, generally they think it's very very useful, students respond very well and of course it gives you feedback and it's very good for plenaries and starters (SN-30).

I asked Simon to comment on what he thought needed to be done to improve the way the teachers in his Department were using the EVS. He pointed out, among other things, the need to change the software they were using. He explained that: '...we probably need to look at the software again and probably have some refresher [professional development] and to look at some alternatives...we perhaps need Active voting system [another brand of EVS] as well so that people can use them' (SN-32). I felt the need to establish from him, as the HOD, if there are any indicators that can be used to prove that the

EVS is a 'brilliant' piece of technology. I was mainly concerned about the impact of this technology on students' performance, for instance. Simon went on to say:

> To be honest we don't see it as a standalone thing so we don't look at it as a strategy as such, we see it as one part of many different tools that people would use, so we haven't got standalone evidence as to the effectiveness of the voting system...but what I can say is that the people who have used the system regularly [names of the teachers supplied] are very enthusiastic about their use... (SN-34)

From what Simon says in the above quotation, it can be seen that as yet the Department has not found a way to measure the impact the technology has on the student learning in any objective way.

Summary

Talking to Simon was very helpful as it enabled me to gain some insights into the way the Department handles innovative technologies. They are keen to try out some innovations but at the same time they do not have a Departmental policy to enforce the use of the innovative technology by every teacher in the Department. The choice to use the innovative technology depends, among other factors, on the teaching approach and professional judgement of the individual teacher. Teachers who are more interactive in their teaching tended to embrace the EVS. Time remains a major constraint making it difficult for some of the teachers to use the new technology in their lessons. The Department has not been able to provide regular professional development to cater for new teachers and there is no provision of technical support to those teachers who are using the EVS. Both teachers and students using the EVS enjoy the instant feedback they get.

Teacher: Morris Gray (MG)[23]

On the 6th of October 2010, I visited school E in the Miltonshire County to meet Morris who I was going to interview regarding the use of EVS in science classrooms. Morris is a science teacher in the school. The school is an 11-18 comprehensive school. The school is 11-18 comprehensive school. It has specialist status in technology, mathematics and science. I felt that Morris's experiences with the EVS were important as it could help other teachers to know how effectively this piece of technology could be used.

Interview context

Morris is one of the two teachers in the science Department who were on record of using the EVS frequently in their lessons. At the time of the interview he was using a brand of EVS called the Word Pad with software called Word Wall which they acquired in the Department about two years ago. Before that the Department was using other brands including Activote and Qwizdoms. Morris invited me to observe one of his lessons with a y9 group where he was using the EVS, before I interviewed him. They refer to the EVS as clickers. The lesson was in the second period and immediately after that he had a free period and he decided that we could have our interview during that time. We used one of the free science labs for the interview. It was a quiet environment and there were no disturbances. Following below is a presentation of the issues we discussed and an attempt has been made to present them under clearly defined themes. I deliberately left out some questions that I used to ask some of the teachers because I got some answers during lesson observation. The interview was recorded using a digital voice recorder.

Adoption of the EVS

In the first place I wanted to know how Morris adopted the use of clickers in his science lessons. He went on to narrate the following:

[23] Pseudonym used.

> ...well, I just started using them when [another teacher in the Department] started using them in the school; I just started using small activities with classes so I just put together the first quiz because that's the easiest one to do... I did it like a starter activity with classes that I was confident with and then just started playing around with it and looking at the functions and whenever I was to teach another subject I just put it on the other side and think about ways of how I could integrate the Word Wall into what I was teaching and then just started playing around with the functions from there and have just continued using it throughout (MG-2)

From what he says in the above quotation, Morris was curious and this led him to try out the use of the technology in his lessons. He started using them towards the end of 2009.

Learning to use the EVS

Another teacher in the Department brought the idea of using the clickers forward and it is this same teacher who played an important role in encouraging Morris to use the technology. Referring to that teacher Morris said '...he was sort of the one who encouraged me to use them, and he arranged to meet the guy who developed the programme, he came into the school and sort of gave us a bit of training on it...' (MG-8).He also indicated that another teacher from the same Department started using the clickers at that same time but has since stopped because she lost confidence, the software continues to be updated and one has to keep pace with such changes to be able to continue to use them. It appeared to me that the software is user friendly because when I asked about further training, Morris indicated that they did not get any further professional development as such, instead after the induction session which was led by the developer of the programme, he went on to teach himself most of the stuff. This was his perspective regarding professional development:

> Well, except the guy who developed the programme, he came into the school and did sort of run through the main functions of it, he showed us

> but we didn't really get much of hands on training with it so it was more like he showed us what it can do, he showed us how to sort of get the wizard open and then I just taught myself basically how to use it (MG-14)

His account can be very inspirational to other teachers who may be scared of trying something new, especially the use of new technologies. Commenting on the software, he highlighted that, 'it's quite user friendly, I think you would need a bit of introduction to start you off but you just have to play around with it, there are some functions that I don't use just because I haven't put time in it, I don't know how to use them' (MG-16).

Different ways of using the EVS in the classroom

Morris appears not to use the clickers in a regular way. When I asked him to comment on the frequency of use of the clickers in a week, he stated that, '...probably once every two weeks on average actually, sometimes I use it few times in a week but sometimes I don't use them in a month...' (MG-10).I was also interested to know whether the lessons where he uses the clickers are pre-planned or spontaneous and he said:

> It's normally planned, I think it's maybe twice when I have thought well, I will get them out...the programme is built in such a way that you can use it spontaneously, like I showed you with the blank grid, you can put the blank grid on and get them to insert things in and you can get answers from them...I do prefer to use it with planned activities after or before [teaching] (MG-12)

Basically, Morris uses the clickers to assess the students' performance. Like he highlighted in the previous quotation, he sometimes uses the clickers to find out how much students remember from the previous lesson and sometimes uses them as a plenary, that is, to find out how much students have learnt in a lesson. There are various activities that he can use; sometimes he can use a quiz or a test which can be easily found in the activity bank of the system. The availability of a repository of activities facilitates the spontaneous use of the clickers during a lesson.

I was interested to find out the impact of clickers on the academic performance of the students, however, as the teacher said, 'that's hard to say...' (MG-25).The teacher stated that he had not been able to measure this. The use of the clickers was not regular and again it was just used as a complementary teaching tool hence it was not easy to attribute any changes to the effect of the clickers alone. I tried to find out if the teacher had looked at the impact of using clickers on students' knowledge retention. He noticed that his students tend to remember the content he teaches using clickers and they can easily apply the skills and concepts in subsequent lessons:

> I think it does help with retention of knowledge because I have used it with A level students and we calculated resistance...they were set there and working out with a calculator ... and because it's competitive and they were working quickly I think it's a lot more interesting than if I would have given them a list of problems on a sheet of paper which I could have done, I could have given them a list of problems on a sheet of paper...it's not competitive and there is no like urgency about it, whereas, if you do it on the board with this [clickers], they know that there is gonna be a lead board at the end, they work faster I think, really trying to do well and I think that definitely helped them remember because when I came the following lesson, it was a different lesson, but using the same ideas about using the two ways of working out resistances, and they remembered straight away just from that one activity and I don't know whether that can be a good example but I think it does help because they enjoyed doing it and if you enjoy doing something, I think you will remember it (MG-27)

Students' attitude towards the use of EVS

I asked the teacher for his assessment of students' response to the use of the EVS. He was very happy with the way his students were responding to the use of the clickers. When I posed the question about students' attitude towards the clickers, Morris went on to say, 'well, I think you saw it in that lesson, they love using them, it keeps them alert and they like the competitive element of it...' (MG-30). Both girls and boys were equally excited when it came to the use of the clickers. Morris uses the clickers with all his students ranging from y8 to 'A level', and he reported that all of them were happy with the use of this piece of technology in their lessons. The students did enjoy the clickers and they found it easy to use the handsets which resembled mobile phones.

Problems and challenges of using the EVS

I was interested to know from his point of view, the problems and challenges associated with the use of clickers in the classroom. He stated that sometimes they face minor technical problems during the lessons. On that very day they actually experienced a technical problem during the lesson I observed. Some students' answers were not getting connected hence they were not showing up on the screen, so when I asked about problems he made reference to that: 'there are occasions when things like what happened today with answers not getting connected do happen, which is a problem because although I can stop it and start it again, it disrupts the lesson...' (MG-23).He pointed out that this was the only problem that he faces with the system. Apart from this he was very happy with the system. In the event of serious technical problems they always refer them to the programme developer. They do not have any technical support from within the school.

Impact of the use of EVS on the teacher's attitude and perspectives about teaching

One of the issues I was interested to find out was the impact that the technology was having on the teacher, for instance, I wanted to know whether using the technology was helping to change the way the teacher perceived the way of doing his job. When I asked Morris to reflect on this he did not feel that the use of this technology had changed anything really in the way he teaches the subject. He said:

> I wouldn't say that they have made a massive impact on the way I teach or anything like that...I see it as a nice way of like summarising a lesson or checking, I mean, it's a good way of assessing the pupils' learning at the end of the lesson...it gets every child involved in the class...it's better than starting to give questions and getting hands up and getting a few kids responding... (MG-18)

In terms of attitude, Morris was very positive about the use of the clickers in his lessons. From the above quotation, it can be seen that he enjoys using them. He is happy with the level of student participation in class and the instant feedback he gets from the system. He further explained that:

> You get an overall view of how the class is understanding...you can look at specific questions and see how many of the class members got it right and it gives you an overall view of how well the class is understanding it, whereas when you have just the question and answer session with the class you often get the more confident, more intelligent kids, the ones who understand the questions putting their hands up... (MG-21)

Morris reiterated that he uses the clickers mainly because they allow all students to participate in a lesson. He lamented over his failure to use the clickers regularly and stated that he would try to use them more frequently because of the main advantage of increasing student participation.

Teacher: Phillip Charlton (PC)[24]

Phillip is a science teacher at school E, same as Morris, located in the Miltonshire County. He had been using EVSs for several years and, as one of the most experienced users in the locality, he had led introductory sessions on EVSs to other educators. Through informal contacts I got to know that he uses the EVS in his teaching and I went on to contact him for possible participation in my study. He agreed to participate in my study and so I made an

[24] Pseudonym used

appointment to interview him over the use of clickers (as they call them in the school). Initially Phillip agreed to be interviewed on the 1st of December 2010, however, due to some commitments he had to cancel this appointment and instead move it to the 10th of December 2010. I travelled to his school and conducted the interview.

Interview context

Phillip, just like his colleague Morris, uses a brand of EVS called Word Pad with software called Word Wall. I was, therefore, interested to find out about his experiences with the use of this technology in his science lessons. He arranged for us to have the interview in one of the meeting rooms in the school. The conditions were excellent; there was a computer in the room which Phillip used to show me some of the activities he was using with his students and there were no disturbances from either staff or students during the interview session. The interviewee agreed to be recorded and I went on to record the full interview session using a digital voice recorder. The issues we discussed are presented under specific themes in the subsequent section.

Adoption of the EVS

The use of clickers in the Science Department was the brainchild of Phillip. He got to know about this technology when he attended a science conference several years ago. At that conference he felt that '...I would like to get a set of these [clickers], I think these are going to make learning different because of the interactive nature of them...' (PC-6).To date, Phillip has used three different types of EVS. About 8 years ago, he started using a brand called Activote, followed by Qwizdoms and then the Word Pad. According to Phillip '...the first generation of these clickers was not as good as they are today because you can just use them in the hall or in the classroom and they would still pick up the answers, whereas the first generation were infrared controlled and you had to point them to the board and sometimes if something was in the way the signal got lost...' (PC-6).He started using the Word Pad two years ago and he explains the reason why he started using these particular clickers as follows:

> ...the reason why I went for these clickers is the size of them...I also talked to the people who designed them and who actually operate the company, so I know two people...the one who writes the software and the person who sells them. So I feel I've got a direct link to them that when there is a problem with the clickers I can say can you try and sort this out for me...I feel it's really good that I have that kind of direct link with the person who writes the software...I can say I don't like this, can you do this next time and they do listen and make improvements on the software (PC-2)

I asked him whether he had made any recommendations to the company in the past and he indicated that '...there are things I've mentioned to them [and] they're going to try to put these things in future releases' (PC-4). He enjoys a good professional relationship with the company that manufactures the clickers he is using. Realising that Phillip has got massive experience with the use of different types of clickers I asked him to reflect on the important features that someone should look for when purchasing clickers. He provided the following information:

> The reason why I think these are better handsets is, first of all, they resemble mobile phones. The second thing, they [students] can put text in, you can text just like a mobile phone and if you ask most youngsters they're very comfortable texting into an actual phone and there is predictive text in it as well. The key thing about it also is the battery. The batteries last about a year and half where some of the bigger ones that have big screen and more buttons they run out a lot quicker, there [are] too many buttons that are confusing on the handset, so it's about making it for even higher able or less able students they can all access these clickers...because they are basically mobile phones key pad on the actual clickers...think about all learners...I like this handset because it is not too complicated, straight forward mobile phone technology sort of thing (PC-10)

Learning to use the EVS

Phillip is the one who brought this technology in the school for the first time. He got the initial support from the manufacturers of the technology; they are the ones who trained him how to operate the system. Within the school he is the 'champion' as he put it: 'within the school, if it comes down to it I am the one who basically got the handsets in, I was trained by one of the partners in the company...but if people want to know how to use these they will come to me to get the training for it...I'm seen as an expert in that field' (PC-14). He added that the manufacturers sent someone to train staff in his Department on two occasions. However, it is basically Phillip and one other teacher in the same Department with him who help to induct other teachers who are interested to use the technology in their lessons within the school. In the event of any technical problems they contact the manufacturer to come and fix it for them.

Different ways of using the EVS in the classroom

Phillip teaches different year groups ranging from y7 to y12 and he uses the clickers with all his different classes. Through my discussions with him, I learnt that he uses the clickers in different ways during the science lessons with different classes. While talking about the reasons why he went for these clickers he pointed out that they were fantastic for diagnostic assessment of students, as can be gleaned in the following quotation:

> ...if at the end of perhaps two or three lessons you wanted to find out how much the students have learnt very quickly you can actually get this information by putting a series of questions on them...you can actually gather that information very quickly and [the system] will assess and analyse the results...
>
> ...sometimes if I have got that set of questions I sometimes give them before we start the work and after the work to see how much they have improved. So it might be the same questions but in different order five or six weeks later to see if they have understood it... (PC-16)

The EVS allows students' responses to be anonymous or to have their names appearing against them. Phillip explained that sometimes students enjoy being anonymous but there are also times when they enjoy the competition and opt to have their names shown on the screen against their responses. He explained that sometimes he uses the clickers as a starter or a plenary. In some instances, he uses them in the middle of the lesson, however, he expressed that he would not use them throughout the lesson arguing that '...it has its moments...it depends on what you are doing in that lesson...you can have a test, you can have an opinion poll, you can have a quiz...' (PC-16)

I was also interested to know whether the use of clickers in his lessons was something pre-planned or spontaneous and he went on to say, 'a lot of the exercises are pre-planned...' (PC-18). However, he also highlighted that sometimes the use of the clickers can be spontaneous. I wanted to know whether it is a time consuming task to plan a lesson involving the use of clickers and in response to this Phillip indicated that:

> ...if you are familiar with the software and you know what question you need to ask [you] can put a test together of say 15 questions in about 20-25 minutes...but for somebody who doesn't know the software it might take him a couple of hours...I think it's familiarity with the software that makes it not a time consuming task... (PC-20)

Phillip explained how he deals with the issue of designing questions for use with the clickers. One major advantage that the brand of clickers he is using over others is that the system has got its own repository or activity bank where teachers can access questions. He explained the following:

> ...I generate my own questions that I've seen basically in books...there is a repository where people can upload anything they do...I can go to what is called the activity bank and I can put in let's say 'properties of materials' and it will tell me any quizzes that people have done beforehand and I can take those quizzes and then amend them or add to them or change them to the way I want them to be...sometimes I'm very

lucky I can get an activity that someone has already done that does not take as much time to then change to something else (PC-22)

He showed me how the system works and I was able to open the activity bank and see some examples of activities that were ready for use. He refuted the idea that the use of clickers reduces the amount of teaching time in a lesson. He felt that: '...it just aids it and it's a different way of actually assessing what you are doing, I don't think you lose time by it as such...' (PC-26).Phillip argued that 'they motivate the children...when they see the clickers come out, especially in lower school, younger people's faces light up. In upper school you get the older students saying, "oh we have done this before", unless you do something new with it there is a bit of [resistance] with the older students...' (PC-26). He clarified that his y12 classes like them because they appreciate that he poses difficult questions.

He explained how he uses the clickers to promote peer instruction: '...sometimes I get them to work in pairs and discuss before they put their answers up' (PC-30). Looking at the time he gives the students to submit their answers, he said this was dependent on the nature of the question '...if it's an open ended question I give them a minute or two minutes to discuss it and sometimes I ask them a question and I want a quick yes or no, true or false, a quick response and I want it to be straight away without thinking about it...' (PC-30).

I was interested to establish if the teacher had assessed the impact of using clickers on students' knowledge retention capacity. He stated that due to the difficulty involved in measuring that kind of impact he had not been able to assess it. He said, '...I can't say that, that bit is difficult to measure...I think there is the enjoyment side of it and the excitement but whether it makes them learn the information better or retain it for longer I don't know, I've never actually measured that as such' PC-38). Commenting on the impact of the clickers on the academic performance and achievement of students he said,

‘...the majority have shown an increase in the understanding and learning has taken place...’ (PC-40).

Phillip revealed to me that these clickers have got a lot of applications than just being a teaching tool. They are also used to make sitting plans, asking questions and it can also be used to access live news from newspaper sites.

Students’ attitude towards the use of EVS

The success of anything brought into the school also depends on the students’ response to it. I was, therefore, interested to find out how students were reacting to the introduction and use of the clickers in the science lessons. It was of interest for me to know how this technology was impacting on students’ attitude towards science as a subject. Phillip stated that ‘generally speaking, there is a level of excitement especially whenever they see it for the first time, they are really excited, they can’t control themselves really but as they get older you have got to do something slightly different with it or different tasks to keep them motivated...’ (PC-34).It appears that the students are positive about the use of the clickers but the level of excitement tends to go down with age. The teacher has to be creative to sustain the interest of students to use the technology. I gathered that both girls and boys are generally happy with the technology in the classroom although they behave in a slightly different manner in lessons where the clickers are used. Commenting on the levels of excitement of boys and girls, Phillip indicated that:

> It’s about the same except that boys like the competitive nature, they love to have their names up there, they love to see the leader board...during any kind of assessment there is nothing better than boys to see their names up at the top...they want to be number one...you don’t see that as much in the girls... but lads want to show up (PC-36)

Boys are more publicly competitive than girls when it comes to the use of clickers in lessons but otherwise both groups enjoy the use of the technology. They are motivated to learn the subject as a result of the clickers.

Problems and challenges of using the EVS

Phillip seemed to be quite happy and comfortable with the clickers. When asked if he has faced any problems with the use of the clickers he did not seem to have much to say. He only made reference to some 'teething problems' at the beginning involving some technical issues, not the actual use of the clickers in the classroom. He said 'there has been some teething problems but I think now they are very stable...we had problems like the handsets would not connect with the wireless device. Recently we had a small one about not going to the internet through the handset...' (PC-42).He demonstrated that he had an excellent understanding of how the software works as he kept showing me on the computer the different ways in which activities can be made. However, he made it clear that if one does not understand the software then the use of the technology can be difficult. The other issue he mentioned was the need for the teacher to be creative to avoid situations where students get bored and lack motivation to use the clickers.

Impact of the use of EVS on the teacher's attitude and perspectives about teaching

Phillip was very positive about the usefulness of the EVS in his science lessons. It was of interest for me to know if there was anything that he had started doing as a result of using the clickers in his teaching and assessment of the subject. He was happy that he could do different forms of students' assessment within a short time and the feedback he got could be used to deal with misconceptions in the next lessons or during the same lesson. This was revealed in his response:

> It's a reliable piece of software, I do use it a lot more for assessment because if I didn't do it I can give the same questions in the classroom and ask them to write their responses to it but this makes it a lot quicker than I can do and it's instant feedback, it's graphical feedback so you can see in a glance, if all the students are getting the questions wrong...you can explore that in the next lesson...you can find out and

> dig down and drill down to find out what was going wrong with that question...it's a lot faster than marking papers (PC-32)

I took the opportunity to ask Phillip for any advice he would give to a teacher interested in using the clickers for the first time. He emphasised the need to have a mentor, someone who has used the technology should be able to assist any teacher who is curious to try out the technology. Making reference to what he normally does in his school, Phillip pointed out that he advises teachers interested to use the technology to call on to him for induction '...might say if you want to know about it call on me and then I go through and show them how to use the software...' (PC-46).According to him, it is important for the teacher to know how the software works right from the beginning otherwise it would take a lot of time to prepare activities for use in lessons.

Teacher: Chris Watford (CW)[25]

Chris is a Maths teacher at a school I will refer to as school G, same as Peter, located in the Midshire County. I also researched the use of a VLE in the same school so I will not repeat the characteristics of the school here as they have been stated before. The initial arrangement with this teacher was that I was supposed to visit their school and observe him teaching using clickers and then subsequently conduct an interview. However, I failed to visit him to observe the lesson and to conduct the interview because their system was having some technical problems at the time I was supposed to visit the school. I ended up going for the second option, which involved e-mailing him the questions. On the 13th of December 2010 I emailed him a set of questions similar to the ones I was using during face to face interviews with teachers. I included some prompt questions to ensure that I elicited as much information as possible. In the following section I am going to present the issues we dealt with under specific themes, similar to the one I used with interview data.

[25] Pseudonym used.

Adoption of the EVS

Chris indicated that he started using the clickers in 2009. He further explained that the school had already purchased them prior to him joining the school. This means that he was not part of the decision making body that was responsible for the purchase of the technology that he was now using. He found the technology in the school and according to him 'they weren't in regular use, so [he] was keen to use them' (CW-2). He considers that ease of set up for a teacher is one of the important factors that should be borne in mind when choosing a particular brand of clickers (CW-4). I also wanted to know some of the personal reasons for his decision to adopt the use of clickers in his lessons and he mentioned the following: 'Pupil enjoyment. It adds an element of competition. Responses are anonymous, so I am able to discuss misconceptions without pupils feeling awkward' (CW-8).

Learning to use the EVS

Chris stated that it took him 'a few hours' (CW-6) to learn how to use the clickers. No one gave him any formal training for this, in his own words, he said 'I experimented with a colleague' (CW-6).

Different ways of using the EVS in the classroom

I was keen to establish how the clickers were being used by Chris in his maths lessons. To begin with I enquired whether the lessons with clickers were pre-planned or spontaneous. He stated that the lessons where he used the clickers were all pre-planned. I also wanted to know how much time he needed to plan a class session and he indicated that this was not a time consuming task for him at all, saying 'I can plan an activity within 30 minutes to one hour' (CW-10).

The other issue that I was interested to know was the issue of question design; I wanted to know whether there existed a repository of activities in their system or had he to design the questions himself. He highlighted that he was responsible for creating the questions. I went on to ask for the type of questions that he was able to use with the clickers. Chris explained that he usually makes use of '...multiple choice, with the other options being common wrong answers, sometimes allow number responses' (CW-12). Following below are examples of questions he gave me that he normally uses with the clickers:

Question1. Multiply out 2(X-2)

a. 2X +2
b. 2X +4
c. 2X -4

Question 2. What is 4 + -5? Where answers will include 1, 9, -9 and -1

I sought to find out whether the use of clickers reduced the amount of time for teaching the course content. The teacher did not feel that clickers led to loss of time. Instead he stated that '...they allow practice, re-enforcement and a chance to discuss misconceptions' (CW-14). Responding to the question on how much wait time he gives students before they can actually submit their answers, he went on to say 'Varies. The response system I use says what percentage of pupils has responded so [I] use that as a guide' (CW-16). Regarding the point at which he introduced the clickers in his lesson, he stated, 'usually as a starter or after explaining a new topic' (CW-18). He indicated that he had not been able to assess the impact of clickers on students' knowledge retention highlighting that, '...it's one of a range of strategies to improve retention. It is difficult to assess which has the greatest benefit' (CW-24). I was interested to find out what the teacher thought about the impact of clickers on students' academic performance. The teacher, Chris, felt that the clickers helped to improve students' academic performance. According to him, '...I see misconceptions challenged and shared in a non-threatening environment. Secondly, their enjoyment adds to the positive feelings towards maths, so a knock on effect!' (CW-26)

<u>Students' attitude towards the use of EVS</u>

I wanted to know whether the students were happy with the use of the technology and whether the technology helped to change their attitude towards the subject, mathematics in this case. I asked Chris, 'did you notice any changes in students' attitude towards your subject as a result of using clickers in your lessons?' (GC-21) From what he said, I noticed that the clickers were having a positive impact on the students. He said, 'they were always enthusiastic but this adds to the fun!' (CW-22). The students' response to the clickers was said to be 'very positive' (CW-28). The majority of the students were said to appreciate the competitive element that the introduced in the lessons. On the other hand, Chris highlighted that some of the students, a small minority group do not like the element of competition.

Problems and challenges of using the EVS

The only problem that Chris cited which affects the use of clickers was "technical failure" (CW-30). It appears that there is no technical support guaranteed in the school. Chris stated the following: 'make sure it works beforehand! Reboot if necessary or use the mini whiteboards on the same questions if all else fails' (CW-30). He did not mention whether there is anyone within the school who could provide some technical support in the event of a problem. He mentioned that the use of clickers depended on the level of technical confidence highlighting that, 'if you are IT literate then experiment. If not, you need to practice on your own or set up with another colleague' (CW-32). So the challenge for teachers interested to use the technology is to be IT literate!

Impact of the use of the EVS on the teacher's attitude and perspectives about teaching

One of the issues I was interested to find out was the impact of clickers on the teacher's attitude towards technology and his perspectives about his practice, that is teaching and assessment of the subject. I asked him the following question 'Is there anything new that you have started doing in your teaching and assessment of the subject as a result of using clickers?' (GC-19) He went on to say, 'become more aware of individual pupil understanding' (CW-20). Although he did not explain further, it is clear that the teacher acknowledges that the technology has had an impact on his practice. He was very positive about the use of clickers and he valued the feedback he got from the system.

Teacher: Josephine Hardy (JH)[26]

Josephine is a science/biology teacher who is also the current HOD of science in the school. The school, which I will refer to as school H, is located in the Miltonshire County. It is a high achieving 11-18 Comprehensive school judged to 'outstanding' by OFSTED inspectors in 2009. It was designated as a Language college in 2005 and gained full international school status in 2008. The school moved into a new building in 2009 and according to the school website, teaching and learning have been greatly enhanced by the introduction of a Managed Learning Environment which allows students access to learning and support inside and outside formal hours. Most of the students are from white British backgrounds and the proportion of students from minority ethnic groups is above average. One sixth of the school population speaks English as an additional language.

I got to know about the use of EVS in the science Department when I got in touch with one member of staff from another Department in the school. This particular member of staff helped to link me up with Josephine. I visited the school to meet with Josephine, using the opportunity to explain the nature of my study and to secure an interview appointment with her. The interview was held in the morning on the 9th of November 2010.

Interview context

The interview was conducted in one of the science labs in the school during one of Josephine's free periods. She was aware of the nature of my study as I had taken time to explain this to her when we met in the school two weeks prior to

[26] Pseudonym used.

the interview date. She was comfortable with me and happy to share her experiences about the use of EVS. She agreed to be recorded so I proceeded to record the interview using a digital voice recorder. This helped me to focus mainly on asking questions. The atmosphere was very friendly and discussions went on smoothly.

Adoption of the EVS

The science Department started using the EVS 14 months ago and they called them 'handsets'. When I asked how this idea came up in the Department Josephine explained the following:

> ...a colleague called [name supplied] in the science Department had used these handsets in the previous school and she thought they were a good idea. We had moved into this new building and we were being encouraged to use new technology and the school had a pot of money available that we could make a bid for...so we put the bid in and said we would like the handsets to make use of the technology and also to help the pupils with their learning and we were given £1000 in order to buy 32 handsets (JH-6)

Josephine's colleague is a physics teacher who brought with her to the Department massive experience of using EVS in her lessons. I made efforts to meet up with this teacher to discuss her experiences about using the EVS; however, it was difficult to achieve this, she was said to be busy all the time. The EVS appears only to be used in the science Department. I enquired, 'so is this happening in the science Department only?' (GC-24) Josephine responded, 'as far as I know...myself as the HOD, I made the bid to buy the equipment and we have it down here in science and I haven't been approached by anyone else in the school to use it...'(JH-25). She however, expressed hope that the use of the EVS might spread across all the Departments in the school at some point if the people responsible for professional development in ICT decide to share the knowledge and skills with the rest of the school. The brand of handsets they are using is called ‘Activote’ and this was chosen on technical grounds. Josephine commented that:

> Activote handsets [are] compatible with the Promethean products in the school, all the white boards in the school are Promethean and the software is Active Board software so we have got Activote handsets which are compatible with the Active board software so when we load up the software for interactive whiteboard the Activote software is already there so it’s not an extra thing which is why we chose that product really (JH-31)

Josephine was actually involved in making the decision to purchasing this particular brand of handsets. Apart from technical aspects she alluded to in the previous question, I also asked her what she thought were other important factors to consider when choosing a particular brand of handsets and she said the following:

> ...so the primary reasons were my colleague had used this particular one and so she had experience with this particular one and so that came with a positive evaluation, it’s compatible with the software that we have on the Active boards and obviously we thought the price was competitive... (JH-39)

She, however, lamented that soon after purchasing this brand of handsets, another brand called Word Wall became available, ‘...within weeks of buying the product, another product became available that probably we would have chosen instead but it was too late. So I don’t feel now that we probably made the best choice but at the time it was the best choice’ (JH-39). From what she said, the market for the handsets is expanding, different types of handsets are being manufactured and they are getting better in terms of what teachers can do with them in the classrooms as Josephine commented making reference to Word Wall, ‘the product called Word Wall...it seems it would suit us much better because there are a lot of resources already there and so the making of activities would be less time consuming and I think we would be able to use it more frequently if we got a product like that...’ (JH-41).

Learning to use the EVS

It was of interest to me to find out how Josephine and other teachers in the Department learnt how to use the EVS in their science lessons. Josephine indicated that her colleague, the physics teacher, had played a significant role in inducting them on the use of the technology, however, in addition to this, they also got help from two other members of staff from the school:

> ...what happened was that the handsets came and the Physics lab technician who is the person who first of all worked out how they work, how to use them, what we needed to make them compatible with our school PCs and our interactive whiteboards...there was a technical back up that was required before the teachers could actually begin and then really one of the other physics teachers who is our ICT champion in the school ...led the training session for the rest of the teachers (JH-15)

She clarified that they had Departmental professional development. I asked her how much time it had taken them to learn how to use the EVS in their lessons and she highlighted that they took less than an hour to learn this: 'he did a professional development session which was less than one hour...he put up a quiz together that we all tried it so that made sure people engaged with it and thought it was a good idea and they could see how they might use it with pupils' (JH-19). Professional development was extended to all the science teachers in the Department, however, not everyone is using the technology in their lessons. When asked about how widespread is the use of EVS among the science teachers, Josephine said the following:

> It's quite difficult to estimate...I think the majority of the teachers have tried to use them at least once but we have the problem of trying to make a lot of activities which takes time, it takes time to produce the activities so they have been used in Biology, Chemistry and Physics with a range of different year groups but it's quite difficult to quantify (JH-27)

It appears that the use of EVS is affected by the time needed to prepare the activities for each lesson. Not all teachers appear to have the time to prepare the activities; hence, some have continued to use the technology while others have abandoned it. I asked Josephine if they have any time set aside for preparing the activities for EVS, for example during curriculum days. She indicated that there was not much time for teachers to work on the development of such innovative technology citing that, 'teachers' time is spent a lot on preparation for normal lessons and marking...' (JH-54)

I looked at the issue of technical support in the school. It was of interest to me to find out who gives the teachers the technical support when the need arises. Josephine explained that she could either get support from within the school or outside the school:

> The Physics lab technician is good. He knows, so I would first of all try to get him to see if there is any problem that I should know about if there is an easy solution. I could also call Civica ITC helpline within the school and maybe they could come and give me some help or I may just reach a decision where we just abandon this for something else and see if it can work for next lesson... (JH-72)

She added that abandoning the technology if it does not work in a lesson is important in terms of avoiding wasting time and also keeping students engaged: 'you can spend a lot of time fluffing around...you need to keep them occupied using the time profitably...' (JH-72).

Different ways of using the EVS in the classroom

Firstly I asked Josephine how much time she needed to prepare for a lesson where she would use the handsets. She expressed that:

> If I have an activity already saved to use then it's very easy because I need to just book the equipment and make sure nobody else has said they want to use it for that lesson, so we book it as if we are booking an experiment...so that no one else can have them and the other thing

> which is a technical thing is to check that it is definitely going to work in the lab that I am teaching in... (JH-44)

I gathered that if the activities are already set it does not take much time, however, it would take more time if one has to put in place the activities "...it could be a couple of hours to create the activity and that's the barrier to making it more widespread" (JH-44).

She also explained to me the different class sizes she works with highlighting that class size, '...varies a lot, in y7 there are all around 32 mixed ability, from y8 to y11 some classes might be as small as 10 where the ability level is low...and A levels up to about 25' (JH-46). She added that she has used the EVS with GCSE and also with A levels. When she indicated that some low attaining students can be in small groups of about 10 students I went on to ask if it is a good idea to use the handsets with small sized groups. She explained the following:

> Well, we have 32 handsets so we can accommodate big classes and everyone can have their own handset, the problem with the [low attaining] students is you have got to make sure that the reading demand on the screens is not too difficult so you have got to make whatever put on the screen accessible to whoever is in your group. So sometimes we may have created something which is for GCSE high ability. In that way you need a second resource to differentiate because they can't, some of them want more challenge so we have to make it harder, some of them need it more simplified so it's complex to build up a bank of resources but then we would share them so if I make a resource for my y8 all the other biologists can then use that as well... (JH-52)

It is important to know the characteristics of your group. In addition to this, I was also interested to know the types of questions they could make use of with the brand of handsets they have in the Department. To this end, I found out that the handsets they have enable them to ask multiple choice types of questions. She explained, ‘our handsets do not allow them to type in an answer...our key pad is basically set up for multiple choice mainly’ (JH-58).

I went on to ask if the use of EVS had the potential to develop critical thinking skills among students. She commented that the development of such skills depended on how the questions were designed. She put it clearly in her own words:

> ...I think it depends on how you phrase the questions, if you want to make them think you could have evaluation based questions, for example, that would be higher order than just recall. The nature of how you phrase the questions and the questions that you set up is the opportunity to address thinking skills (JH-60)

From what Josephine said, the teacher plays an important role in driving the technology in order to achieve what he or she wants from the students. I was very much interested to know how exactly the teacher used the EVS in a lesson, for instance, I wanted to know whether the EVS is introduced at the beginning or at the end of the lesson. She gave the following explanation:

> I think either of those approaches is possible. For myself I have tended to use them either as a plenary at the end to check on the learning of that lesson, for example, with the y8 lesson that I am planning it will be quite a main activity because the whole lesson is about revision so one of the activities within the lesson will be a quiz on the handsets (JH-62).

I also asked the teacher to reflect on the amount of time she gives her students to submit their answers. She indicated that their handset system has got a time counter which enables the teacher to set wait time for each question. Turning to how much time she gives students she highlighted that,

> It varies...you can have an open amount of time and then give them as long as they need and then verbally ring them up if you see that a certain amount of students have responded. Alternatively, you could say well, I think this question should take 30 seconds to read, think about

> and choose and so put them under more pressure...we can do times that range from 15 seconds up to a couple of minutes if you want it to run in an automatic way (JH-66)

Again, the teacher plays an important role here:

> it's about knowing your group, I think if you know that there are slow readers then you can help sometimes by reading the questions to them, let them look at all the answers and then start the timer...it's kind of strategies, you might even vary that from one question to the other, if I am conscious that some questions are very quick to read then I may start 30 seconds immediately. If I think it's quite a lot to read, it's complex decision I might give a little bit more thinking time before I say right now you have got 30 seconds in which to vote (JH-68)

I wanted to hear from the teacher if in her opinion she felt that using EVS limits the amount of content that can be covered in a lesson. In her response she indicated that she does not think that EVS limits the amount of content that can be covered in a lesson. She posited the following:

> I think as long as the technical side of it behaves on the day...if it's smooth to give out handsets and get started then it's no more time consuming than any other method that you would use to check understanding so it's just an alternative approach rather than something you will do on top of everything else...it's just a different strategy (JH-70)

She added that this approach can be more exciting compared to the other conventional methods. I asked her to comment on the impact of using the EVS on students' knowledge retention capacity. She indicated that she had not focused on measuring that directly and was not comfortable to attribute any observable changes to the effect of using EVS alone. She explained the following: '...if we do a revision test with handsets then we do a test afterwards they do seem to do so well on the sort of questions that have been on the

Activotes lesson but whether that's because of the active votes or whether they have just been revising at home we can't tell' (JH-80). She further added that, '...my hunch is they engage well with it, they enjoy it, they will, therefore, remember some elements more successfully than others and that will be beneficial somehow in the big picture' (JH-82).

I was also interested to know the impact of using EVS on the students' general academic performance in science. Josephine made the following observations:

> I think the impact will be in that you are always trying to motivate and engage students and I think particularly students who are maybe disaffected if this is a hook that brings them in and makes them feel that this is more exciting, more interesting or more fun, their academic progress may prosper as a result of that. So again it's a contributing factor...it does engage with most students that use them so that should be a positive achievement really (JH-85)

Still focusing on the way the teacher uses the EVS, I went on to ask her if she uses it to promote peer instruction. The teacher appeared to be unfamiliar with the concept of peer instruction so she asked me to explain what I meant by that. After giving a brief explanation, she told me that she had not used that approach before but agreed that it would be a good idea to try it out in her lessons. She explained that sometimes she uses the feedback she gets from students to promote class wide discussions as she explains here, '...when they have all responded you may say if anybody has chosen 'A' is there anyone who is prepared to explain why they have chosen 'A'...' (JH-93).

Students' attitude towards the use of EVS

One of the issues I was keen to find out from the teacher was her views regarding the way students were responding to the use of the EVS in their science lessons. Having indicated to me that she taught different year groups, I was interested to know if students of different ages responded in the same way to the use of EVS. She elaborated the following: 'Sixth form love it, they definitely don't grow out of it, they don't get to a point where they think it's a baby issue, they really like it, the older ones I tried it with, they really think it's a good thing, they are very competitive. Lower down the school... they enjoy it as well...' (JH-50). She indicated that when she uses the handsets in lessons there is evidence of high motivation and interest in the subject compared to the other conventional methods:

> ...if I try to ask them questions and have their hands up and say give me the answers you would see particular students contributing more than others, some hoping that they didn't have to say anything, some holding back not doing anything as such, so this forces their hands, everybody has to join in and the system is anonymous so nobody knows if they get it wrong even if they get every question wrong they don't feel any sense of embarrassment so they know they are wrong and hopefully they learn from what the correct answer is so it's a safe way of them perhaps gaining confidence to stick their neck out and say what they think you know whereas they are reluctant to do that verbally (JH-87)

She pointed out that the students really enjoyed the competition with their colleagues. However, she also indicated that the teacher should be careful as some students may end up just pressing buttons without taking time to think through the questions carefully. She said:

> And one other thing which they like which you have got to be careful with is you can actually find out who answered fastest and some of them see it as a competition to press quickly without thinking so it becomes a race rather than a careful selection of the answer but they do get competitive about the speed of their responses as well as whether they have chosen the correct thing (JH-98)

I asked the teacher to reflect on anything typical that students appreciate about the EVS and she posited the following:

> I think they appreciate that they don't involve writing because quite a lot of students are reluctant to write or they just like a break from the requirements of writing things down...they like the independence...they like the competitive side of it...they like the fact that it's technology and therefore it feels modern, it feels new, it feels like a game show and I think all of that is appealing... (JH-102)

I was keen to know whether what the teacher said applied to both boys and girls. She pointed out that both boys and girls responded in the same way, they all enjoyed the use of technology in the lessons, however, Josephine pointed out that:

> ...the boys are usually just louder or excitable when we are doing these things, they will be more like "Yeah!!!I got it right!" You know, a bit more show off about it if they are getting it right whereas the girls will just be maybe quiet inside, feel pleased that they got it right rather than being vocal but it depends on the class and I'm sure that there are age group variations as well (JH-106)

<u>Problems and challenges of using the EVS</u>

Talking to Josephine, I gathered that one of the big challenges they face is trying to keep pace with the ever changing technologies. She pointed out that soon after buying their handsets a new brand was made available on the market. One of the constraints in terms of using the EVS effectively is time needed for the preparation of activities. Commenting on the attitude of teachers towards the use of EVS, she made it clear that teachers were very happy with the technology, however, its use was limited by lack of resources: ' ...the main barrier is putting resources together that are useful for our students because it takes time, that's the big problem really' (JH-112). I sought to establish if she felt there was any way of dealing with the problem of time that was affecting most of the teachers interested in using the technology. She was not very optimistic about it. She went on to say:

> I imagine it will be there for a long time...we have INSET time, we have staff training time but there is always something else that needs doing...as a subject leader I keep flagging up reminding everybody about the handsets and if I find windows of time will say, well in this particular staff meeting time I would like everybody to make a resource that uses technology and it might be that some people do something and so make a bank of resources that others can draw upon...(JH-114)

The Department did not have any policy that encourages all teachers to use the new technology, every teacher chooses either to use the new technology or not.

Impact of the use of EVS on the teacher's attitude and perspectives about teaching

As HOD of Science, I felt that Josephine could comment on the attitude of the teachers in her Department towards the use of EVS. She explained that the teachers in her Department were very positive about using the new technology, however, problems like lack of time to prepare the resources was militating against the widespread use of the technology. She reiterated that, 'I don't think anyone resents their use, I think they either choose to use them or not to use them, I don't think there is any negative feeling about it, I suspect there are some people who would love to use them more but we haven't had enough time to create the resources to make that possible' (JH-29).I also asked her to reflect on the reasons why she would want to continue to use the EVS and she responded:

> I would use them because the pupils enjoy using them, I think they feel it's like a game show and it's fun and it's something that's different, so I wouldn't want to use them all the time because like anything else they get bored if we do it all the time but I think that's just, er, something different, something original that will engage them, motivate them, it's also something where they all have to take part because you can tell if they have not voted...everybody is accountable and everybody has to

> participate and there is a good element of competition that you can introduce as well (JH-33)

There are quite a number of reasons why Josephine would continue to use the EVS. She is very positive about the utility of this technology in her science lessons. She also added that, '...it's flexible, you can use it as a tool for revision and checking on learning but one of the things I would want to explore maybe eventually is using it for pupil voice and gathering opinions about things which is something that we are encouraged to do more and more really' (JH-35). I asked Josephine if there is something that she had started doing differently as a result of using the EVS and she did not feel like there was anything new that she was now doing. She said:

> ...I don't think because I'm using the handsets it's changed anything else. I just think it's another tool, it's another tool in use to try and get kids to learn and enjoy their science. I see it as just another tool in selection so when you are making a decision about your lesson that's something you consider. I don't think it has changed my practice in other ways... (JH-76)

She emphasised that nothing had changed in terms of the way she did her work before, 'no it's not changed how I asked questions of them or anything like that, no! It's more how I do most of my lessons will impact on how I run my Activote lessons really' (JH-78). Lastly, I asked her for any advice to some teachers who would be interested in using the EVS for the first time and she was happy to share the following:

> Make sure you get the right product, be aware that certain products like ours there is a lot of time investment needed to maximise the use of the equipment...start with something simple...design a simple quiz and make sure students are comfortable with how they are using the handsets and then next time increase the demand or increase the number of questions, share with your colleagues, encourage resources to be not reinvented by everybody...share up topics and agree with colleagues so

> everybody will try to do a certain activity and then you can easily share those and save them... (JH-111)

Views from Geh Koh Sung (GKS)[27]

Geh Koh Sung is a Mathematics teacher in the School of Informatics and IT at a Polytechnic in Singapore. I got to know him through my Supervisor. He uses the EVS in his maths lessons. I was interested to get his views regarding his experience with the technology in his lessons so I got in touch with him and he agreed to participate in my study. I could not travel to meet and discuss with him in person, therefore, I sent him the same questions I used during interviews with UK based teachers through email. I sent him the questions on the 20th of November 2010 and I received his responses on the 25th of November 2010. He answered all the questions I gave him and these covered all the aspects I was interested to know regarding the use of the EVS. Following below is a presentation of the issues he responded to and they are presented under specific themes in the same way I presented interview data of UK teachers.

Adoption of the EVS

Geh Koh Sung started using EVS, commonly referred to as clickers, in early 2009. He indicated that a couple of staff from the institute attended a presentation by a local vendor on Classroom Voting Systems (CVSs) (the other name given to EVSs), and won a set of clickers in a contest. From that he started using the clickers in his lessons. According to him, use of the clickers was basically his own initiative. He added that, 'I wasn't consulted on the brand we have got because it was free' (GKS-2). At the moment they are in the midst of purchasing more sets and he has been asked to work with the Resource Team in the drafting of the invitation to quote. His experience with the clickers is being valued and hence his inclusion in the consultations for the new

[27] Pseudonym used.

purchases being sought. He feels that some of the important factors to consider when purchasing clickers include compatibility with the software already in existence in the institution, for instance, in his case he needed a system that would work with MS Power Point,

> Compatibility with MS Power Point...the brand I am using has a plugin for Power Point which makes it easy to rapidly create quizzes in presentations... [He also added that the system should meet their needs] configurable for both large and small classes. Say I am getting 100 clickers; I would want to get it with 3-4 receivers, so when I am in a large class I will deploy all 100 clickers with a single receiver but I should also be able to split the set into 25 clickers plus 1 receiver and use them for concurrent smaller classes (GKS-4)

He further indicated that he decided to use the clickers in his lessons, 'mainly to provide instant feedback to individual students' (GKS-8).

Learning to use the EVS in the classroom

I was also interested to know if the teacher had undergone some formal training either within the institute or outside for him to use the clickers in his lessons with considerable success. He mentioned attending a presentation by a vendor before they got the clickers, perhaps gaining some insights into how the technology worked in a classroom situation. Once he got the clickers he explained that no one taught him how to use them, instead, he, '...figured it mostly on [his] own via the web...' (GKS-6) and it took him about two days to do that. He was, however, optimistic that once they acquire some more clickers, '...some form of [professional development] would be conducted, someone from the Research Machines Team [vendor] would be able to handle and advise in the event of technical difficulties' (GKS-30).

Different ways of using the EVS in the classroom

It was of interest to establish the ways in which the clickers were being used in the classroom. Issues like, at what point during the lesson are the clickers introduced, what sort of activities were used and how often the teacher used the technology in his lessons, were among some of the aspects that I was keen to find out from him. To begin with I asked him whether the use of clickers in his lessons was something pre-planned or spontaneous. He indicated that all the class sessions where he used the clickers were pre-planned: '...I used [them] in topical revision [sic] so after completion of one topic and before the start of the next I deployed the clickers in class to get a feel of their conceptual understanding' (GKS-10). He stated that the set of clickers he has got at the moment only supports multiple choice questions and he gave me some examples of the questions he uses, these are shown below:

Q1. A compound logical expression is said to be a tautology if...

X A. Its output values have more True than False

X B. Its output values have more False than True

√ C. Its output values are all True

X D. Its output values are all False

Q2. Given the truth table below, which is/are the critical rows?

Premise 1	Premise 2	Premise 3	Conclusion
F	F	F	T
T	F	F	F
T	T	T	T
F	T	F	F
F	T	T	F
T	T	T	T
F	T	T	F
T	T	T	F

X A. Rows: 1

X B. Rows: 3, 6

√ C. Rows: 3, 6, 8

X D. Rows: 1, 3, 6, 8

Key: X: wrong answer and √: correct answer

Source: (GKS-12)

I asked, 'Does the use of clickers in class reduce your time for teaching the course content' (GC-13). He responded to this indicating that his teaching time was not affected in any significant way by the use of clickers. He confirmed that some instruction time is lost distributing and collecting the clickers but since he only has 20 clickers he felt that the time lost was insignificant in his own case. The other issue I raised with him was the question regarding the amount of time; that is, wait time, he gives students to submit their responses. He explained that, 'default time is 1 minute but since the model that we have has an indicator of which clicker had logged a response, I can pause the countdown timer to give students more time in the event that a large number of them had not logged in their response' (GKS-16). The teacher makes a judgement of the amount of time he wants his students to take to think about the question before submitting their answers.

When I asked him at what point he introduced the clickers in a lesson, I wanted to find out whether he uses them as a starter or as a plenary. However, he simply stated that he uses the clickers for revision and it was not clear whether he would use them at the beginning or at the end of a lesson. Unfortunately I could not seek clarification on this. I also raised the question of whether he thinks these clickers are helpful in terms of promoting knowledge retention. In this case he went on to say, 'rather than knowledge retention, it would be more accurate to say that I was able to identify areas of weakness and misconception that students have about the topics covered' (GKS-24). He chose not to comment on the issue of knowledge retention. I presume this is not one of the things he has been able to measure but it was helpful to know that through clickers the teacher was able to identify areas where students needed more help. It was also difficult for him to comment on the impact of clickers on students' academic performance; he said, 'I don't think I can attribute their performance to the use of clickers' (GKS-26).

Students' attitude towards the use of EVS

I elicited the views of the teacher regarding his perceptions of students' attitude towards the use of clickers. Geh Koh Sung stated that 'students participated readily... [They] appreciated the anonymity and immediate feedback...some said that our tests should employ the use of clickers...' (GKS-28). He lamented that the number of handsets was not enough for all students, students have to pass them around so that everyone gets a chance to use them, '...although no one complained about it, I get a feeling that they would rather have a clicker to themselves during [a lesson]' (GKS-28). Students also developed positive attitude towards the subject as a result of using clickers in his lessons. He stated that, ' some were quite excited when they saw me bringing the clickers for the second time after they had used it once' (GKS-22).

Problems and challenges of using the EVS

I took the opportunity to find out if there are any typical problems that a teacher can encounter while using clickers in a lesson. Geh Koh Sung went on to say, 'I am fortunate that I have not faced any serious technical problems in the use of clickers thus far, if I do, there's no one I could call because our resource management team are basically just the custodian of the set, none of them are trained in the use of the clickers, only hope is to call the vendors' (GKS-30).

Impact of the use of EVS on the teacher's attitude and perspectives about teaching

The teacher does not feel that he has started doing anything new in his way of teaching and assessment of the subject as a result of using clickers. However, he was very happy with the technology highlighting that the instant feedback he got from the system was helping him to identify and deal with students' difficulties and misconceptions. In terms of advice to other teachers who might be interested to try the technology in their own classrooms, he encouraged them to follow his example: 'just do what I did, sign out the set and experiment with it...ask other staff who have used the set' (GKS-32).

4.3.2. Views of students regarding the use of EVSs

I had the opportunity to elicit students' views regarding their learning experience using EVSs in science lessons. A total of 150 students participated in the study and these were derived from two schools in Miltonshire County and one school in Milkshire County. The students were drawn from classes of teachers who were participating in the study and they were from different year groups as shown in Table 9 below:

TABLE 9: NUMBER OF STUDENTS WHO PARTICIPATED IN THE EVSs PROJECT

Year Group	Number of students
7	29
9	77
10	24
12	20
TOTAL	150

I used a questionnaire with 22 closed-ended questions and three open-ended questions (see appendix 8). The responses to the 22 closed-ended questions (see appendix 11) were analysed quantitatively using Excel and the responses for the three open-ended questions were analysed qualitatively using the thematic approach. The first 22 Likert scale questions required students to look at a statement (such as 'I liked the lesson because it was fun' and then rank this statement according to the degree to which they agreed or disagreed (Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), Strongly Agree (SA) and Pass (P). Each category was given a numerical value to facilitate calculation of weighted mean by Excel and these were as follows: 1=SD, 2=D, 3=N, 4=A, 5=SA and 6=P. The last category, pass (P), was not used in the calculation of weighted mean and in similar transformations of data because the response was considered to be equivalent to non-participation or withdrawal, that is, the vote was unknown. In each question, the number of passes can be worked out by comparing the number of recorded participants with the statistics of participants in the study shown in Table 9 above. On the basis of my research questions I identified six categories, shown below, and used them for the analysis of findings generated from students' questionnaires.

- Impact of clickers on student participation in class
- Knowledge retention
- Ease of use of clickers
- Students' attitude towards the use of clickers
- What students appreciate about using clickers
- What students dislike about clickers in the science classroom

I analysed the students' responses per year group in an effort to find out whether age constituted an important variable in determining students' attitudes towards EVSs. Furthermore, I explored gender differences in some cases to establish whether gender was an important issue in terms of students' perceptions about the use of EVSs. After explaining the ratings, in order to draw comparisons, I used weighted averages calculated using Excel. I found this to be a parsimonious way of presenting the data. One advantage of calculating weighted means is that they can be used to assess the response of groups taken as a whole, in terms of the Likert categories. A weighted mean of 4.0, for instance, suggests a group view corresponding to 'Agree'. A weighted mean of 1.0 would indicate 'Strongly disagree'. The findings are presented in the subsequent section.

I used weighted means as a simple and easily interpretable indicator with which to derive a 'feel' for the Likert data. This use of weighted means is no more than a handy but basic indicator. There are more sophisticated indicators such as the 'Consensus Measure' as discussed by Tastle et al. (2005). Taste et al. (2005) contend that the use of weighted means is '...fraught with error, since Likert scales are ordinal measures' (p.1). The same views are reiterated by Jamieson (2004) who argues that, the mean and the standard deviation are inappropriate for ordinal data and hence, calls for Likert data to be treated as ordinal data and not as interval data. Knapp (1990) cited in Jamieson (2004, p. 1218) highlights that 'treating ordinal scales as interval scales has long been controversial' and, it would seem remains so. This is well illustrated by Kislenko and Grevholm (2008) who contend that: 'there is no common agreement on what statistical methods are appropriate in relation to use of Likert scale' (n.p.). It has been pointed out in the literature that there are two kinds of views when it comes to the analysis of Likert-type items: the supporters of measurement and the supporters of statistics. The first ones claim that the level of measurement defines the statistical procedures that can be applied to the numerical data. The latter ones declare that the level of measurement is not a constraining factor when analysing data. Dawis (1987, p.487) sums up the contrasting views:

> Those who accept the latter view tolerate the use of parametric statistics with scores from quasi-interval scales that actually are at the ordinal level of measurement, a common practice that is criticised by proponents of the former view

For the purpose of my study, I did not go into much detail about the debates surrounding the analysis of Likert scale data. As highlighted earlier on, I chose to use weighted mean because it was a simple method which enabled me to interpret views of different groups of students involved in my study. Clearly, there is scope for further work in this area to try and identify appropriate statistical measures to be applied to Likert-type data.

Impact of clickers on student participation in class

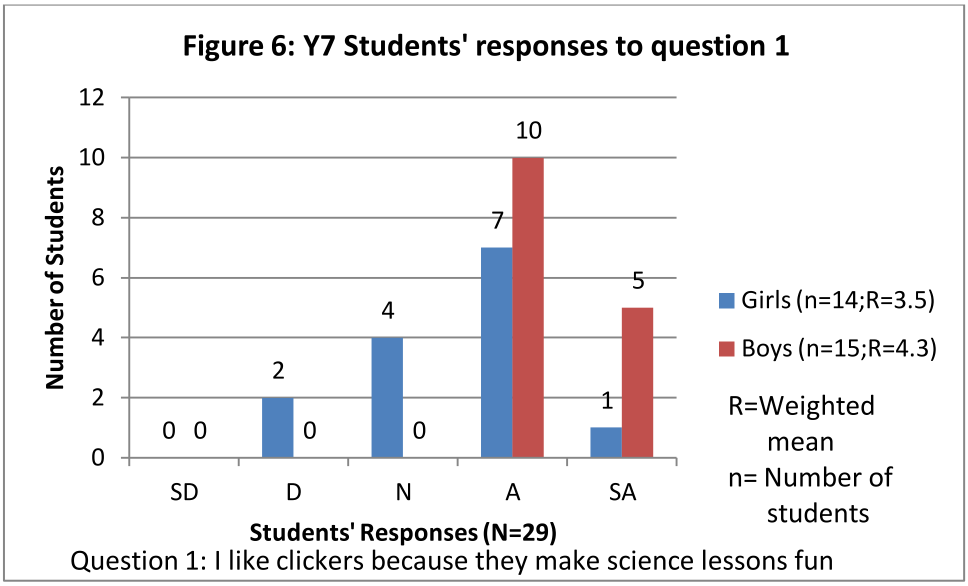
The questions that fall within this theme are numbers 1, 17 and 21. Most of the students across the different year groups felt that the use of clickers makes science lessons fun. The results of the first question which stated, 'I like using clickers because they make science lessons fun' are shown in the Table 10 below:

TABLE 10: STUDENTS' RESPONSES TO QUESTION 1 (N=150)

Year Group	Students' Responses					Total	Weighted Mean
	SD (1)	D (2)	N (3)	A (4)	SA (5)		
Year 7	0	2	4	17	6	29	3.9
Year 9	0	1	4	24	48	77	4.5
Year 10	0	0	1	8	15	24	4.6
Year 12	0	0	0	7	13	20	4.7
Total	0	3	9	56	82	150	

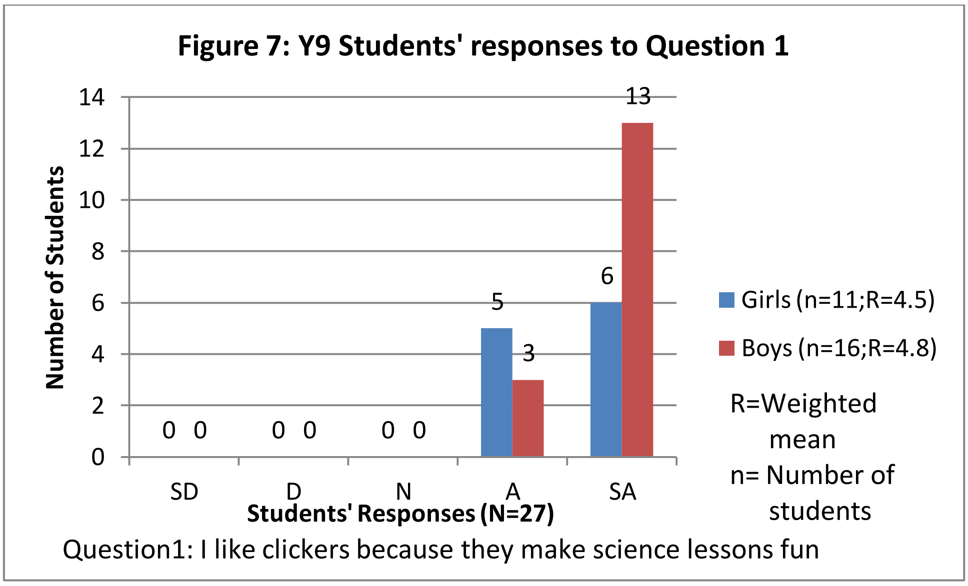
Source: Students' Questionnaire

From the 150 students who were surveyed, 92% of them were positive about the use of clickers in science lessons. The above table shows that 56 (37%) of the students agreed that clickers made science lessons fun while 82 (55%) of the students strongly agreed. A small number of students, notably, students from year 7 and year 9, either disagreed or were not sure about which position to take regarding the issue of using EVSs in science lessons. I examined gender differences among year 7 students and one of the three year 9 groups I worked with. Students from these two groups had been asked to indicate their gender on the questionnaires unlike students from the other participating groups. The results for the year 7 and year 9 students are shown in figures 6 and 7 respectively. Year 7 results of the first question indicated that all the boys were positive about the use of EVSs in their science lessons while on the other hand, it can be seen that some of the girls were not agreeable to the use of the technology. The weighted mean scores help to illustrate the differences between boys and girls. Boys had a weighted mean score equal to 4.3 while girls had a weighted mean score equal to 3.5 showing that on average all boys viewed the use of clickers positively while for girls although 57% of them were positive about use of clickers, 43% of them were either disagreed or neutral about the notion of clickers making science lessons fun.



Source: Students' Questionnaire

From year 9, all students, including boys and girls, either agreed or strongly agreed with the notion that clickers were making their science lessons more fun. There is, therefore, no marked difference between boys and girls in terms of their response to the use of EVSs in the science lessons. Results shown graphically in Figure 7 below help to illustrate that there were no major differences between girls and boys with the groups having weighted means of 4.5 and 4.8 respectively.



Source: Students' Questionnaire

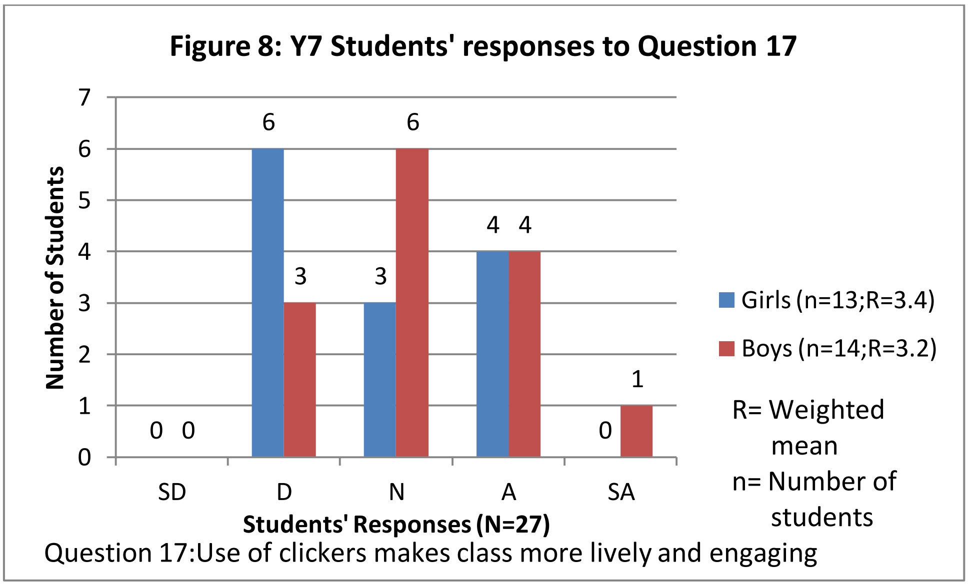
A considerable majority of students also felt that the use of clickers made class more lively and engaging. This can be seen from the results of question 17 which are shown in the Table 11 below:

TABLE 11: STUDENTS' RESPONSES TO QUESTION 17 (N=145)

Year Group	Students' Responses					Total	Weighted Mean
	SD (1)	D (2)	N (3)	A (4)	SA (5)		
Y7	0	9	9	8	1	27	3.0
Y9	2	5	14	33	20	74	3.9
Y10	0	1	2	13	8	24	4.2
Y12	0	0	0	12	8	20	4.4
Total	2	15	25	66	37	145	

Source: Students' Questionnaire

From the above table 11, it is worth noting that almost one third of the students (42 of 145) were not agreeable to the notion that clickers were making the classes lively and engaging. Most of the students in this group belong to year 7 and year 9. The weighted means in the table x above show that Y7 and Y9 had the lower scores compared with the other two groups with year 7 having the lowest score. It is possible that the younger students have not yet fully appreciated the value of the technology in their classrooms. Another, different, hypothesis is that the students on examined courses: GCSE and post-16, welcomed the variety offered by the use of clickers more than those on non-examined courses. I examined gender differences by looking at responses given to question 17 by a group of 27 year 7 students and 26 year 9 students. No clear differences were discernible between the boys and girls in year 7. The weighted mean for girls was 3.4 and for boys it was 3.2 showing that there was no marked gender effect on the way the two groups of students viewed the value of EVSs in their science lessons. Figure 8 below depicts the results:



Source: Students' Questionnaires

The above graph 8 shows that only a third of the Y7 students (9 of 27) appreciate that the EVSs make their science lessons lively and engaging. In year 9, contrary to year 7, the majority (over two thirds) of both boys and girls were agreeable that the EVSs made lessons lively and engaging. No sharp differences were observed between the response of boys and girls to the technology in the classroom as can be seen from the results in Figure 9 where girls had a weighted mean of 3.6 and boys had 3.8.

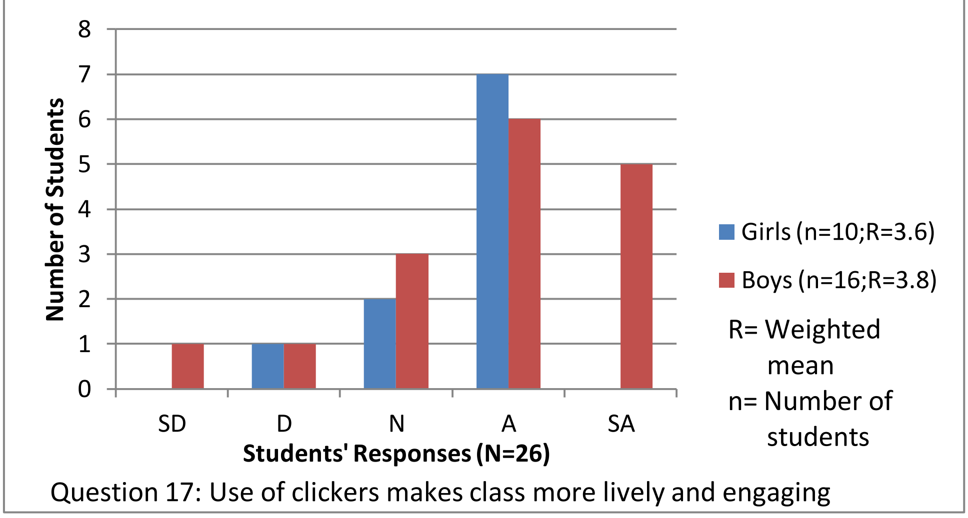


Figure 9: Y9 Students' responses to Question 17

Source: Students' Questionnaires

I gave the students a direct question focused on how they felt about their participation in class when they use clickers. Question 21 read, 'I can participate more when I use clickers'. The following results were obtained:

TABLE 12: STUDENTS' RESPONSES TO QUESTION 21 (N=141)

Year Group	**Students' Responses**					**Total**	**Weighted mean**
	SD (1)	D (2)	N (3)	A (4)	SA (5)		
Y7	2	2	7	10	1	22	3.3
Y9	1	5	11	29	30	76	4.1
Y10	0	1	7	12	3	23	3.7
Y12	0	3	2	13	2	20	3.7
Total	3	11	27	64	36	141	

Source: Students' Questionnaires

Calculation of the weighted mean values indicated that Y9, Y10 and Y12 had more students who felt that they tend to participate more in class when they use clickers. However, a different scenario was observed with the year 7 students where less than half of the students agreed with the notion that clickers helped them to participate more in class. This group also registered the highest number of students (7) who decided to pass the question. As I have argued earlier on, it is possible that Y7 students being the youngest among the participants had not been widely exposed to clickers and as a result they were limited in terms of making judgements about the value of the technology in the classroom. It is possible that with more exposure to the technology students who were neutral and those who considered not answering the question would appreciate the value of this technology in learning situations.

Knowledge retention

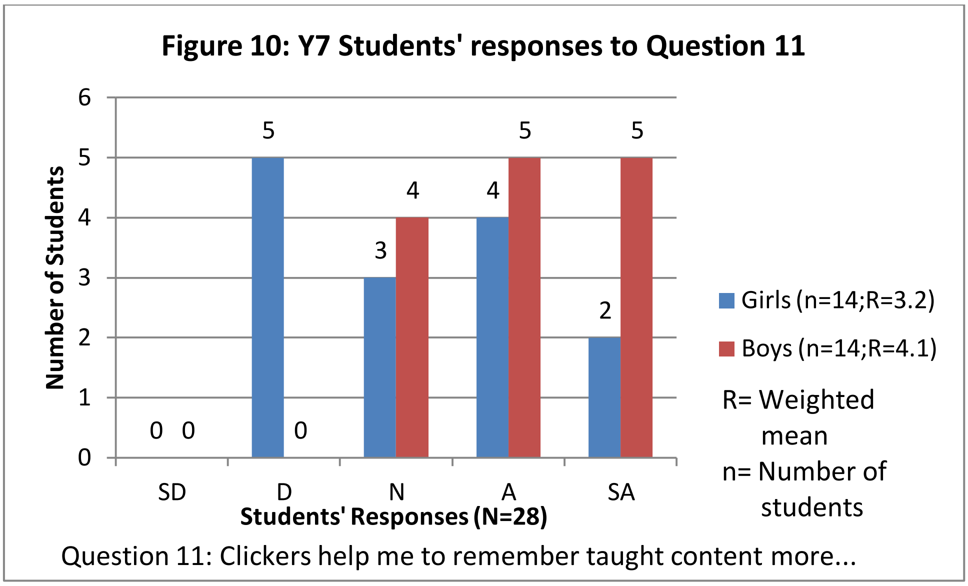
My second category for thematic analysis is knowledge retention, involving questions 11 and 2. I asked the following question, that is, question 11: 'I remember things more when I use clickers in the lesson'. The results are shown in the table 13 below:

TABLE 13: STUDENTS' RESPONSES TO QUESTION 11 (N=147)

Year Group	Students' Responses					Total	Weighted mean
	SD (1)	D (2)	N (3)	A (4)	SA (5)		
Y7	0	5	7	9	7	28	3.6
Y9	4	5	19	36	11	75	3.6
Y10	2	3	11	6	2	24	3.1
Y12	0	3	9	7	1	20	3.0
Total	6	16	46	58	21	147	

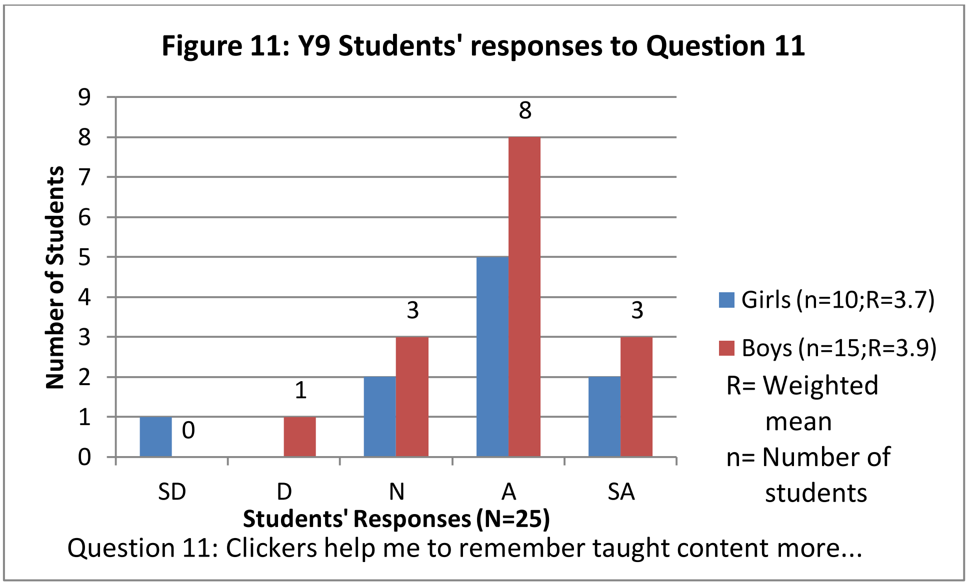
Source: Students' Questionnaires

More than half of the students in year 7 (57%) and year 9 (63%) were agreeable that clickers helped them to remember taught content more than when they used other methods of learning. In the other two groups, that is, year 10 and year 12, less than half of the students (year 10, 33% and year 12, 40%) felt that clickers helped them to remember taught content more than they do with the other methods of learning. It appears that it is difficult for a considerable majority of the students to establish the impact of clickers on their knowledge retention capacity. This result is interesting especially given the responses to the questions discussed previously, in particular responses to question 2 and question 17 discussed above. This and other similar cases will be discussed in more detail in the next chapter. I examined gender differences in two groups, namely year 7 and year 9 and got the results shown in figures 10 and 11:



Source: Students' Questionnaire

Figure 10 shows year 7 results. Only 43% of the girls in year 7 agreed that clickers help them to remember taught content as opposed to 57% who felt differently. As can be perceived from the graph, no single boy disagreed with the notion that clickers make them remember taught content, instead, 71% of the boys either agreed or strongly agreed that clickers were helping them to remember the content more than what happens when taught using the conventional methods. The weighted means of 3.2 and 4.1, for girls and boys respectively, help to illustrate the difference between the way the two groups understood the clickers to impact on their knowledge retention capacity. From these statistics, it appears that more boys were contented with the way the technology was being used than girls. Although I had three year 9 groups in my study, for the gender analysis, I undertook a gender analysis in only one of the year 9 groups where students had indicated their gender on the questionnaires. The results shown in figure 11 were obtained:



Source: Students' Questionnaires

From the above figure 11, weighted mean score values of 3.7 and 3.9 for girls and boys respectively, indicate that no clear difference was discernible between the boys and girls; they seemed to share similar views regarding the impact of clickers on their knowledge retention capacity. Almost 70% of both girls and boys were positive that clickers helped them to remember the taught content more than when they used the other conventional methods.

<u>Ease of use of clickers</u>

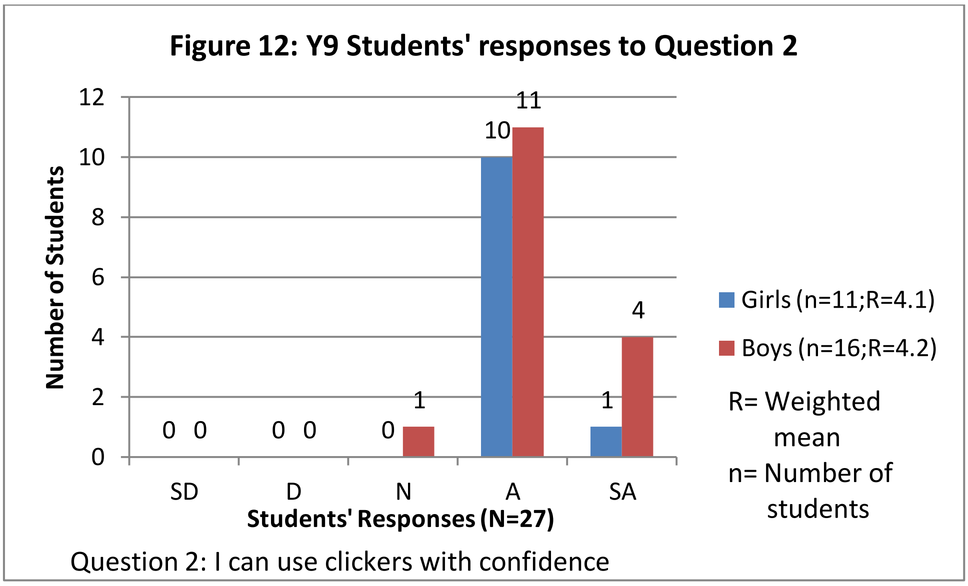
My third category for thematic analysis is ease of use of clickers, involving questions 2 and 6. Question 2 read 'I know enough about using clickers for the science lessons'. Through this question, students were meant to express their satisfaction with regards to the use of clickers. I got the results shown in table 14 below:

TABLE 14: STUDENTS' RESPONSES TO QUESTION 2 (N=144)

Year Group	Students' Responses					Total	Weighted Mean
	SD (1)	D (2)	N (3)	A (4)	SA (5)		
Y7	0	0	3	10	15	28	4.4
Y9	0	3	6	48	15	72	4.0
Y10	0	1	5	12	6	24	4.0
Y12	0	0	0	13	7	20	4.1
Total	0	4	14	83	43	144	

Source: Students' Questionnaires

A considerable majority of the students from all groups were quite happy with the clickers as can be seen from the results in the above table: 89% of students in year 7 felt that they had no problems with the use of clickers, while 88% of students in year 9, 75% of students in year 10 and 100% of students in year 12, felt that they were comfortable with the use of clickers. All the groups had a weighted mean of 4 or slightly above 4 indicating high agreement that they had no problems using clickers. An analysis of year 7 results showed that 100% of the girls had no problems with the use of clickers while 94% of boys from the same group also felt confident enough with the use of clickers. In year 9, the weighted means of 4.1 and 4.2 for the girls and boys respectively confirm that both girls and boys were all positive and happy with the use of clickers. In this group, all girls either agreed or strongly agreed that use of clickers posed no difficulties at all to them. Almost all boys were also happy with the use of clickers. This is shown in figure 12 below:



Source: Students' Questionnaires

The results seem to indicate that there were no gender factors involved regarding the use of clickers. Both girls and boys showed high level of confidence regarding the use of the technology in the classroom. Question 6 was closely related to question 2; it read, 'I need the teacher's help to understand the use of clickers'. From this question, 88% of all the 150 students in the study stated that they do not need any help from the teacher to use the clickers in class while almost 5% felt that they needed help from the teacher to be able to use the clickers during the lessons. Although there are some students who were not happy with the use of clickers, the majority of students appear to be comfortable with the use of the technology.

<u>Students' attitudes towards the use of clickers</u>

The fourth category for thematic analysis is students' attitudes towards the use of clickers, involving questions 3, 4, 5, 15, 16, 18, 19 and 20. I decided to analyse the responses given by the 150 students as a single group after realising that there were no sharp differences between the different year groups and the responses given by the male and female participants.

Question 3 read, 'I would take more science lessons involving use of clickers if they were offered'. A weighted mean of 4.0 shows that the majority of students would be happy to have more science lessons where they would use clickers. I asked a related question 4 which read, 'I am not satisfied with my use of clickers in science lessons', and it generated results which support results obtained in question 3. A weighted mean of 2.3 indicates that most of the students disagreed with the notion that they were not satisfied with the use of clickers in science lessons. In other words, a greater proportion of students were happy with the use of clickers which explains why in question 3 most of the students were prepared to take more science lessons involving the use of clickers. Results from question 5, which read, 'I like lessons where we do not use clickers better than those involving use of clickers', show a consistent pattern with answers to questions 3 and 4 discussed above. The majority of students (65%) disagreed with the idea of having lessons without clickers. A weighted mean of 2.1 shows that the group did not prefer lessons where clickers were not used.

I decided to find out whether students would be interested in using clickers with other subjects apart from science, so I went on to ask in question 15, 'I would love it if clickers were to be used in all subjects in the school'. As can be seen from the table x below, a large majority of the students (76%) agreed that they would be happy if the use of clickers was extended to include other subject areas within the school as opposed to about 9% of the students who disagreed with the statement. Similar trends can be seen in results from question 16. The question read, 'I always have a sense of achievement in lessons where we use clickers. Most of the students (56%) agreed with the notion whilst about 13% of the students were in disagreement with that position. A big number of students (28%) were neutral, that is, they could not tell whether using clickers gave them a sense of achievement or not. A weighted mean score value of 3.6 shows that students' ratings were slightly above neutral position moving towards agreement with the notion of having a sense of achievement when using clickers in lessons. From this result, similarly to the results for Y10 and Y12 students in question 11, it can be seen that students tend to have difficulties in making judgements about the impact of clickers on their academic performance. This will be discussed in more detail in the next chapter.

An overwhelming majority of students (115 out of 140) disagreed with the notion that 'using clickers made them feel angry' as was expressed in question 18. A weighted mean score of 1.7 shows that students' responses were concentrated between strongly disagreed and disagreed. Only 8% of the students expressed that using clickers made them feel angry. In question 19, I asked students whether they would enjoy science more if teachers used clickers in their science lessons. Question 19 was phrased as an inverse of question 5 and an almost mirror image pattern to responses given in question 5 emerged: more than half of the students (59%) agreed that they would enjoy science more if teachers used clickers, while 12% of the students did not want to link clickers with their enjoyment of the subject. It appeared that a big proportion of students (30%) were not sure whether they could find the subject more enjoyable with clickers or not. Question 20 read, 'I would work harder if I could use clickers more often'. Forty-four percent agreed that clickers would motivate them to work harder, while 20% of the students disagreed. Regarding this, many students appeared undecided about whether they would work harder or not as a result of using clickers. From the results shown in the table 15 below, 36% of the students decided to take a neutral position to this question. A weighted mean score of 3.4 reinforces the point that the group as a whole is undecided as to whether clickers would motivate them to work harder or not. It is possible that more exposure to the use of clickers would help students to assess the impact of clickers on their learning. In summary, it appears that a large majority of students have positive attitudes towards the use of clickers in their science lessons. A complete set of all the results under this theme is shown in table 15 below:

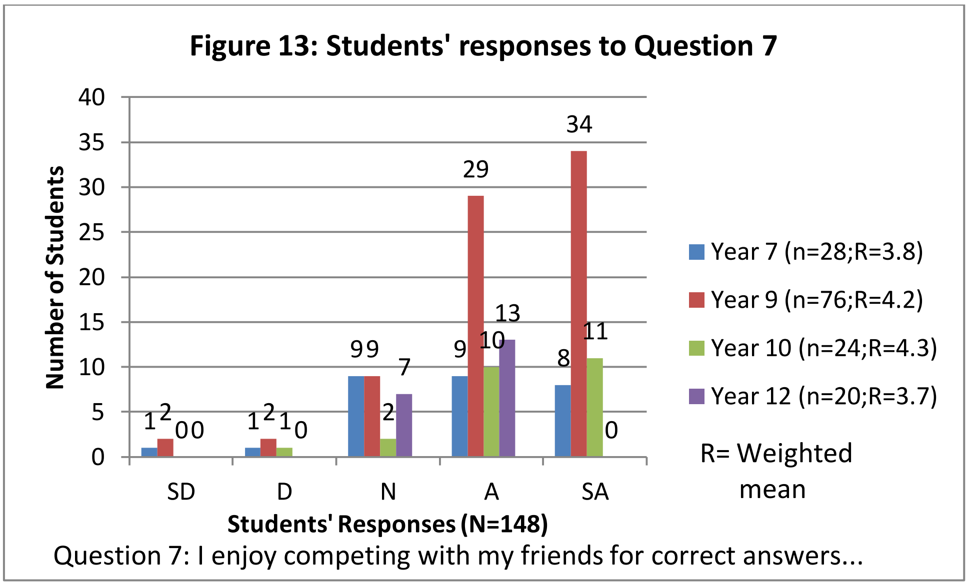
TABLE 15: STUDENTS' RESPONSES TO QUESTIONS ON ATTITUDE TOWARDS CLICKERS

Question	Students' Responses					Total	Weighted mean
	SD (1)	D (2)	N (3)	A (4)	SA (5)		
3	1	14	31	39	62	147	4
4	35	55	33	15	4	142	2.3
5	41	53	40	11	0	145	2.1
15	6	8	22	49	64	149	4.1
16	2	18	40	61	23	144	3.6
18	83	32	14	7	4	140	1.7
19	5	12	43	41	44	145	3.7
20	7	21	52	39	24	143	3.4

Source: Students' Questionnaires

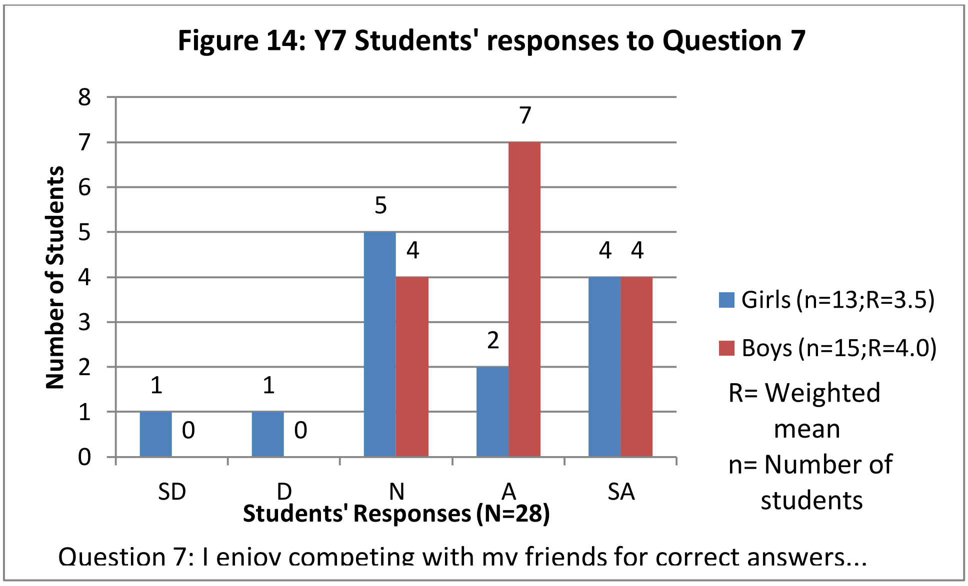
What students appreciate about using clickers

I took the opportunity to find out some of the reasons why students like or enjoy it when they use clickers in the science classrooms. The fifth category for the thematic analysis is what students appreciate about using clickers, involving questions 7, 9, 10, 13, 14 and 22. Question 7 read, 'I enjoy competing with my friends for correct answers using clickers'. Students' responses are shown in figure 13 below:



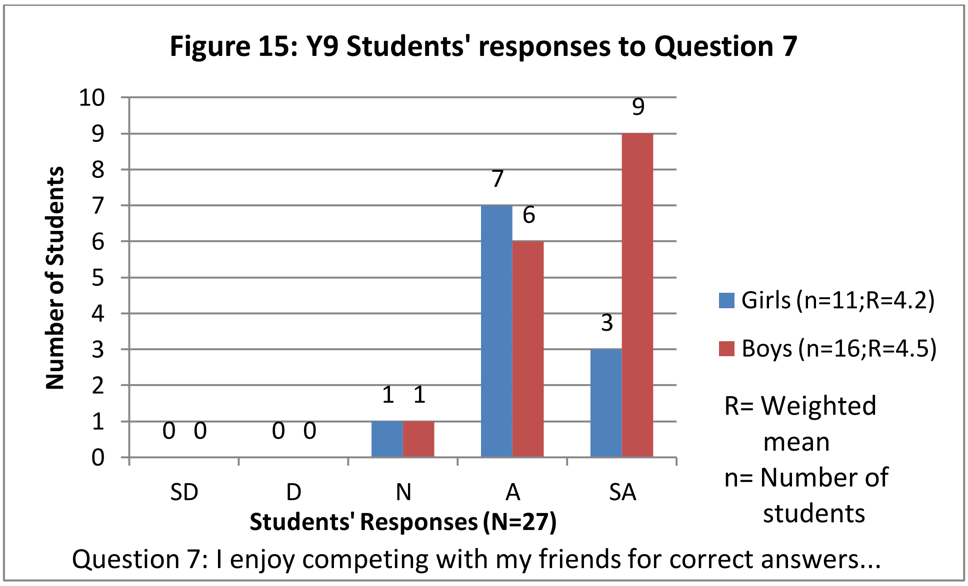
Source: Students' Questionnaire

From the results in figure 13 above, it appears that most of the students, regardless of their age, enjoy the competitive element introduced in the lessons when using clickers. From each year group, it can be seen that a large proportion of students agreed that clickers encouraged them to compete with their friends for correct answers during lessons. The weighted mean score values are either close to or slightly above 4 in all the year groups (year 7, 3.8; year 9, 4.2; year 10, 4.3; year 12, 3.7). Year 7 and year 12 have a big proportion of students who chose to be neutral, 32% and 35% respectively. I did not establish why so many students chose to be neutral. However, I examined gender differences in year 7 group and got the following results:



Source: Students' Questionnaires.

Results from figure 14 above, show that girls had a weighted mean score equal to 3.5 while boys had a weighted mean of 4.0. An analysis of results for the same question with a year 9 group produced different results as shown in figure 15 below:

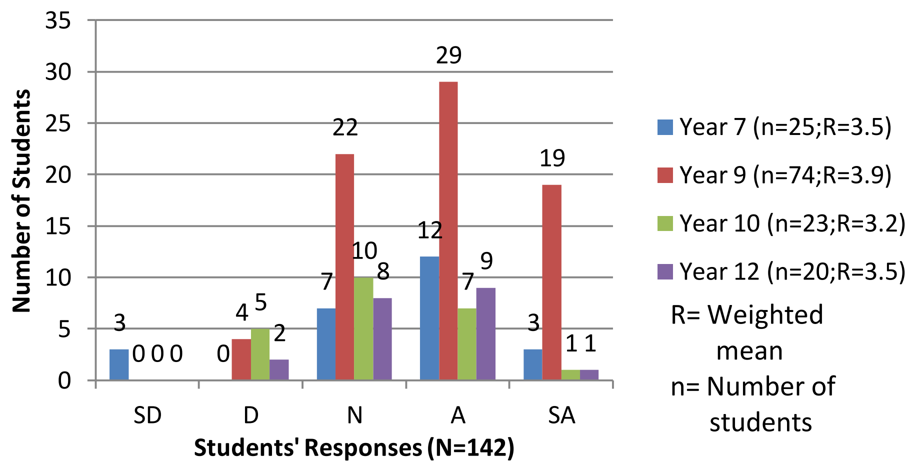


Source: Students' Questionnaires

Weighted mean scores of 4.2 and 4.5 for girls and boys respectively, indicate similarities between the two groups. In both cases, more than 90% of the students were happy to compete with their friends for correct answers while using clickers.

Clickers can be used to generate class-wide or group discussions. I sought to find out what students felt about the discussions in terms of understanding subject content, so I asked question 9, 'Discussing clicker questions with other students helps me understand course content'. The following results were obtained:

Figure 16: Students' responses to Question 9



Question 9: Discussing clicker questions with other students helps me...

Source: Students' Questionnaire

In three year groups, that is year 7, year 9 and year 12, 10% or less of the students disagreed with the notion that discussing clicker questions with other students helped them to understand subject content. However, a large proportion of students from each of the three groups were not sure (year 7, 28%; year 9, 30%; year 12, 45%). In the three groups, the weighted mean scores are above the neutral value (year 7, 3.5; year 9, 3.9; year 12, 3.5) because a considerable majority of students agreed that discussions held with other students helped them to understand course content better. Year 10 was the only group where less than 50% of the students agreed that discussing clicker questions with friends helped them to understand subject content. In the same group, 22% of the students disagreed and 43% of the students chose to be neutral on the issue. Year 10 had a weighted mean of 3.2 indicating that they were not decided on whether discussing clicker questions with other students was helping them to understand course content better or not. On average, 57% of all the 142 students agreed that discussing clicker questions with friends helped them to understand course content while 10% of the students disagreed. A surprisingly high number of students (33%) were not sure about whether they can link the discussions they have with other students with better understanding of the subject content or not. One possible explanation of this is that use of clickers was not linked to peer discussion by the teachers. Another question closely related to question 9 was question 13 which read, 'clickers have helped me to learn more from my friends'. I will report the 150 students' responses as a single group because they did not show any big differences among the groups. Thirty-nine percent of the students agreed that clickers have helped them to learn more from their friends while 21% disagreed. Again, a high proportion of students (36%) chose to be neutral on this issue. I sought to find out how students felt about the idea of participating anonymously in the classroom. I asked question 10 which read, 'I feel comfortable when my name is not shown against my responses to questions'. This question generated the following responses:

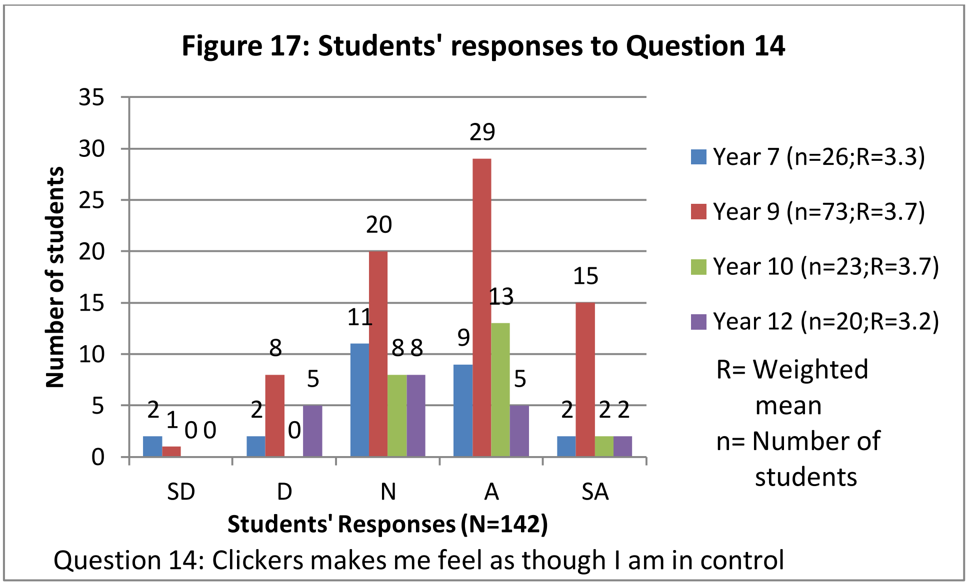
TABLE 16: STUDENTS' RESPONSES TO QUESTION 10 (N=145)

Year Group	**Students' Responses**					**Total**	**Weighted mean**
	SD (1)	D (2)	N (3)	A (4)	SA (5)		
Year 7	5	1	6	8	8	28	3.5
Year 9	7	11	31	14	11	74	3.1
Year 10	2	6	11	4	1	24	2.8
Year 12	1	1	10	5	2	19	3.3
Total	15	19	58	31	22	145	

Source: Students' Questionnaires

In year 7, 57% of the students enjoy participating anonymously during lessons. In the other three groups namely year 9, year 10 and year 12, less than half of the students indicated that they felt comfortable participating anonymously. In all groups, a large proportion of students chose to take a neutral position regarding the issue of whether they wanted to participate anonymously or not as can be shown by the weighted mean values (year 7, 3.5; year 9, 3.1; year 10, 2.8; year 12, 3.3). I took a further look to see if there existed any differences between boys and girls on this issue. In year 7, I observed that 86% of the girls agreed that they felt comfortable when they participated anonymously while on the other hand only 27% of the boys indicated that they enjoyed participating anonymously in lessons. At this level (year 7), it looks like boys want to go public more than girls. I examined the responses from boys and girls in one of the year 9 groups and observed that for those students who chose to make their position clear, 38% of the boys disagreed with the notion that they enjoy participating anonymously in lessons while only 18% of the girls followed suit. In this group, a considerable majority of students chose to be neutral, however, judging from the proportions of those who disagreed with the idea of enjoying participating anonymously in lessons, it can be seen that more boys than girls tend to enjoy it more when their names are publicised. Although EVSs were being used anonymously most of the time, there were instances where the teachers publicised the names of the students to inspire competition among the students.

I looked at the perceived distribution of power between the teacher and the student during lessons involving use of clickers. Question 14 read, ‘Using clickers makes me feel as though I am in control’. The results shown below were obtained:

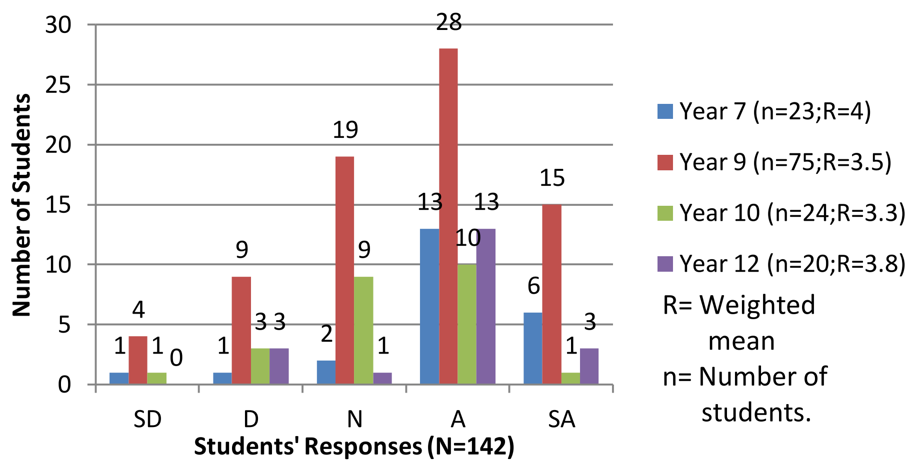


Source: Students' Questionnaires

Weighted means shown in Figure 17 indicate that students from all the four groups
felt that they had control of their own learning when they used clickers. Fifty-four percent of all the students agreed whilst 13% of the students disagreed with the notion that using clickers gave them some control of their own learning in the classroom.

One of the celebrated advantages of the clickers is that they provide instant feedback to both the teacher and the students during a lesson. I was, therefore, interested to find out how this feedback was being used by the teacher in the lesson. I went on to ask the following question, question 22 on the questionnaire, which read, 'Clickers help my teacher to focus attention on things we don't understand'. The question generated the following results:

Figure 18: Students' responses to Question 22



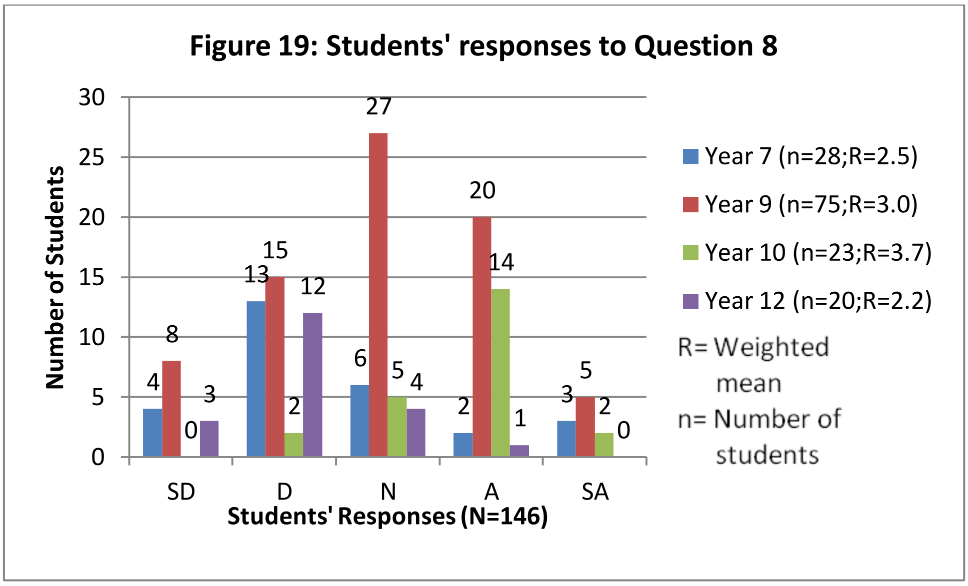
Question 22: Clickers help my teacher to focus on our learning needs.

Source: Students' Questionnaires

From the above figure 18, it can be seen that a total of 22 out of 142, or 14% disagreed that clickers helped their teacher to focus on things they did not understand in a lesson. However, looking at the bigger picture, a large proportion of students from all groups (62%) indicated that they thought that the use of clickers was helping teachers to focus their attention on issues that were of concern to the students during lessons. The weighted mean scores show that all four year groups were positive about the role of clickers in providing important feedback to teachers, allowing them to focus on students' learning needs. It seems that the students can appreciate that clickers play an important role in facilitating diagnostic assessment.

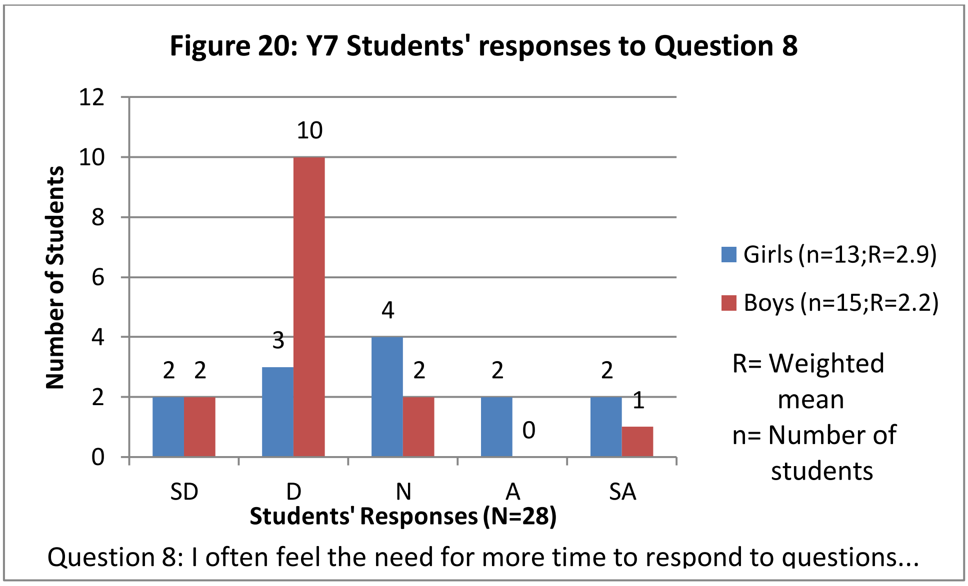
What students dislike about use of clickers in science lessons

Questions 8 and 12 on the questionnaire addressed some of the issues that can be seen as being negative regarding the use of clickers by students. Question 8 read as follows: 'I often feel the need for more time to respond to questions when using clickers'. This question generated the following results:



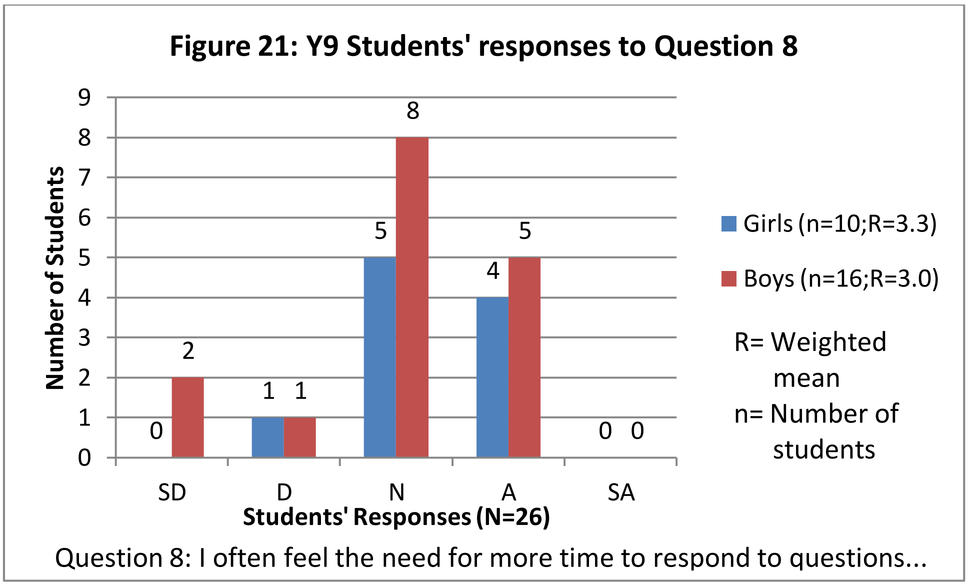
Source: Students' Questionnaire

In year 7 and year 12, a considerable majority of students (61% and 75%, respectively) did not feel any need for more wait time when they use clickers. This is also shown by the weighted means of 2.5 and 2.2 for year 7 and year 12 respectively. However, in year 9, a weighted mean score of 3 shows that the group was undecided as to whether they needed more time or not. In year 10, a large proportion of students felt that they needed more wait time when using clickers (weighted mean equals 3.7). It can be frustrating if students do not get enough time to think properly and respond to the questions. I examined gender differences by looking at the responses given by male and female students in year 7 and one of the year 9 groups. In year 7, the following results were obtained:



Source: Students' Questionnaire

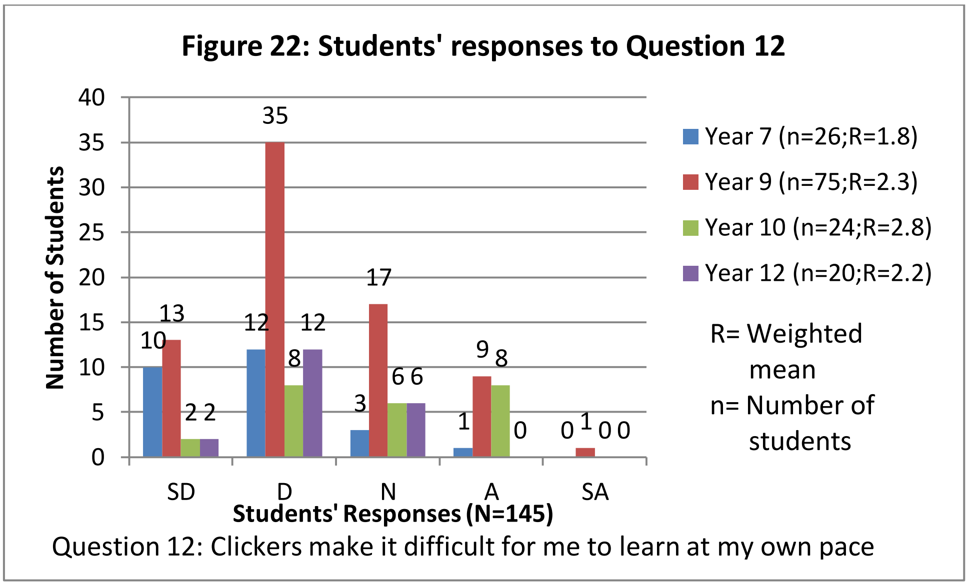
In year 7, 80% of the boys did not feel that they needed more wait time during lessons involving use of clickers while only 38% of the girls also felt the same. On the other hand, a greater proportion of girls (31%) chose to be neutral compared to boys (13%). Thirty-one percent of the girls indicated that they often felt the need for more wait time when using clickers in lessons as opposed to only 7% of the boys. Judging from these results, it can be seen that girls feel that they are less impulsive than boys when using clickers and therefore require more wait time. However, no sharp differences were observed between girls and boys in year 9 as can be gleaned from figure 21 below:



Source: Students' Questionnaire.

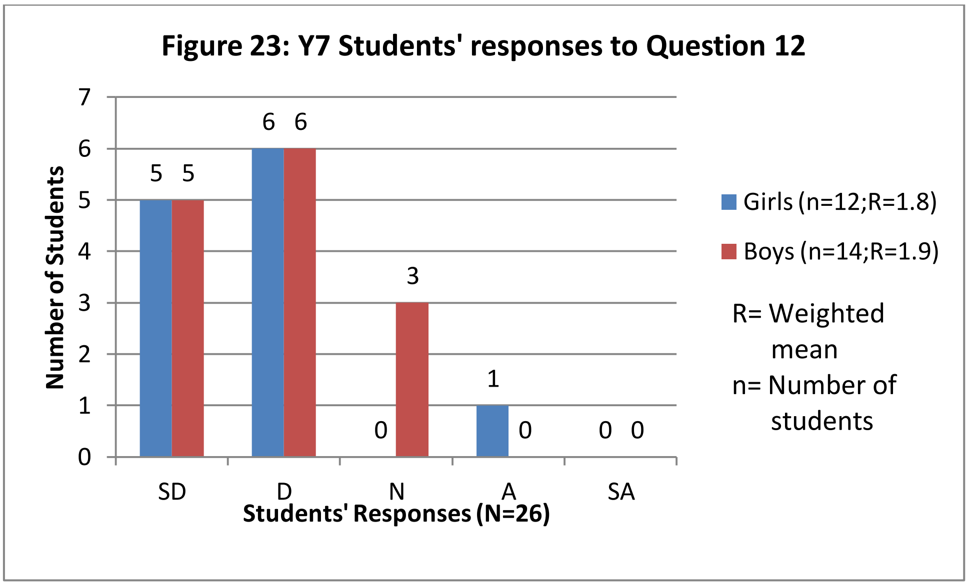
In this group, boys were undecided whereas girls felt that they needed more time to respond to clicker questions (boys, 3.0; girls, 3.3). When teachers are using clickers there is need for them to give students enough time to respond to the questions and this should be done carefully without risking frustrating students who work faster with having to wait too long before moving on to the next question.

Question 12 read, 'I am unable to learn at my own pace during science lessons where clickers are used'. The following results were obtained:



Source: Students' Questionnaire

In almost all groups except year 10, a large proportion of students (year 7, 85%; year 9, 64%; year 10, 50%; year 12, 70%) disagreed with the assertion that clickers made it difficult for them to learn at their own pace during a lesson. The weighted mean score values in figure 22 help to show that year groups disagreed with the notion that clickers make it difficult for them to learn at their own pace. No big differences were observed between girls and boys in year 7 as was the case in question 8, almost the same percentage of boys and girls showed that clickers did not affect their pace of learning as can be seen in the figure 23 below:



Source: Students' Questionnaires

Ninety-two percent of the girls and 79% of the boys disagreed that they were unable to learn at their own pace during science lessons where clickers are used. No gender differences were detected in year 7 regarding the impact of using clickers on the students' pace of learning as can be appreciated from the weighted mean scores of the two groups, 1.8 and 1.9 for girls and boys respectively. Almost the same proportion of girls and boys refuted the assertion that clickers made it difficult for them to learn at their own pace.

The closed-ended questions on my questionnaire were evidently interpretable by the students as indicated by the very high response rates. All the questions received between 93 and 100 percent response rate. As I mentioned earlier on in the preceding section, I also included some open-ended questions in the students' questionnaire. The open-ended questions were meant to provide students with the chance to provide more detailed information without being limited by my own thoughts regarding their experiences with the clickers. I was interested to establish what students liked most about using clickers and what they disliked about use of clickers in the science lessons. Following below is a presentation of the views of students regarding these two issues.

What students like most about using clickers

Competition

Students expressed a variety of reasons pertaining to why they like the clickers to be used in their science lessons. One of the issues that was cited by more than 80% of them was the issue of competitiveness that is brought up by the use of clickers. It emerged that many students enjoy competing with their friends for correct answers. This was well articulated by one of the students who stated that, 'clickers make lessons more exciting and fun because most people compete to get to the top' (Year 9 Student). Another student expressed the following, 'they are fun and involving and offer a great sense of achievement if you come top in class' (Year 10 Student). In the same vein, most of the students indicated that they like the clickers because they give them a sense of achievement when they win the competitions in lessons; a student from year 9 said, 'competing against your friends compels you to get the answer right which means it's making us remember the science...'. On a similar note, one year 7 student stated that, 'I like competing with my friends and enjoy beating them'. It appears that the competition they have with each other can be helpful in their learning; one student said, 'I like how the competition element helps you to remember and focus on facts and methods with other people unable to view your answer' (Year 9 Student).

Anonymity

From what the year 9 student said in the previous paragraph, it can be seen that the element of anonymous participation in class was viewed positively. In fact many students pointed out that they liked clickers because they enable them to participate actively in class without their names being revealed. Commenting on the issue of anonymity, one student said, 'It can be anonymous so gives you confidence' (Year 12 Student). Another student reiterated that, 'you can contribute more without being belittled when you get it wrong' (Year 10 Student).

Interactivity

When asked to specify what they liked most about use of clickers, more than 90% of the students from all the year groups involved in the study mentioned that they liked clickers because they make the lessons very interactive. One year 7 student commented that, 'it gets the whole class involved and you don't have to do much work'. The same view was echoed by a year 12 student who stated that, 'it engages every student and keeps the lessons interesting, too much paper work gets dull and the clickers are a good variation in lessons'. It appears that many of the students do enjoy interacting with each other instead of spending most of the time writing in class; I got many responses where students were expressing that they like clickers because, 'it's a break from writing'. One student stated that, 'it gives me a break from writing...' (Year 7 Student). A year 10 student said, 'I like the fact that we can learn in a way that encourages everyone to have an active part in the lesson'. Echoing the same view, another year 10 student said, 'it gets everyone involved and it's fun, makes the class a lot livelier and it's a good way to learn'. With clickers, it appears that everyone in class gets to participate. This view was well articulated by one student who stated that, 'it gets everyone together and lets people that are shy have a chance to shine' (Year 9 Student).Commenting on the efficacy of the clickers, a year 12 student said, 'you don't have to talk and everyone doesn't have to hear'.

Instant Feedback

Another important issue that was brought up by a considerable majority of students was the aspect of instant feedback. Clickers provide feedback that is useful to both students and the teachers. A year 7 student said, 'I like that if you get a wrong answer you can learn from your mistake straight away'. In the same vein, a year 9 student stated that, 'I like them mostly because I have the freedom to put what I think and the teacher can see what level I am at on the subject'. It was evidently clear that the majority of students were happy with the clickers and they felt that they helped the teacher to see the progress of individuals as well as the whole class. This was highlighted by a year 12 student who posited that, 'clickers allow the teacher to see what we struggle with as a class'.

'Cool' technology

There also exists a group of students who posited that they liked the clickers most because they made them feel part of the modern world as one year 10 student put it, 'it is technology for the 21st Century'. One year 9 student indicated that, 'clickers are easy to use and make me feel like school is modern and fun'. On the same note, another year 9 student expressed that, 'they [clickers] mimic a mobile phone in my point of view so they go down well in class because answering is like texting'. A year 7 student captured a view shared by a considerable majority of the students when he said, 'they are like a game but [we] learn from it'. A few students commented on other aspects like the key pads and the colours of the clickers as being some of the positive aspects they liked most about clickers. One year 7 student pointed out the following: 'they have squishy buttons and they are pretty colours'.

What students dislike about use of clickers in science lessons

Competition

I also asked students to reflect on the negative aspects of clickers in science lessons. While some students felt that there was nothing wrong with clickers at all, I managed to get some students who pointed out some issues that did not go down well with them regarding the use of clickers. Some students appreciated the competitive element brought up by the clickers in classrooms; however, some of the students indicated that they were not very happy with the element of competition. For instance, one year 12 student said, 'it scares me when some people get competitive'. A year 9 student stated that, 'I dislike the way people race to finish first'. The same view was reinforced by several students as a student from year 7 said, 'I would prefer perhaps a longer time scale to think about the question'. Another student observed that, 'it's too fast and competitive, when I don't do well I feel sad' (Year 10 Student).

Reliability

It was highlighted that the use of clickers is also hampered by some technical problems which can be frustrating to students. Students pointed out that sometimes some of the handsets do not get connected (they are locked out), making it difficult for students to submit their answers. A large proportion of students across all the different year groups complained about being 'locked out' which means one cannot participate in the lesson. One year 10 student stated that, 'I dislike the fact that they aren't always reliable in the way they work'. A year 12 student said, 'sometimes there are technical issues that can stop the lesson'. Some of the students felt what was pointed out by a year 10 student, 'the teacher doesn't know how to use the software'.

Learning

Some students felt that they do not learn much when they use clickers. For instance, a year 12 student said, 'they don't cover in detail what the course entails'. In the same vein, a year 9 student reiterated that, 'you don't learn a lot from it'. The same view was echoed by a year 10 student who said, 'I don't learn anything that I actually can remember'. Some students were also concerned about the lack of a wide variety of activities that they can do using clickers. On the other hand, there also existed a group of students who were not happy with some of the activities available. This can be appreciated from what one year 10 student expressed, 'I don't like the games we do because the questions are easy and they are about speed and some people aren't speedy'. Arguably it is possible that teachers could get more out of the use of clickers by learning to create better questions and activities.

Time cost

I learnt that the use of clickers can result in loss of time at the beginning of the lesson as the teacher distributes the handsets and sets up the system. The problem was well articulated by a year 12 student, who said, 'they take ages to set up'. The same view was echoed by another year 10 student who stated that, 'they take forever to set up'. Commenting on the distribution of handsets, one year 7 student said, 'I don't like the race to get them from the front of the classroom, it would be better if we were already allocated one from the beginning of the lesson'. A year 9 student cited that, 'they sometimes take a while to get to work at the start of the lesson'. It was also pointed out that the handsets were not always enough for every student. Set up time is an area where teacher skill is involved, hence this needs to be reflected on in continuous staff development sessions.

Distraction

Some of the students expressed discontent with the use of clickers citing that they make everyone excited and this can be disruptive. The views of these students were well articulated by a year 9 student who stated that, 'if you use them at the beginning of the lesson, it gets everybody excited and then they don't concentrate...'. Another student expressed the following feelings: 'it can make the class really noisy at times which can destroy a good working atmosphere' (Year 7 student). In the same vein, a year 10 student said, 'I dislike it sometimes when people are screaming at each other to answer the same question'.

Design issues

It emerged that for those students who have got spelling problems it can be difficult to answer the questions that need texting. Some students also complained about how difficult it can be to read the questions, as portrayed by a year 9 student: 'sometimes the handwriting is way too small...' Commenting on the same issue, a year 10 student indicated that, 'the questions aren't big enough to read'. A minority group of students felt that the key pads were difficult to use. Some students felt as a year 12 student said, 'this is an easy lesson for the teachers to plan when they can't be bothered to plan an actual lesson...'

More!

The third question on the questionnaire invited students to provide any information they felt necessary to share about the use of clickers in science lessons. The response rate to the open ended questions was high as I managed to get answers to all questions from more than 90% of the students. I think this was a result of both the clarity of questions and the way the questionnaire was administered. Students were supervised by either the teacher/researcher or by both the teacher and the researcher as they completed the questions and this way, they were encouraged to write down their ideas. I observed that a considerable majority of students (more than 80%) in each year group were calling for more frequent use of the clickers in their lessons. Some students, like the following year 7 student, felt, 'they make you feel comfortable and happy in science lessons'. In the same vein, a year 9 student said, 'it would be better if we could use them more often'. A few students shared the same view as the following year 12 student, 'they are good to use at the end of a topic, not every lesson because would lose novelty if used in every lesson but are useful at the end of a topic as an overview'. There was also a group of students who felt the same as the following year 10 student, 'it is good for interaction and competitiveness but I would like more difficult questions'.

Summary

This chapter presents the primary data of my research study. There was a very impressive return of questionnaires from students. The quotations from students were used as they were exactly, no editing was done. In the next chapter implications of the data will be discussed.

CHAPTER 5: DISCUSSION OF FINDINGS

In this chapter, I am going to outline my responses to the research questions drawing on the data presented in chapter 4 and the consulted literature presented in chapter 2. In the preceding chapter, data for the two technologies was presented separately; however, in this chapter I will discuss the emerging themes from both sets of data concurrently under the specific research questions.

5.1. Response to research question 1

What are the circumstances which led to the adoption of the innovative technologies by the participating teachers and what implementation challenges did they face?

The present study showed that both VLEs and EVSs are relatively new technologies in the secondary schools under study. These technologies were adopted with a view to enhance the student learning experience. In the subsequent section I will discuss the circumstances which led to the adoption of these particular technologies by the teachers involved in my study and also highlight some of the implementation challenges they faced.

5.1.1. Adoption and use of VLEs and EVSs

The adoption of VLEs and EVSs was motivated by several factors. The study showed that the initiative to begin using an innovative technology such as a VLE or an EVS emanated from different sources including the following: Local Authority (LA), teachers, Head of Departments (H.O.Ds) and school heads. There was evidence of collaboration between the different sources of innovative ideas. Events like conferences and educational shows were shown to play a significant role in terms of facilitating and supporting the sharing of good practice. Most of the teachers in the study highlighted that they either got the idea to use an innovative technology from a conference, educational show or from a colleague who had participated in a similar event. On the other hand, it also emerged that such factors as the Government policy towards technology use in educational institutions, the availability of funds and teacher assertiveness impacted on the adoption of technology by the teachers in schools. The idea to innovate can therefore be external (coming from outside the school) or internal (when the idea originates from a member of staff within the school) (Fullan, 2001). For instance, the Midshire VLE project: the LA took advantage of the then Labour Government's policy of promoting the use of new technologies in schools (BECTA, 2003) and went on to promote partnership among selected schools in their County by introducing and supporting the use of VLEs in science education. Given that the Government had its weight behind the idea of using technology in schools, some funds were made available for this purpose. This enabled the LA to provide some financial incentive to teachers who were willing to take up the technology. However, despite the availability of a financial incentive, the project ran into difficulties indicating that there are more factors that affect the implementation of an innovation. Another good example of how the Government policy can facilitate the adoption of an innovation is the case of the Polytechnic in Singapore. As argued by Sally, the Government in her country was determined to make the country a 'technologically advanced nation', hence the support extended to those institutions willing to try out new technologies. Government support has the potential to create an enabling environment for innovative projects to be adopted.

Generally, all the teachers in my study were happy to try out the new technologies as a way to enhance the student learning experience. This may well be because the teachers who participated in my study were people who were involved in ICT innovations in some way. While in some schools there existed policy frameworks for the adoption and use of new technologies, this was not evident in other schools, however, individual teachers adopted the new technologies out of their own willingness to try something different in their classrooms. Adoption of innovations is not a smooth process. The study revealed that teachers who adopted the new technologies faced some implementation problems and challenges. Some of these will be discussed in the subsequent section.

5.1.2. Leadership

From the two innovations in my study, one theme that emerged clearly is that, for a new technology to be adopted and used successfully there has to be an enthusiastic leadership (Ebersole & Vornddam, 2003). It is important to have someone who can motivate and give support to other users. This element appears to have been missing on the Midshire VLE project as was mentioned by the science consultant from the LA when she reflected on the possible reasons for the failure of the VLEs to get institutionalised in the teaching of science in the participating schools. The VLE project, although it had lots of potential applications was affected by lack of clearly defined leadership from the initial stages of its development. Ely (1999; 1990) and Rogers (2000) highlighted the need for leadership to be engaged enthusiastically as this would have a bearing on the motivation of the users of the innovation. If the leaders, in this case the school management, are not engaged I think it will be difficult for an innovation to take root. Schein (1993) argues that the change initiative has to come from the leader of the organisation. It was evident that in schools where the VLEs were being used successfully there was a high level of commitment by the school leadership. At a school in Southampton, for example, the VLE was being used across the whole school because the school leadership was actively involved. They gave support and encouragement to all the Departments and the supporting environment they created made it possible for teachers to use the technology in their teaching. The same was observed from school G in Midshire South where the school's top management was committed to the adoption and use of new technologies in the school. In this school, the appointment of an assistant director for e-learning who was enthusiastic about the use of new technologies helped to bring about a cultural change which resulted in the consistent use of technology across the school.

Apart from the school's top management's engagement, it is important to highlight the role that individual teachers can also play in the uptake of new technologies. From my study, it emerged that in the majority of cases, teachers who were using EVSs started using the technology out of their own volition. There was no evidence of any existing policy in either the school or Science Department that spelt out that teachers were supposed to use the technology, however, there were individual teachers committed to the adoption and use of the new technology. An outstanding example is Phillip Charlton from school E in the Miltonshire County. He learnt about the use of EVSs from an educational conference and went on to use the technology and he was now helping other teachers in his Department to use the same technology. The same applies to Geh Koh Sung from Singapore; he was introduced to the use of an EVS at a presentation event by a local vendor and from there he went on to use the technology in his classrooms. This indicates that these technologies are user friendly and those interested can learn to use them and enrich their classroom practice. In this case it can be appreciated that individual teachers have the potential to offer effective leadership in the uptake of technology in schools.

5.1.3. Staff Development

Teachers using the VLEs and the EVSs were invited to reflect on how they started using the technologies and how confident they were in terms of using the new technologies in their teaching. From their responses I realised that even though the technologies are said to be user friendly, provision of appropriate staff development to staff prior to the adoption of the technology can make a huge difference to the way the technology will be used. Almpanis (2009) contends that the use of technology involves competence and self confidence. It is possible that teachers who have little or no confidence in using computers in their work will try to avoid them altogether (Larner & Timberlake, 1995; Russell & Bradley, 1997). These views appear to be supported by the findings from my study. There were observable differences in competence and confidence levels between staff who had received appropriate staff development prior to the adoption of the technology and those who did not receive any staff development. This will be elaborated with some examples in the subsequent section.

Teachers on the Midshire VLE project did not receive any formal professional development prior to the adoption of the technology. The interview data showed that the teachers faced some technical problems at the time of using the technology including preparing and uploading of resources on to the VLE. This is likely to have been one of the factors that militated against the success of the project. One of the teachers on the project, Yasmin, from school C, pointed out that preparing the lessons using a VLE was a bit difficult for her because it was a new skill that needed to be developed. Rose Adams, a teacher from school A, indicated that she had had a bit of staff development on the use of a VLE, however she lamented her lack of skills especially when it came to the preparation of resources. She felt that she needed further development in this area if at all she was to improve the quality of the teaching resources. In schools beyond the Midshire VLE project, like the school in Midshire South and in Southampton, the use of VLE was quite successful. One possible explanation for this was that all staff in these schools were staff developed prior to the adoption of the technology and they also continued to have in-service staff development sessions. I found the arrangements at the school in Midshire South quite motivating to staff: Peter explained that every week each teacher has an hour dedicated for professional development and they have a Twilight programme which encourages every teacher to do some four hours of extra staff development in something. If a teacher does the four hours then they get days off in lieu as an incentive. This encourages teachers to engage actively with new technologies. Elsewhere, in Singapore, the use of a VLE at the polytechnic where Sally works is reportedly successful. I think this is due in part to the way they handled the issue of staff development. According to Sally, prior to rolling out the VLE across the polytechnic, staff development was conducted.

For the EVSs, the study showed me that the teachers using the technology got to know about the technology and its educational value from either an educational conference or from a work colleague in the same Department. In some instances, staff development sessions of between 30 minutes to one hour were held either by the vendor or another colleague in the school. This does not appear to be sufficient time to learn everything about a new piece of technology to facilitate and support its effective use in the classroom (Fabry & Higgs, 1997). On a positive note it can be argued, as some of the teachers indicated to me, that the technology is user friendly. However, it also emerged from the interview data that most of the teachers lamented over their lack of full understanding of the software which made it difficult for them to exploit the full potential of the technology in their classrooms. For example, Morris, a teacher from school E, was doing his best to use the technology but lamented that because of lack of time he was not able to understand fully the technology and so this limited his use of the technology. The same view was echoed by several other teachers. Joseph expressed contentment with the technology which he said was enabling him to do all his work without requiring extra time. However, it is worth noting that he did not find it easy to understand the software at first, he grappled with the software for a long time to reach the level of competence at which he was at the time of the interview. There was no evidence of consistency in staff development regarding the use of the technology. Teachers who were using EVSs only mentioned brief introductory sessions at the beginning of their use of the technology and no further staff development sessions were arranged for either new staff or to refresh the skills of the old staff members. Absence of staff development prior to the adoption of a new technology is not helpful. It limits the potential applications of the technology by the interested staff. On the other hand, new staff find it difficult to adopt the new technologies if there is no mechanism to prepare them adequately for using them. These findings link well with previous literature on the role of staff development in fostering the implementation of an innovation. Dhanarajan (2001) identified low level of skills and the need to provide staff development to intended users among the factors that influenced implementation of an innovation. There is an overwhelming consensus that teachers need support to integrate ICT through sustained professional development (Gillespie et al. (2007); Osborne & Hennessy, 2003; Ely, 1999; 1990).

5.1.4. Technical constraints

In my view, it can be argued that the primary goal of adopting any innovative technology in the school, or in any particular Department within a school, is to facilitate effective teaching and learning (Bransford et al., 2000). This view resonated with the perspectives of the teachers in my study where every teacher made the decision to adopt a new technology to enhance their teaching and student learning experience. The study demonstrated, however, that the pedagogical value of the technology can be limited if the technical side of the technology is not attended to properly (Cuban, 1999; Bradley & Russell, 1997).

The Midshire VLE project was started without paying attention to issues regarding the provision of technical support to the participating teachers and this proved costly to the project. The teachers did not get any technical support from the school or from the LA. Yet they were in need of technical assistance to enable them to make effective use of the technology. Both Yasmin (teacher from school C) and Rose (teacher from school A) lamented over their lack of technical expertise which made it difficult for them to use the VLE effectively. This resonates with studies in the past which highlighted the need for users of innovative technologies to possess sufficient knowledge and skills to do the job (Ely, 1999; 1990). For instance, the two teachers mentioned above had problems with the preparation and uploading of resources onto the VLE. Rose, for example, clearly indicated in her interview that she needed further staff development to be able to design resources with animations for use with the VLE. It is possible that lack of technical expertise and failure to get the much needed technical support might have contributed to the failure by both teachers to continue to use the technology despite having shown great interest in trying out the innovative technology. This is congruent with Cox & Webb's (2004) findings that teacher-related factors such as low levels of confidence and ICT skills were among the reasons for poor uptake of ICT in schools.

The other technical problem that emerged in the study was linked to issues to do with students' home access to broadband. The study showed that while the majority of students had access to a computer and internet at home, a minority group of students had no access. As argued by Rose, the VLE was not totally inclusive although schools put in place some mechanisms to counteract the problem (Gillespie et al., 2007).

A sharp contrast in technical support existed between schools in the Midshire VLE project and the schools that I was referred to by BECTA as being centres of good practice regarding the use of VLEs. For instance, in Southampton, Edna's school had a team of IT programmers employed by the school to provide staff development and other technical support needed by the teachers. In the same school, it was reported that teachers received good induction and lots of INSET regarding the use of a VLE in the school and this helped teachers across all Departments in the school to use the VLE with some confidence, as opposed to schools in the Midshire VLE project. The same case was observed at school G in the Midshire County (another centre of good practice) where technical support was made available to all teachers within the school. This highlights the need to provide technical support for an innovation to get institutionalised and links well with literature which emphasises the need for technical support (World Bank, 2005; Ely, 1999).

Teachers using EVSs also faced some technical issues. All the teachers interviewed indicated that there was no technical support in place within the schools. Apparently, the technology was only being used by individual teachers who were passionate about the technology who spared time to learn about the technology, in most cases on their own or with a colleague. I would argue that if there was technical support within the schools, probably more teachers would be using the technology, and those who are already using the technology could probably make use of it even more frequently. Simon, a science H.O.D from school F in the Milkshire County pointed out that most of his staff who had tried to use the EVS cited difficulties operating the software. In that school, teachers were introduced to the EVS in less than 30 minutes and no further staff development had been done. The absence of refresher staff development sessions makes it difficult for experienced staff to maintain interest with the use of the technology especially if they are being put off by some technical issues, and for the new staff, it becomes difficult to adopt the new technology. Phillip, a teacher from school E in the Miltonshire County had massive experience with the use of EVSs and he insisted that every user of the technology should master the software if the technology is to be used effectively. This underscores the importance of putting in place staff development activities and ensuring that there is provision of technical support to teachers whenever they need it. Teachers using EVSs did not cite many technical problems involving use of the technology; the only problem that was recurrent in all interviews was the problem of handsets failing to connect with the wireless device making it difficult for some of the students to submit their responses during a lesson. Joseph, same school as Simon, highlighted that due to time constraints teachers had no time to learn how to use the software which he said was not user friendly. This resonates with the suggestion by Ely (1999) that organisations should provide paid time for users to learn the new skills or procedures in order to use the innovation. On the other hand, contrary to the VLE, the use of EVSs was hailed by all teachers as being very inclusive. Every student has a chance to participate including those who would normally be shy to participate in the conventional lessons. In my view, inclusivity was possible in this case because students were not purchasing the handsets on their own; these were supplied by the school for use during the lessons.

5.2. Response to research question 2

Can the innovations help to change teacher ideas about the teaching and assessment of science?

It was of interest to me to establish whether the adoption and use of innovative technologies has an impact on teachers' ideas about the teaching and assessment of science. Firstly, I am going to discuss the ways in which the teachers in the study were using the technologies under study and then discuss what emerged from teacher interviews in response to the research question 2.

5.2.1. How VLEs and EVSs were being used by teachers

The idea behind the adoption of a VLE in each of the four schools in Midshire VLE project was to try and teach a selected science topic fully online, that is, each teacher was to upload all the material online for students to access it and learn in a self-directed way either in a classroom or outside the classroom. As highlighted in chapter 4, this innovation did not succeed; only two of the four schools implemented the project briefly before abandoning it.

The other schools involved in the study used the VLE in different ways. In a school in Southampton, the VLE was being used for administering homework activities, communicating with students and for sharing resources. It was also used creatively in case of emergency, for example, during snow days; teachers would give students some work to do while at home, through the VLE. Unlike in the Midshire VLE project, in this case the VLE was not being used as a platform for teaching purposes in a classroom. At school G in Midshire South, the VLE was used differently in different Departments. Most of the Departments used the VLE in the same way it was used in the school in Southampton, however some Departments like Food and Technology used the VLE as a platform for teaching purposes in a classroom just as schools in the Midshire VLE project had aspired to do. Sally, from a Polytechnic in Singapore, indicated that staff in her institution were using the VLE in four different ways depending on the nature of the subject: fully online, blended learning more than 50%, blended learning less than 50% and as a medium for supplementary learning (lots of resources online but students still come for face to face sessions). Findings from my study resonate with the literature. According to Gillespie et al. (2007) VLEs are being used to complement the existing face-to-face teaching strategies. This was evident in the schools I worked with in my study. The teachers felt that there is no way the technology can substitute the teacher from the classroom completely. As argued by Almpanis (2009), teachers felt that VLEs have the potential to support different learning styles. The teacher's role remains critical, as Almpanis (2009, p.72) emphasises, 'the software provides the opportunity for a wide variety of resources to be placed there, but that really relies heavily on the expertise and the knowledge of the person who is setting it up'. To my knowledge, the use of a VLE to offer a course fully online has not yet been explored at secondary school level.

The teachers who were using EVSs indicated that they adopted the technology in order to enhance student engagement in classroom settings arguing that this technology provided the opportunity for every student to participate during class-wide discussions. These views related well with literature on the use of EVSs. EVSs have been identified to be good at fostering student engagement and increasing student participation in class (Bruff, 2009, Caldwell, 2007; Draper & Brown, 2004). The EVSs were being used differently by the teachers depending on the software and its affordances. Most of the EVSs used by the teachers had software that only used multiple choice question formats. Only one school in my study, school E from Miltonshire County, had a software (Word Wall) that enabled students to text in their answers. The teachers argued that they could use the EVSs to develop critical thinking skills even when using multiple choice questions as this was dependent on the nature of the question rather than the question format. This is consistent with what literature says (Bruff, 2009). Most of the teachers indicated that most of their clicker lessons were pre-planned although it was also possible to use the technology spontaneously during a lesson. The use of the technology was dependent on the availability of learning resources. Word Wall has got a repository of already made resources so for teachers who had this software it was easy to use the technology spontaneously. One possible explanation for teachers' failure to use the technology spontaneously is the fact that in most cases I found that one set of equipment was shared among all teachers in the

Department so one had to book in advance if they wanted to make use of the technology. During a lesson, some teachers were using the EVSs as a starter or as a plenary. In some cases teachers used the EVSs for revision lessons. This I believe was because they could get immediate feedback about their students' understanding (MacArthur & Jones, 2008).

Do these technologies lead teachers to do their work differently? In the subsequent section I am going to discuss what emerged from my study regarding the implications of using these two technologies on the teachers' ideas about teaching and assessment of science.

5.2.2. Impact of the use of VLEs on the teachers' ideas about teaching and assessment of science

The research has shown some very useful findings on the way the teachers see a VLE and interact with it. Generally teachers in my study who used the VLE appreciated its value in terms of helping students in their learning. It was interesting to notice that although all the teachers could see the value of the technology, no single teacher was agreeable to the idea of substituting the teacher completely with the technology. This was graphically portrayed by Edna when she said 'I cannot see how the teacher could be substituted from the classroom with any piece of technology'. The same views were echoed by Sally and Yasmin who felt that the teacher was supposed to drive the technology and not vice versa.

It was commonly agreed that the VLEs facilitated independent learning in line with the constructivist learning approach. Some teachers felt that the technology did not change their way of teaching in any dramatic way; they argued that they have always been in the classroom as facilitators, implying that they have always been using learner-centred approaches in their teaching. Yasmin, however, made it clear that although she had always been a facilitator rather than a teacher in all her lessons, the use of a VLE in the classroom had brought up some changes in the way she does her work. She felt that she continued facilitating the learning process; however, the approach had been different because the VLE was now compelling her to do this on an individual rather than group level. I would argue that the VLE makes it possible for the teacher to attend to individual needs more than is possible in a conventional lesson. This is because through a VLE the teacher interacts more at individual level with the learner enhancing the chances of identifying and discussing real felt needs of every learner. Yasmin was forced to abandon VLE lessons with her two year 11 groups, however, despite her disappointing first experience of using a VLE in class, Yasmin remained open to further attempts and had some optimism about the contribution a better designed VLE might be able to make.

Some teachers like Rose (school A) cautioned against seeing the VLE as a substitute for a teacher and instead opted to consider it as a complementary tool rather than a standalone strategy. Rose highlighted an important point that many teachers can be sympathetic with. She was not confident that her students would actually spend the necessary time working through the information on the VLE. This can be true; internet offers many potential distractions to students if they lack discipline. The trouble is, if students are left on their own to do the work online, they may end up distracted and this will not be good enough in time of examinations. The impact of examinations cannot be ignored when it comes to teachers and their response to the new technologies. Teachers will embrace technologies that will help their students to achieve good results in public examinations. The use of VLEs gives a substantial amount of control to students. It emerged from the study that some teachers want to remain in control of their students' learning, as evidenced by what Rose suggested when she highlighted that she had problems in letting go some element of control over teaching the material and being reliant on the pupils to actually spend a good amount of time doing the work. Although teachers in this study indicated that they were incentivised to use the VLE because it reinforces the notion of independent learning in line with the learner-centred approach, it also emerged that some teachers were not keen to try the technology because they felt that the use of online teaching takes longer time. This view resonates with what Almpanis (2009, p. 74) observed, namely that teaching online can be more time demanding than teaching face-to-face. This is principally because its thrust is the fostering of individual and group dialogue, rather than the transmission of information. None of the teachers in my study complained about time, however, I would argue that using new technologies such as a VLE might be time consuming at first (when one has to prepare resources) but later it can help the teacher to save time.

5.2.3. Impact of the use of EVSs on the teachers' ideas about teaching and assessment of science

Teachers who were using EVSs cited several reasons for embracing the innovative technology in their classrooms. Some of the reasons they cited are: increased student participation in class, enhanced student engagement with learning material, quick assessment and immediate feedback for both the teacher and the students. These views are in consonance with studies in the past (Bruff, 2009; Draper & Brown, 2004; Draper et al., 2002). As they used the technology, teachers felt that the EVSs had brought up some changes to the way they conducted their teaching in the classrooms. Following below is a discussion of some of the issues that emerged in the interviews with teachers regarding the ways in which the EVSs had impacted on their teaching.

Inclusivity

All the teachers who were using EVSs credited the technology for enabling them to appreciate more the importance of inclusivity. This was well illustrated by Janet, a science teacher from school F, who clearly stated that because of the impact of clickers she was now planning lessons to suit everybody. Even in lessons where she does not use clickers, she was now using approaches that encouraged class-wide participation. This is surely a significant outcome from the adoption of a new technology. The teacher's conception of her teaching has been changed in a profound way. Joseph, a science teacher from the same school with Janet, added that clickers had helped him to reinforce ideas that he had always believed and felt about in his teaching. Joseph had always believed in learner-centred approaches and he indicated that clickers had made it possible for him to focus his attention on each learner and helped him to address the needs of every learner.

The main advantage of clickers has been that students can participate anonymously (Jackson & Trees, 2003). This encourages all students to participate in class including those who would normally find themselves too shy to raise their hands in a lesson, as argued by Morris, a science teacher from school E, when he said that use of clickers 'gets every child involved'. This relates well with what Caldwell (2007) found in her study, that EVSs encourage active participation of all students in class.

Formative assessment

As indicated above, one of the most heralded advantages of using the clickers by the teachers was the provision of immediate feedback to students about their learning. It emerged from the study that teachers were happy to use the clickers because it was very easy for them to assess and provide feedback to their students during a lesson. This was clearly articulated by Joseph, a science teacher from school F in Milkshire, when he said clickers 'give them immediate feedback so they get immediate insight into their misconceptions, mistakes that they are making and gaps in their knowledge' (JM-32). The immediate feedback students got, in many cases, encouraged them to concentrate and engage more actively with the learning material during the lesson. As highlighted by the teachers during interviews, the clickers introduced an element of competition in the classroom which inspired some students to work hard to produce good results. Through clickers teachers confirmed that they were now able to assess their students more frequently providing them with immediate feedback and they were also able to provide good feedback about students' learning progress during parents' meetings. The value of formative assessment or assessment for learning to students has been well documented (Black & Wiliam, 1998). Students like receiving feedback immediately (Bruff, 2009; MacArthur & Jones, 2008; Draper et al., 2002) and EVS technology is very well suited to provide this.

Diagnostic assessment

Apart from providing immediate feedback to students, clickers were also reported to generate useful feedback for the teachers. Looking at how teachers were using the technology in their lessons, I found out that the clickers were used in different ways which facilitated diagnostic assessment. Listed below are some of the ways in which clickers were being used:

- as a starter when a new topic was being introduced enabling the teacher to find out how much the students already know about the topic
- as a starter to test the students on how much they remembered from the previous lesson
- to follow up on homework, instead of marking students' books, the teacher gives them a voting test and that immediately tells her/him whether students learned what the teacher intended them to learn from the homework exercise or not.

It was interesting to notice that teachers could also take note of the differences between classes as they used the clickers. One of the teachers from school F, Joseph, explained how he used different quizzes depending on the characteristics of the students in a specific class. This demonstrates that it is possible to use differentiation approaches with the new technology in the classrooms. It has to remain clear though that it is not the technology alone but the combination of technology and the teacher's pedagogical understanding that can make it possible to achieve positive results in the classrooms.

No single teacher in my study mentioned the concept of diagnostic assessment during my conversations with them but I was able to identify this from the descriptions they gave me concerning the way they were using the clickers in their classrooms. This showed me that diagnostic assessment or assessment for teaching (Scaife & Wellington, 2010) is not a familiar concept among teachers as opposed to formative assessment or assessment for learning (Black & Wiliam, 1998). Teachers referred to formative assessment and assessment for learning frequently as we discussed the use of clickers. Talking about diagnostic assessment, without using the concept per se, Chris, a science teacher from school F, explained that clickers had enabled him to 'become more aware of individual pupil understanding' (CW-20) while Geh Koh Sung, a maths teacher from a Polytechnic in Singapore, highlighted that he was '...able to identify areas of weakness and misconceptions that students have about the topics covered' (GKS-24). Joseph, a science teacher from school F, reiterated that '...you get instant feedback which allows you to not only see how individual students have done...so you can pick out individuals struggling with a topic, it also allows you to see which areas of the topic you have just taught the whole class is struggling with...'(JM-22). These personal accounts given by the teachers help to illustrate how useful clickers are in terms of providing teachers with useful feedback which they can use to prepare lessons or address misconceptions or gaps of knowledge among their students. Hattie (2009, p.12) asserted that, 'the most powerful single influence enhancing achievement is feedback...the most important feature was the creation of situations in classrooms for the teachers to receive more feedback'. Clickers provide important feedback to teachers. I am not aware of any other teaching method that can provide such useful information instantly. Given that teachers can get instant feedback about how their students are learning, it is possible for them to adopt approaches like contingency teaching (Draper & Brown, 2004) or active teaching (Bruff, 2009) which helps to address students' learning needs during a lesson. Hattie (2009, p.173) makes an apt observation about the importance of feedback to teachers arguing that:

> When teachers seek...feedback from students as to what students know, what they understand, where they make errors, when they have misconceptions, when they are not engaged –the teaching and learning can be synchronised and powerful. Feedback to teachers helps make learning visible'.

This technology enables the teacher to increase her/his effectiveness in the classroom. They provide feedback which helps the teacher to know the direction of the lesson as argued by Hattie (ibid., p.239) when he said 'teachers need to know ...where to go next in light of the gap between students' current knowledge and understanding and the success criteria'.

Teachers in the study appreciated how clickers reduced their work load. The technology does the marking and provides feedback instantly, a task which normally takes teachers a lot of time. It is helpful for students to get timely feedback; they can make use of it immediately. One teacher argued that if you bring feedback to students after a long time, they may not even remember where they went wrong. Clickers are helpful in that students get to know where they went wrong in a matter of seconds. It must remain clear that teachers were not saying use of clickers is not time consuming. Indeed, at the beginning, it takes some time and practice to develop good questions (Burnstein & Lederman, 2001; Elliot, 2003; Beatty et al., 2006; Simpson & Oliver, 2006).

5.3. Response to research question 3

What are the students' perceptions of the value of using the innovative technologies in the teaching and assessment of science?

In my view, the success of an innovation in the classroom is not only dependent on the teacher but also depends on how students respond to it, among other factors. My study has generated interesting findings on the way students perceived the value of using innovative technologies like VLEs and EVSs in the science classrooms. Different views were gathered and these will be discussed in the subsequent section.

5.3.1. Students' perspectives of the value of using VLEs in the science classrooms

In my interviews and discussions with students, two groups of students emerged. One group of students considered themselves to be independent learners while another group considered itself to be dependent learners. The group of independent learners was positive about the use of VLEs for science lessons while the opposite was true for those students who described themselves as dependent learners. Independent learners would find use of VLEs convenient as Almpanis (2009, p.74) says, 'a particular learning approach associated with self direction is also required, as students have to engage themselves in the online activities'. The independent learners made comments such as: 'well, I enjoy it because I am more of a computer person...I like teaching myself using computers' (TW-2). Some students enjoyed the independence provided by the VLE in their learning. Speaking against teacher led sessions, one student pointed out the following: 'just that, if she [the teacher] is telling you something that you already know, you begin to lose interest in what she is saying and like by the time she is telling you something you don't know, you have lost completely interest so you are not fully there with her, you might be somewhere else' (HK-18). This student raises an important point here, so it is possible that students might be in a class and come out empty handed, without learning anything! It is important that teachers should find diagnostic ways to know and address the needs of their students in a class to make sure that no one loses attention during a lesson. This also shows that sometimes when students are behaving awkwardly in a classroom it may not necessarily mean that they are undisciplined; it is possible that the teacher maybe failing to address their felt needs.

A further exploration of why some students enjoyed VLE lessons more than teacher-led sessions showed that they find it easier to learn by themselves rather than trying to keep pace with the whole class. From focus group 1, student 2 clarified why he preferred VLE lessons instead of teacher-led sessions: 'if you are in a classroom if everyone else understands and you don't it will be different'. It emerged that VLE lessons offer students the flexibility to learn at their own pace, in their own time without having to compete with others as often happens in a classroom situation. This view supports the findings from previous studies where it was shown that students enjoy VLEs because they can participate in 'anytime-anywhere' learning (Finnis, 2009; Gillespie et al., 2007).

Students also felt that VLE lessons were more interactive and more involving compared to teacher-led sessions where they spend most of the time just writing or reading from a textbook. It was also felt that VLE lessons have got the advantage that one can read the material over as many times as they want, unlike in a classroom situation. Previous research has clearly revealed that computer mediated communication (CMC) tools, when they are well designed and executed by the teacher, enable participants in online environments to support each other and learn from one another through collaboration (Prestera & Moller, 2001). Debard & Guidera (1999) argue that if online discussions are carefully designed they can be more effective than face-to-face discussion where the exchange of ideas is fast paced and participants are not given the opportunity to reflect on those ideas.

Some of the students also felt that VLEs prepared them better for examinations as they have access to different search engines for more information. Apart from VLEs being repositories of information, they promote student engagement (McCabe, 2006) with learning material which can have a knock on effect on their academic performance. My study also showed that it is not always true that students who are positive about the use of computers in a lesson would obviously embrace the use of a VLE without any reservations; I noticed that some students who were positive about the use of computers in lessons had some reservations when it came to the use of a VLE in the science lessons. For example, in an interview with Hannah, although she liked computers in lessons, when she reflected on the use of a VLE, she highlighted that sometimes she liked the VLE lessons '...but there are times when it was too difficult to find everything...'. It can be argued that perhaps if the VLE was designed properly then students like Hannah would not have any reservations about their use in lessons. Some students felt that excess use of VLE lessons could be boring in the same way they felt having the teacher in front of them all the time could be. This might suggest that it is a good idea to use the VLE in a blended learning context (Almpanis, 2009). This would be helpful in terms of refreshing learners' attention through varying the learning environment.

The group of students who were completely negative about the use of VLE lessons cited the following as the main reasons why they disliked the VLE lessons:

- it is boring to sit on the computer all the time
- they get easily distracted and get focused on something else
- they are dependent learners
- they lose concentration easily on the computer
- they need help
- they missed talking, having discussions
- teachers were not responding to mails
- they cannot type everything
- difficult for the teacher to keep everyone on track

I think that it is important for every learner to participate actively in the learning process. Teachers should promote the notion of independent learning whether they are using a VLE or they are leading the sessions as what happens in the conventional lessons. Students cannot be justified to say, for instance, they do not like VLE lessons because they do not like independent learning. Arguably an aim should be to develop self-directed learning skills. A VLE could be designed to 'scaffold' this. It is easy for students to lose concentration even in a non-VLE lesson when the lesson is not properly designed. The challenge is for the teachers to design the VLE lessons in such a way that students would be motivated and interested to learn by themselves. In line with this, Almpanis (2009, p.71) emphasises that the educational value of the technology use should be prioritized highlighting that, 'it should not be done for expediency, the key should be how the learner can be engaged'. A consideration of the circumstances at school C may explain why it may be unsurprising that many students disliked the VLE lessons. Their teacher (Yasmin) was unfamiliar with VLE lessons herself and it is evident from what students said that the VLE lacked some essential communication features to enable students to interact and share ideas as they would normally do in a conventional lesson.

5.3.2. Teachers' views regarding students' engagement with VLEs

The interview data revealed that in schools where VLEs were being used successfully, the majority of students were happy and engaged very well with VLE learning material. For example, at school G in Midshire South, Peter reported that students were provided with guidelines on how to use the VLE and they were engaging happily with their learning materials on the VLE. Edna, a science teacher from a school in Southampton where a VLE was being used across the whole school, indicated that students were positive about the use of the VLE in their learning activities. She, however, mentioned that y7 and y8 students enjoy it more than y10 and y11 students. As expected, the younger groups were happier with the VLE lessons because they were using the internet for the first time for learning purposes in the majority of cases whereas y10 and y11 students would have had more exposure to online working, which no longer has the appeal of novelty. At a polytechnic in Singapore, Sally indicated that most of the students were happy with the VLE and they valued their interactions with fellow colleagues online. It must have been difficult for Yasmin to implement VLE lessons successfully because no other Department in her school was using the VLE in the same way; students only used the VLE lessons in science. I think this relatively impoverished VLE context made it difficult to motivate and sustain student interest in using the VLE for learning in the science classroom.

5.3.3. Students' perspectives of the value of using EVSs in the science classroom

My findings from the three secondary schools showed that contrary to the case of VLEs, most of the students were positive about the use of clickers in science lessons. In this section I am going to discuss students' views on the benefits of using EVSs in science classrooms.

Increased participation in class

Analysis of students' responses to questions that focused on the impact of clickers on student participation in class (questions 1, 17 and 21) showed that an overwhelming majority of students agreed that clickers enhanced their participation during class activities. This result echoed findings from previous studies where it was shown that clickers enhance student participation in class (Bruff, 2009; Esponda, 2008; Caldwell, 2007; Burnstein & Lederman, 2001). From question 1, 92% of the students across the different year groups (that is year 7, 9, 10 & 12) indicated that clickers made science lessons fun. In other words, students enjoyed the lessons more when using clickers. Age was not seen to be an important variable in this case; students of all age groups expressed the same feeling towards the use of clickers. Results from question 17 demonstrated that while clickers are seen to make class livelier and engaging, younger students (year 7) appeared not to have had a full appreciation of the value of the technology in their classroom. No differences were discernible on a gender basis in the two groups that were analysed for gender differences (year 7 and year 9). Both girls and boys responded equally to the clickers' use in their classrooms, they both felt that clickers had some tangible value in their classrooms. Similar trends were observed in the results to question 21, most of the students felt that they could participate more when they use clickers in class. Again, year 7 students registered the lowest number of students who agreed to the notion of increased participation when using clickers (see weighted mean scores: y7=3.3; y9= 4.1; y10=3.7 and y12= 3.7). One possible explanation for year 7 students' low weighted mean value can be limited exposure to EVSs compared with the other year groups.

Increased knowledge retention capacity?

Judging from the results obtained from question 11, it appears that students from year 7 and year 9 were more convinced than students from year 10 and year 12 that clickers were good in terms of increasing knowledge retention. More than half of the students from year 7 and year 9 agreed with the notion that clickers increased knowledge retention while more than half of the students in year 10 and year 12 were not in agreement with that notion (see weighted mean values: year 7=3.6; year 9=3.6; year 10=3.1 and year 12=3.0). It appears that it was difficult for a considerable majority of the students to establish the impact of clickers on their knowledge retention capacity. One possible explanation about this is that the clickers were not being used as a standalone strategy; they were being used in conjunction with other approaches, hence, it becomes difficult to ascertain the impact of clickers alone on knowledge retention capacity. However, it can be argued that if students enjoyed lessons more and participated actively and engaged more with the material in lessons where clickers were used, it is possible that they would remember the content more. There are not many studies that have explored knowledge retention and use of clickers. Sawdon (2009) suggests that the use of EVSs helps to improve knowledge retention. This may be true if we consider that EVSs promote active engagement which in turn leads to effective learning (Draper et al., 2002; Cutts et al., 2004; Knight & wood, 2005; Simpson & Oliver, 2006; Caldwell, 2007).

Clickers are user friendly

Students' responses to questions 2 and 6 indicated that they did not have problems with the use of the technology in the classroom. Both girls and boys expressed a high level of confidence with the use of clickers. In question 2, all groups had on average, a weighted mean score of 4.1, showing that they all agreed that they knew enough about using clickers for the science lessons. In question 6, 88% of all the 150 students expressed that they did not need help from the teacher regarding the use of clickers. It appears, therefore, that from students' perspective, clickers are a user friendly technology.

Competition

The study showed that students generally enjoy competing with each other during lessons where clickers are used and this resonates with previous studies (Bruff, 2009). This was observed from the results of question 7(closed-ended) and the first question on the section containing open-ended questions on the questionnaire. Question 7 read, 'I enjoy competing with my friends for correct answers using clickers', and the following weighted mean scores were obtained (year 7=3.8; year 9=4.2; year 10= 4.3 and year 12=3.7). These results show that a considerable majority of students, regardless of their age, enjoy competition. In year 7, girls had a weighted score of 3.5 while boys had a weighted score of 4.0, showing that the girls were less competitive than the boys. However, in year 9, there was little difference observed between boys and girls (weighted mean score values: girls=4.2 and boys=4.5), both groups appeared to be happy competing with their friends in lessons. In question 1 (open-ended), students were required to indicate what they liked most about using clickers and more than 80% of the 150 students in the study indicated that they enjoyed competition. Students tend to compete naturally in class but I think use of clickers makes competition higher because students get feedback immediately and they compare their results with each other, and also 'safer' if used anonymously.

Interactivity

The study showed that clickers play a significant role in facilitating interactivity in science lessons. Most of the students appreciated that holding discussions with their friends helped them to understand course content. The weighted mean scores (year 7=3.5; year 9=3.9; year 10= 3.2 and year 12=3.5) showed that apart from year 10, the other three groups contained a majority of students who agreed with the notion that discussing clicker questions with other friends helped them to understand course content. Clickers also helped students to learn more from their friends. Results from question 13 indicated that use of clickers increased interactivity among students and as a result they learnt from each other. Thirty-nine percent of the students agreed that they learnt more from their friends due to interactivity promoted by the clickers. A high proportion of students (36%) was undecided on whether interactivity had helped them to learn more from their friends. Studies conducted by Draper et al. (2002), MacArthur & Jones (2008) and Bruff (2009) indicated that clickers were quite useful in terms of enhancing students' interactivity in science lessons which is congruent with the findings from my study.

Anonymity

Existing literature shows that students appreciate participating anonymously when using EVSs (Jackson & Trees, 2003; Hinde & Hunt, 2006; Bruff, 2009). My study showed that students had mixed feelings about anonymous participation. Some students were happy to participate anonymously while others enjoyed having their names publicised and on the other hand there was a group of students who were undecided. Weighted mean scores for the four groups demonstrate this (year 7=3.5; year 9=3.1; year 10=2.8 and year 12=3.3). Only the year 7 group had more than 50% of students happy with anonymous participation, in the other three groups, less than 50% of the students were happy with anonymous participation. A further analysis of year 7 students' results on gender basis showed that 86% of the girls were happy to participate anonymously in class while only 27% of boys agreed with anonymous participation. At this level, it looks like boys want to go public more than girls! A similar pattern was discernible among the year 9 students. An analysis of results from one group showed that 38% of boys disagreed with the notion of anonymous participation while on the other hand only 18% of the girls disagreed with the idea of anonymous participation. These results indicated that more boys than girls tend to enjoy it when their names are publicised during class participation.

Instant Feedback

The study findings indicated that most of the students appreciated the instant feedback that teachers and students get when using clickers. For teachers, clickers are an excellent diagnostic assessment tool. Sixty-seven percent of the students stated that clickers helped teachers to focus attention on things they did not understand. This was a good indication that clickers were facilitating 'assessment for teaching' (Scaife & Wellington, 2010; Bull et al., 2002). It means that, as much as clickers can be used to facilitate formative assessment or assessment for learning (Black & Wiliam, 1998), they are also good at generating useful feedback that teachers can use to address students' learning needs during a lesson (contingency teaching) (Draper & Brown, 2004).

'Cool' technology

It also emerged from the study that students appreciated being on the edge of technology. We are living in an information society and when students are introduced to the use of new technologies they feel happy and enjoy the learning experience which responds to the needs and challenges of the modern society. There was a common feeling among most of the students across the different year groups that use of technologies such as clickers made them feel like they are in a modern school. It was interesting to note that apart from enhancing student engagement with learning material, use of new technologies such as EVSs also contributed to institutional engagement. Students indicated that they were happy to be at a school using new technologies and described the school as being 'modern'.

Control

The use of clickers was shown to give students control over their learning. The mean scores of all groups (Year 7=3.3; Year 9= 3.7;Year 10= 3.7 and Year 12=3.2) show that on average student felt that use of clickers gave them some control over their learning. Use of EVSs is, therefore, important in shifting power relations between the teachers and the students. In line with the constructivist learning approach, the technology tends to place students at the centre of their learning process, in other words, students have a sense of more ownership for their own learning.

Wait time

Some useful results on how much time teachers gave their students to provide answers during clicker lessons were found from the study. In year 7 and year 12, most of the students indicated that they did not require more time to respond to questions when using clickers (61% and 75% respectively). Analysis of year 7 results on gender basis showed that 80% of the boys did not feel the need for more time while on the other hand only 38% of the girls shared the same feeling. Thirty-one percent of the girls needed more time compared to only 7% of the boys. It can be seen that at this level the girls felt that they are less impulsive than boys when using clickers and, therefore, require more wait time. Year 9 results showed that on average, every student was undecided as to whether they needed more time or not. On the other hand, year 10 students showed that they needed more time to answer questions. Wait time for each question can be determined and set by the teacher, so the year 10 results might be an indication of how the teacher was using the clickers with the group. Students indicated that they need more time, which might mean that the teacher was not giving them enough time to answer questions properly and this had a bearing on the way students perceived the educational value of the technology. Results from question 12 appear to contradict those students who were asking for more wait time in question 8. Almost all students from the different year groups indicated that they were able to learn at their own pace during science lessons where clickers were used (weighted mean scores: year 7=1.8; year 9=2.3; year 10=2.8 and year 12=2.2). No differences were observed between boys and girls from year 7 as was observed in question 8. It appears that there were some problems in the way clickers were being used in year 10 because a weighted mean score of 2.8 shows that almost every student in this group was not sure whether they were learning at their own pace or not.

More benefits

Various questions were used to elicit students' attitudes towards the use of clickers (questions 3, 4, 5, 15, 16, 18, 19 and 20). Analysis of results showed that a considerable majority of students, both boys and girls, and all age groups, were quite positive about the value of using clickers in their science classrooms. These findings support the overall trend in the literature which reflects that students enjoy the use of clickers in lessons (Caldwell, 2007; Jackson & Trees, 2007; Barnett, 2006). For example, in question 3, a weighted mean score value of 4.0 was obtained, which showed that on average all students agreed with the notion that they would like more science lessons involving use of clickers. In question 4, a weighted mean score value of 2.3 indicated that on average students disagreed with the notion that they were not satisfied with the use of clickers in the science lessons. It was also interesting to notice that students in the study were not happy with science lessons where clickers are not used. In question 5, a weighted mean score of 2.1 was obtained showing that on average students were in disagreement with the notion that they do prefer science lessons where clickers are not used. If this is true, it appears that the majority of students were not enjoying the regular science lessons. This implies that science teachers should explore the use of new technologies like the clickers effectively to keep their students motivated in the lessons. Apart from using clickers in science lessons only, students also called for the use of clickers in other subjects offered in their schools. In question 15 which read; 'I would love it if clickers were to be used with other subjects in the school', a weighted mean score of 4.1 was obtained showing that on average students agreed with the idea of using clickers across the curriculum. On average students were happy with the use of clickers as shown by the results of question 18. The question read, 'using clickers makes me feel angry', and a weighted mean score of 1.7 showed that on average they disagreed quite strongly that clickers made them feel angry. It also emerged from the results of question 18 that though students were happy with the use of clickers, they had difficulties in making judgements about the impact of clickers on their performance. In question 18, students were asked whether they had a sense of achievement in lessons where they used clickers. A weighted mean score of 3.6 was obtained but a high proportion of students (28%) chose to be neutral. As discussed earlier on, it is difficult to single out the impact of clickers on academic performance when it is used alongside other approaches. This will be discussed further in answer to research question 4. Students' appreciation of the value of clickers in their learning experience was also evident in their response to question 19. Question 19 read, 'I would enjoy science more if teachers used clickers in the science lessons'. Most of the students across the different year groups and across the different gender categories, expressed that they agreed with this notion. It was, however, difficult for the students to know whether they would work harder if they could use clickers more. Question 20 read, 'I would work harder if I could use clickers more often', and a weighted mean score value of 3.4 was obtained showing that on average students were not fully decided on whether clickers would make them work harder or not. If it is true that students enjoy competing with each other for correct answers when using clickers, it is possible that more exposure to the use of clickers would result in students working harder in order to get good results when voting in lessons.

5.3.4. The negative side of clickers

The study also demonstrated that while there are many aspects of clickers that students were happy with, there existed some aspects that they were unhappy with. These emerged from analysis of question 2 in the section with open-ended questions on the questionnaire. Examples of such elements are discussed in the subsequent section.

Competition

There were some pockets of students who were unhappy with the competitive element brought up in the classroom by the use of clickers. There was a feeling that some students lose the main reason for using the clickers and end up engaging in unnecessary competition which included racing to finish first. It is possible that if the teacher was not careful and monitoring the situation closely, some students would just vote without taking time to think through the question before submitting an answer (Sian et al., 2003). Some students found the competition quite stressful.

Reliability

The use of clickers could be frustrating to students especially when the technical side of things does not behave properly. Students indicated that clickers were not always reliable citing that their use can be hampered by some technical problems including handsets not getting connected thereby making it impossible for some students to submit their answers. It was also pointed out that in some cases teachers were struggling with the software. Technical problems were identified as being a major cause of the technology unreliability in the classroom. This highlighted three things to me: the need to offer staff development to teachers prior to adopting the technology, the need to provide a robust technical support team in the school to ensure that any technical concerns are addressed promptly and also the need for critical selection of the actual product purchased by the school.

Learning

It emerged from the study that some students were not happy with the learning that takes place in classrooms where clickers are used. They cited issues like '[clickers] don't cover in detail what the course entails' and 'you don't learn a lot from it'. In my view I do not think clickers are to blame here, pedagogy should drive the technology, which means the teachers are responsible for the outcomes in their technology enabled lessons. This view is echoed by Almpanis (2009, p.79) when he says 'for e-learning to be successful, the role of the [teachers] is of crucial importance... [Teachers'] approach to e-learning is a catalyst for its effectiveness...' It is vitally important to ensure that teachers know how to exploit the affordances of the technology in an educationally beneficial way for students to appreciate its value.

Time cost

One other issue that emerged from the study was the concern for time loss when clickers are used. This appears to support the views by Burnstein & Lederman (2001) and Simpson & Oliver (2006) who asserted that when time is spent on EVS activities, there is usually a decrease in content coverage, the underlying assumption being that some time is lost setting up the system. No teacher in my study felt that clickers reduced content coverage in lessons; however, some students felt that using clickers contributed to loss of time. They felt that the setting up of the system takes some of the lesson time. When the clickers are used at the beginning of the lesson, students can be given the clickers as they enter the classroom and this can be done in an orderly manner. Some students disliked a situation where the clickers are distributed in the middle of a lesson resulting in students rushing to the teacher to get the clickers. In my view, these logistical issues should not undermine the educational value of the technology, however it is worthwhile to think about the best ways to minimise time loss.

Distraction

It was pointed out that the use of clickers can be disruptive. Students cited that clickers make some students overexcited and end up losing focus in a lesson. One student reflected the group feeling when she wrote this, 'it can make the class really noisy at times which can destroy a good working atmosphere'. The technology should facilitate an enhanced positive learning experience for students and the teacher should play an important role in ensuring that there is control and order in the lesson.

Design issues

Use of clickers was also criticised for not being entirely inclusive. Students with spelling problems face texting difficulties. However, this does not apply to questions with multiple choice formats where students only need to press one key to submit their answers. Some students also cited reading problems saying that sometimes the handwriting is too small for them to read well. Surely, the technology cannot be dismissed on the basis of this issue. If the teacher realises that her/his students have problems in reading and understanding the questions, he/she can read the questions loudly and clarify any misunderstandings before students can be asked to submit their answers. Some students also indicated that some of the keypads were too small and, therefore, uncomfortable to use.

More!

The questions received an impressive response rate with more than 90% of students being able to respond to each one of the three open-ended questions included on the questionnaire. My interpretation of this is that the questions were clear and the approach adopted in the administration of the questionnaire was also helpful. This has been explained in the previous chapter. One other issue that emerged from this study is that the technology in the schools was not being exploited fully. Teachers who were using the clickers were not being consistent in their use of the technology. In all the year groups involved in the study, more than 80% of the students were calling for more frequent use of the technology in their lessons. Teachers complained of lack of time to prepare the learning resources and indicated that lack of resources limited their use of the clickers. They can be justified because they already have a lot of marking and lesson preparation to do, however, time needs to be created for them to be able to exploit the new technologies which have been shown to have potential to enhance students' learning experience enormously.

5.4. Response to research question 4

Are there observable indications that the use of the new technologies in the teaching and assessment of science helps to improve the students' academic performance/achievement or views about science?

Findings from the study, presented in the preceding chapter, indicated that it was difficult for the teachers to measure objectively the impact of using VLEs and EVSs on students' academic performance and/or students' views about science. This confirmed my position as a researcher. From the onset of the project I felt that it was not realistic to expect to be able to demonstrate causal connections with learning outcomes. It was more realistic to research users' experiences as I did. In the subsequent section I will discuss the views of teachers and students regarding the evaluation of the outcomes of VLEs and EVSs' use. There was an overwhelming consensus on the role played by these new technologies in enhancing students' learning experience. The following indirect indicators of improvement of students' performance were highlighted: increased student participation in class, increased student engagement with learning materials, increased student attentiveness in class, increased student enjoyment of science lessons and development of critical thinking skills. Some of the indicators apply to both the use of VLEs and EVSs but in some cases as you will see below, some of the indicators only refer to one of the technologies.

5.4.1. Increased student motivation and participation in class

The Midshire LA rationalised that the use of VLEs in the schools would encourage collaboration among schools in the same region and furthermore, it anticipated an improvement of school results. Unfortunately, the project failed to get institutionalised. Yasmin (school C) and Rose (school A) decided to abandon the VLE lessons citing that these lessons were not helping students to hit top grades. Is it true that the use of VLEs does not help students to perform well in examinations? My interpretation is that the VLE lessons were not properly designed and as a result students did not find them very engaging. I conclude this because teachers from schools beyond the Midshire VLE project who had properly designed and well established VLEs gave positive reports regarding the use of VLEs on students' learning experiences. It emerged that teachers from schools where VLEs were being used successfully were motivated to continue using the technology because of its positive impact on students' learning experience. The VLEs were not being used as standalone strategies; hence, it was difficult to measure their impact on students' learning quantitatively. However, teachers indicated that students were highly motivated to do their work and participation on assignments using VLEs was also high. Edna summed up the common feeling among the teachers when she said that the VLEs were, in fact, helping the less independent students to become more independent (EZ68)-surely a key learning goal. Some of the students said they understood concepts more using the VLEs than from the teachers' interpretations. It was therefore believed that the use of VLEs contributed to an improvement in the overall student performance. In support of the use of VLEs and web 2.0 technologies, Solomon & Schrum (2007, p.9) argued that: 'because these new technologies and new capabilities engage and motivate students, we can use them to educate'.

An increase in student participation in class was also observed with the use of EVSs. As highlighted in the discussion of question 3, many students confirmed that they participated more in lessons where EVSs were used. This was reiterated by the teachers. It was commonly agreed that the use of clickers put pressure on students to participate during a lesson as they strive to get a good mark. If they do not know the answer, students either consult with a friend or a book to make sure they submit an answer. The competitive element brought in by the use of clickers encourages increased participation by all students either individually or through peer instruction (Mazur & Crouch, 2001; Mazur, 1997). It can be argued that the more students participate in knowledge construction the better they will perform. Previous studies have shown that students are more active, attentive, and pleasant to teach when using EVSs (Beatty, 2004; Wood, 2004, Elliot, 2003; Draper, 2002).

5.4.2. Increased student engagement with learning materials

VLEs encourage independent learning. Teachers in the study argued that as students use VLEs which offer them access to more resources on the subject matter, they consequently engage more with the learning material and this in turn has a bearing on their overall academic performance. Even teachers from schools that had abandoned VLE lessons remained optimistic that better designed VLE lessons would help students improve in their learning.

The study revealed that use of EVSs contributed to an improvement of students' academic performance. Using EVSs students were said to be highly motivated, enthusiastic and engaged more with learning material. These views related well with previous studies which showed that there is increased student engagement when new technologies are used (Bruff, 2009; Cutts, 2006; Wood, 2004). Through clickers students get immediate feedback which provide insight into their misconceptions (JM—30) and these misconceptions can be challenged and shared in a non-threatening environment (CW-26). It can be argued, as expressed by the teachers in the study, that as students have more fun and engage more with the learning material their academic progress may prosper as a result of that.

5.4.3. Increased student attentiveness in class

It emerged that when students use EVSs they tend to be more alert and attentive in lessons (Middendorf & Kalish, 1996). This increased student attentiveness in class can be interpreted to be a consequence of the competitive element brought in by the clickers. Every student strives to achieve good results because they are aware that the teacher tracks their performance and this can be discussed not only with the student but the parents during parents' evening meetings. Although participation in class can be anonymous (MacArthur & Jones, 2008), students are aware that their results are recorded and kept by the teacher. This motivates them to pay attention in class. Arguably students bring some curiosity in the classroom and the realisation of self-worth when their voice is recognised encourages them to participate actively during lessons.

5.4.4. Increased student enjoyment of science lessons

Apart from the students in schools where the VLEs were abandoned, elsewhere, students were reported to be enjoying the use of VLEs and this was accompanied by positive attitudes towards the subject. Students appreciated taking control of their learning and also enjoyed the resources made available through the VLE and the interactions they had with fellow students and their teachers online.

All the teachers involved in the study who were using clickers stated that students enjoyed science lessons where they used clickers. Earlier on, in the discussion of question 3, it was also shown that most of the students enjoyed lessons where clickers were used more than the regular science lessons (where no clickers were used). Some teachers argued that if you enjoy something you tend to remember it, hence, referring to the impact of clickers on knowledge retention, for instance, they argued that although it is difficult to measure this directly, it can be extrapolated that the use of clickers helps students to remember taught content more. One of the teachers clarified this, as shown in the preceding chapter, by arguing that if students enjoy the clickers, their enjoyment adds on to the positive feelings towards the subject, so a 'knock on effect' (CW-26). These findings resonate with what Fies & Marshall (2006) found out in their comprehensive review of literature; they identified indications of greater student engagement, increased student understanding of complex subject matter, increased student interest and enjoyment, among others, when EVSs are used.

5.4.5. Development of critical thinking skills

It was felt among the teachers who were using the clickers that this technology has the potential to be used to develop students' critical thinking skills. Bergtrom (2006) identified EVSs as interactive and learner-centred devices and reported that they may be particularly useful in enabling critical thinking. The capacity of the EVSs to develop such skills is dependent on the way teachers design the questions used during the class activities (Bruff, 2009). Most of the EVSs used multiple choice question formats which make it easy for teachers to be tempted to use simple factual recall questions. As the teachers argued, if one is creative enough, the multiple choice format cannot be seen as a hindrance to the designing of questions that promote the development of critical thinking skills. Development of such questions need time while it emerged from the present study that most teachers were limited in their use of the new technology because they did not have time to learn how to use them or to prepare the learning resources. The problem of time is not unique to these particular technologies but it remains a challenge for the uptake of any innovative technology in schools. In my view, given time and commitment, teachers can make use of both VLEs and EVSs to develop critical thinking skills among their students.

Summary

The use of VLEs and EVSs resulted in students enjoying and engaging with the subject more and this was helping to improve students' performance. It was, however, difficult for all teachers to establish a way of measuring quantitatively the impact of using these technologies on students' academic performance. The difficulty lies in that these technologies were not being used as standalone strategies; instead they were being used as part of a range of strategies to enhance students' learning experiences. How to evaluate the outcomes of VLEs and EVSs is an issue that remains open to debate. In my view, as indicated earlier on, it is difficult to measure the impact of these technologies on students' performance objectively and the findings from this study support this. Each of these technologies can be viewed as a contributing factor to the overall improvement of students' academic performance, as argued by Josephine referring to the impact of clickers on students' performance: 'my hunch is they engage well with it, they enjoy it, they will, therefore, remember some elements more successfully than others and that will be beneficial somehow in the big picture' (JH-82).

CHAPTER 6: CONCLUSIONS AND IMPLICATIONS

6.1. Introduction

This chapter provides a summary of some of the important conclusions I drew from my study. In addition to this, I will highlight the educational implications of the research findings including implications for further research. The conclusions from the main findings of the study are framed in terms of areas corresponding to the four research questions.

6.2. Adoption and implementation of VLEs and EVSs

My study showed that VLEs and EVSs are relatively new and rapidly growing technologies in participating secondary schools. Their introduction and use is a cultural change for the teachers and students. Most of the teachers in the study reported to have started using these technologies less than five years ago. In most cases only the 'early adopters' (Rogers, 1983) were making use of these technologies in the schools studied. Teachers' interviews confirmed that the adoption of the new technologies (either a VLE or an EVS) was motivated by the desire to enhance their teaching and students' learning experience, in line with the learner-centred approach. Educational conferences and educational shows were shown to be important catalysts for the sharing of good practice which subsequently led to the uptake of new technologies by teachers. Other important factors in the adoption and implementation of new technologies included positive government policies towards use of new technologies in educational institutions, availability of funds and teacher assertiveness.

Focusing on the implementation of the innovations, there appeared to be a host of factors that were influential. My study revealed the importance of an enthusiastic leadership in the adoption and successful implementation of an innovation. The Midshire VLE project appears to have lacked leadership from the onset and it failed to get institutionalised. Elsewhere, in the two centres of good practice in the study, it was clearly indicated by the teachers I talked to that the use of VLEs was a great success partly because of the leadership. An enthusiastic leadership has the potential to bring about the much needed cultural change and to support teachers to make consistent use of the new technologies. Apart from the school leadership, the findings from my study showed that individual teachers' assertiveness plays a significant role in the uptake and successful implementation of an innovation. For instance, teachers who were using EVSs in all the participating schools were not being motivated by the school leadership; the use of the technology was their individual decision. Of course the school management supported them by making funds available for purchasing the equipment and software.

One of the most important findings from the study was the important role of staff development in facilitating the adoption and subsequent use of the technology. New technologies call for the development of new skills by the teachers if they are to use them effectively in the classroom. Teachers who were using EVSs reiterated the need to understand the software to maximise its use in the classroom. On the other hand, teachers on the Midshire VLE project had to abandon the use of the learning platform, in part, due to lack of knowledge and skills needed to use the technology. In schools where teachers received staff development prior to adoption of the innovation and continuous professional development like the centres of good practice, in Southampton and Midshire South, the technologies were being used more effectively. Refresher staff development sessions can be helpful as they help experienced staff to maintain interest with the use of the technology and also help new staff to adopt and use the new technologies. From the interviews with teachers it emerged that teachers needed to be given time for staff development. A school in Midshire South was using incentives to encourage teachers to participate actively in staff development sessions and this helped a lot in terms of encouraging consistent and effective use of new technologies in the school.

In addition to leadership enthusiasm and staff development, my study showed that technical constraints have the potential to undermine the pedagogical value of the technology. In a nutshell, use of new technologies requires the availability of technical support. Teachers need to develop the skills to use the technologies with confidence in the classrooms and technical support can be a key to this. Teachers on the Midshire VLE project faced some technical problems including failure to upload the learning materials on the VLE and this, among other factors, frustrated them, and contributed to their subsequent abandonment of the project despite having shown interest in it. On the other hand, a school in Southampton which had a team of IT programmers provided enough technical support to all teachers and this maximised the use of the technology in the school. Teachers using EVSs had no technical support from the school and this affected the frequency of use of the technology. Teachers who could not keep up with the ever changing technologies chose to drop their use but this could be avoided by ensuring adequate technical support is made available.

6.3. Impact of innovations on teachers' ideas about teaching and assessment of science

The study indicated that teachers were using the innovations differently. VLEs provided the opportunity for a wide variety of resources to be placed on the learning platform but that relied heavily on the expertise and knowledge of the teacher. The VLEs were being used mainly for administering homework and as repositories and for sharing resources among staff. The four schools in the Midshire VLE project wanted to extend the use of VLEs to teach a complete science topic through the learning platform but this was unsuccessful. The teachers, however, conceded that the VLEs have huge potential if well designed. Even in the schools that were considered by BECTA to be centres of good practice, VLEs were used to complement face-to-face sessions, not to substitute them or the teacher. Teachers appreciated the role that VLEs play in facilitating student-centred, learning citing the shift of the power dynamics in education with students being able to learn in their own space and at their own pace. Some of the teachers were uncomfortable with the altering of power dynamics; they were not confident that their students would spend enough time interacting with learning material and other students online. The impact of examinations was discernible; teachers who abandoned the VLE lessons in Midshire feared that students were not getting the needed preparation for examinations from the VLE, which they felt was not well designed. Effective use of the VLEs was shown to involve teacher competence and self confidence. Use of VLEs has the potential to be exclusive especially if schools do not put in place measures to help students with no broadband access at home. Generally teachers who were using the VLEs felt that the technology supported the notion of independent learning. The teachers did not think that the technology had changed their ideas of teaching in any dramatic way; they argued that they had always acted as facilitators in the classroom. However, the study showed that, although the teachers continued to act as facilitators, with the use of VLEs they were now facilitating at individual level rather than group level. VLEs made it possible for the teachers to attend more to the individual students' needs. The failure of the Midshire VLE project to get institutionalised meant that efforts to teach a full topic online remain an area in need of further exploration at secondary school level.

Teachers who were using EVSs used them differently. They were adopted by teachers who used interactive teaching styles as they facilitated active student participation and collaboration in class. Like the VLEs, the EVSs were not being used as a standalone strategy but to complement other strategies employed by the teachers. Most of the participating schools had EVSs that could only use multiple choice questions format but teachers did not see this as a limitation; they argued that they could still ask questions that help students to develop critical thinking skills. It was argued that it is not the technology but the teachers' ability to design challenging questions that was important. The development of critical thinking skills is dependent on the nature of the questions and not the format of the questions. Teachers were happy to embrace the use of EVSs because they facilitated interactivity in the classrooms. Teachers felt that the use of EVSs helped them to appreciate the importance of inclusivity resulting in use of more interactive methods even in lessons where EVSs were not being used. The technology was hailed for enabling teachers to reinforce practice that they had always believed about teaching. Use of clickers helped teachers to assess their students more frequently providing immediate feedback. The study showed that teachers using EVSs were able to make use of diagnostic assessment which made it possible to adjust their teaching to address the needs of students in a lesson ('contingency teaching'). The technology also proved useful to teachers by enabling them to provide student feedback and save time they would normally use for marking.

6.4. Students' perceptions of the value of using VLEs and EVSs in the science classrooms

My study showed that students are not passive recipients of any technology brought into the classroom by the teacher. It was evidently clear from the study that students' perceptions of the value of technology being used in the classroom influence the success or failure of the technology to get institutionalised.

The use of VLEs to provide learning material for the whole topic generated mixed feelings among the students. Students who were positive about the use of VLEs argued that they were independent learners so they enjoyed being in control of their learning. VLEs enabled them to learn flexibly, that is, they could learn at their own pace, in their own time and without having to compete, as they felt is usually the case in teacher-led sessions. VLEs were thought to be more interactive compared to teacher-led lessons where students felt that they spend most of their time either writing or reading from textbooks. VLEs support various types of interaction such as learner-content, learner-learner, and learner-teacher (Chou, 2003; Moore, 1989). These types of interaction make the learning process more interactive and the learners more active and engaged. There was a feeling among students who favoured VLE lessons that teacher-led lessons can be boring especially when the teacher does not seem to attend to the needs of every learner. Contrary to this, students who disliked

VLE lessons felt that they cannot learn much from the computer as they lose concentration easily and need a teacher to keep them on track. It was also evident that the VLE lessons they had were not designed very well, as some of them indicated lack of interactivity with the teacher and among themselves as being one of the reasons for disliking the use of the technology. If the VLE is not designed properly to include essential communication features to enable students to interact and share ideas, it discourages them from appreciating its pedagogical value. From the schools where VLEs were being used successfully, teachers indicated that students were generally positive about their use. It was observed that younger students, year 7 and year 8, tended to enjoy the use of VLEs more than year 10 and year 11 students. These differences could be a result of the fact that VLE use will still be relatively new to the younger students whereas the older groups would have seen more resources online than what would be offered through the VLEs by the teachers. I think it is important for teachers to bear these differences in mind when they design and prepare learning materials for use on the VLE in order for them to keep students engaged.

Generally, EVSs were perceived very positively by students of all age groups and both genders. They felt that the technology enabled them to participate actively in class. This was encouraged by anonymous participation. Students enjoyed lessons more when using EVSs than without them; however, it appears it was a difficult task for students to determine the impact of clickers on their knowledge retention capacity. As argued in chapter 5, EVSs were not being used as a standalone strategy; hence, it was difficult for students to assess their impact on knowledge retention. It could, however, be extrapolated that if students were enjoying and engaging more in lessons where EVSs were being used, then this should have helped them to understand the content more, thereby enhancing their academic performance. One of the celebrated advantages for using the EVSs by the students was the ease of using the clickers. Students appear not to have struggled with the technology. With the majority of students indicating that they were not happy with science lessons where EVSs were not used, it raises concern that most of the regular science lessons in participating schools might not be appealing to most of the students. It appears that teachers need to think seriously about incorporating the use of these new technologies in classrooms to maintain students' interest in learning the subject. Most of the students enjoyed use of EVSs as they liked to compete with each other for correct answers during lessons. Most of the students also cited that holding discussions with their friends helped them to understand course content more. The study showed that students felt happy to be on the cutting edge of technology with the use of EVSs. One of the most celebrated advantages of using EVSs was the provision of instant feedback to students. Having immediate feedback helped students to attend to their learning needs during lessons thereby enhancing their overall learning experience. In the same way as use of VLEs, students felt that the use of EVSs gave them control over their learning. On the other hand, use of EVSs was criticised by other students who did not enjoy the idea of competing in the classroom. The clickers were also criticised for being unreliable sometimes and some students complained that they did not cover much content during lessons where clickers were used. It appears that setting up the system can be time consuming and in addition to this, some students did not seem to enjoy the distraction caused by clickers especially when other students got overexcited during lessons. Students with spelling difficulties were not very happy with the use of EVSs especially when they had to type answers.

6.5. Observable indicators of the impact of using VLEs and EVSs on students' academic performance

Teacher interviews showed that both VLEs and EVSs were not used as standalone strategies; it was, therefore, impossible to demonstrate causal connections with learning outcomes. This seems to be in line with Newhouse's (2002) observation that while it would be convenient to be able to make a direct connection between the use of ICT and learning outcomes, most reputable educational researchers would agree that there will never be a direct link because learning is mediated through the learning environment and ICT is only one element of that environment. It is impossible to entirely control the effects of other elements of the learning environment. Although it was difficult to ascertain direct links of the impact of these two technologies on students' academic performance, it was possible to identify some indirect indicators of improvement of students' performance.

Interviews of teachers from schools where VLEs were being used successfully indicated positive gains particularly in relation to students' motivation and participation in learning using VLEs. The same views were echoed by both teachers and students who were using EVSs. ICT use has been shown to provide opportunities for both engaging students and motivating an engagement in subject learning (DFES, 2003). Use of these two technologies was shown to encourage self directed learning, which is one of the important educational goals. Students who considered themselves to be dependent learners were negative about the use of VLEs, however, as one of the teachers from Southampton said, a properly designed VLE can help to develop such students to become self directed learners. It is vitally important for schools to contribute to the development of such skills because this is basically what learners need in order to be effective in society. Pupils gain increasing independence, as VLEs provide a scaffold to enable them to engage in learning without direct supervision from the teacher. Increased independence should result in greater performance as the opportunities to achieve are much wider. Another key aspect of the responses from teachers and students is the level of engagement in learning activities. Students who interacted with well designed VLEs were reported to have enjoyed access to more learning resources and the interactions they had with their teachers and other students as they discussed their work online. The provision of immediate feedback and competition with their colleagues when using EVSs raised most students' enthusiasm and motivation to engage with the learning material resulting in enhanced student learning experience. Generally, it is difficult to allow students to be sufficiently active as participants in regular classroom situations. Typically most students are passive, as one student said in my study, 'spending a lot of time listening, writing or reading'. If students are interested in what they are doing, they are more likely to be attentive and will normally achieve a wide range of learning outcomes if engaged actively in lessons. Most of the students liked the use of VLEs and the EVSs and this helped them to enjoy science lessons more than they did when they had regular science lessons. For instance, the majority of students clearly indicated that they preferred lessons where EVSs were used. The generation of students in schools, called the 'digital natives' (Prensky, 2001) are used to interacting with technology in their everyday life, therefore, they tend to enjoy it when science lessons at school (this may apply to other subjects too) resonate with their daily life experiences. My study showed that there is increased student attentiveness in class when they are using new technologies, for example, EVSs. If students can be alert, paying attention and participating actively during the lessons, it can be argued that their performance is likely to be enhanced. Depending on the nature of activities designed by the teacher either through the VLE or the EVSs, the study showed that there is potential for students to develop critical thinking skills. The teacher and not the technology is shown to play a crucial role in creating an enabling environment for the students to benefit from the use of the technologies. This highlights the importance of staff development for the teachers to ensure that they learn necessary skills to use the technology effectively.

6.6. Implications of the study findings

Historically, education has not got a good record for embracing new technologies (Cuban, 1986). However, the two technologies in my study were shown to be of great potential value to teaching and assessment of students. Teachers who participated in my study were the technologically motivated ones, hence, it may be unsurprising that they were mainly positive about the technologies they were using. It would be worthwhile to consider how the use of these technologies can be expanded in schools to ensure their uptake and use by those teachers who are not actively engaging with new technologies. In the following section I will consider ways in which the use of these new technologies can be expanded in light of the current budgetary constraints that schools are facing.

6.6.1. Future directions for VLEs and EVSs in secondary schools

Given the potential pedagogical value of VLEs and EVSs as shown by my study findings, I think it will be a worthwhile investment for their use to become more deeply embedded in schools. From the findings of my study, staff development and provision of technical support have been shown to be critical for the successful implementation of these innovative technologies. In terms of staff development, one possible way of enabling teachers to develop the needed skills to make use of these technologies is to introduce their use during Initial Teacher Education (ITE) programmes. Unlike schools, universities are better placed in terms of resources, to acquire and make use of these technologies. If teachers are exposed to the use of these new and innovative technologies during their preparation, it will be relatively easier for them to use the technologies in schools. I think universities need to play a bigger role in promoting the use of these innovative technologies. BECTA used to be responsible for promoting the use of ICTs in schools but at the moment the guiding hand of BECTA is no more. I think universities can be helpful. Through early introduction to teachers of the use of new technologies during ITE, the technology may expand in schools. In my own university (University of Sheffield), I am aware that all PGCE science students are exposed to the use of EVSs and this is helping greatly to bring awareness of the value of this technology to teaching and learning and it will be easier for these teachers to embrace these new technologies in their schools when they start working.

6.6.2 Implications of study findings to science teachers

It is my hope that my analysis and interpretation of the findings of my study could inspire science teachers in schools including teachers of other subjects to reflect upon their teaching and be encouraged to embrace new technologies such as VLEs and EVSs to enhance their students' learning experiences. While VLEs are currently available in schools, their use remains limited yet they have potential to produce significant learning gains if systematically and imaginatively utilised.

6.6.3. Implications for policy makers

My study helped to show that well designed VLEs and the use of EVSs have potential to enhance teaching and learning. Policy makers can use these findings to identify areas for potential future investments aimed at raising standards in schools. Investment should not be directed exclusively towards hardware; my study highlights the essential elements of professional development and technical support for successful utilisation of educational technology.

6.6.4. Implications for vendors

Manufacturers of these new technologies may wish to consider the comments made by the teachers and students regarding the use of these new technologies. This includes the time it takes for the teachers to understand the software and to produce resources. They may find the feedback useful in terms of making improvements to their products.

6.6.5. Implications for further research

In the course of my study, a number of possible lines of further enquiry have emerged. The following are some of my suggestions for possible future studies:

- My study involved working with highly motivated teachers in terms of technology use and it showed that there are some learning gains derived from the use of these technologies. It might be worth conducting a study over a long time to see if the apparent learning gains are sustained over time. Identifying what constitutes good practice and examples of effective contexts for the use of VLEs and EVSs would prove of value to teachers who might want to start using the technology in a similar way.

- It might be interesting to explore the use of these new technologies to support teaching and learning of students with special education needs, an aspect which was not covered in my study. It can be interesting to explore the potential benefits of using technologies such as VLEs and EVSs with students with some special education needs. I read a teacher's account (from Singapore) of her use of a clickers to help students with ADHD to participate more easily in class. I have also read an article talking about the use of a VLE to support dyslexic students. All these are areas of potential development.
- While my study provided some evidence of learning gains as a result of using VLEs and EVSs, by focusing mainly on the teachers and students' experiences, there are opportunities to explore the possibilities of evaluating the impact of these technologies on student learning quantitatively. A similar study to mine but on a bigger scale to allow for broad generalisations to be made would be useful. The findings from my study provide useful insights into the introduction and use of new technologies (VLEs and EVSs) in science classrooms, however, it would be unreasonable to generalise from them.
- In a similar study to mine, Chi-Square test (a non-parametric statistical test) could be used to test whether there is any statistically significant difference between the perceptions of boys and girls towards the use of new technologies.

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APPENDICES

Appendix 1: Questionnaire for students on the VLE Project

Thank you for taking part in this important **University of Sheffield** survey!

I am interested in your views about learning in science using computers and the internet. The survey questions on the next page are a set of statements. You are asked to say how strongly you agree or disagree with these statements. You can answer by putting an **X** in one of the boxes next to each question. To make the survey safe for everybody I will not use your real names in any part of the project.

How to fill in your answersKey: SD-strongly disagree, D-disagree, N-neutral, A-agree, SA-strongly agree, P-pass (not clear/doesn't apply)

So if you think the answer to Q1 is "Agree", put **X** in the 'Agree' box like this:

	Statement	SD	D	N	A	SA	P
1	I liked the lesson because it was fun				**X**		

If you are not clear about what to do please ask your teacher or myself for help.

If you make a mistake delete the cross and mark another box. Make sure that it does not look like you have two boxes for one question.

Please answer all questions.

Key: SD-strongly disagree, D-disagree, N-neutral, A- agree, SA-strongly agree, P-pass (not clear/doesn't apply)

	Statement	SD	D	N	A	SA	P
1	I liked the lesson because it was fun						
2	I knew enough about computers/internet for this lesson						
3	I would take another computer/internet lesson if it were offered						
4	I am not satisfied with my use of computers/internet in this science lesson						
5	I like reading books better than online texts						
6	Reading online took more time than reading from a paper						
7	I could concentrate on the texts when reading online						
8	Reading texts online was easy						
9	I needed the teacher's help to understand the texts properly						
10	I often felt the need for face to face communication with the teacher during the						
11	I felt comfortable asking questions online						
12	I was able to learn at my own pace more during the lesson						
13	I enjoyed sharing ideas with my friends through the chat forums						
14	Working with a computer/internet made me feel as though I am in control						
15	Computer/internet use made learning easier						
16	I felt a sense of achievement in this lesson						
17	Working with a computer/internet made me feel tired and exhausted						
18	Working with a computer/internet made me feel angry						
19	I believe that the more teachers use computers/internet the more I will enjoy						
20	I would work harder if I could use computers/internet more often						
21	I can learn many things when I use a computer/internet						
22	It was easy to get help from friends in this lesson						

1. What did you like most about using computers /internet today?

2. Is there anything you disliked about use of computers /internet in the lesson?

3. Is there anything else you'd like to tell me about your use of computers /internet in the lesson?

Thank you very much for your thoughts!

Appendix 2: Interview questions for teachers using VLEs

1. What were the circumstances which led to the adoption of a VLE use in science lessons in your department?
2. How did you get involved?
3. Did you feel adequately prepared to use a VLE in your teaching?
4. Did you at any point feel the need for in-service training in the use of a VLE? If so, what areas do you feel you needed more training?
5. Did the attempt to use a VLE present any new challenges in your role as a teacher? If so, can you identify any particular challenges faced?
6. What do you perceive as any weaknesses in the way in which a VLE was being implemented in your school?
7. From your experience with a VLE, are there any perceived advantages of using a VLE over the traditional approach?
8. Do you think some topics are difficult to teach using a VLE? What experience did you get from preparing to teach aspects of “Behaviour in humans and other animals” using a VLE?
9. Why did you decide to abandon the use of a VLE on this occasion?
10. How best do you think the use of this innovative approach to teaching and learning can be improved?
11. Is there anything else that I have left out that you think can be useful?

Appendix 3: Interview questions for teachers using EVSs

1. When did you start using clickers in your science lessons? Whose initiative was it? Were you consulted when the decision to choose the particular brand of clickers you are using was made?
2. What are some important factors to consider when choosing a particular brand of clickers?
3. How much time did it take you to learn to use the clickers? Who provided the initial and ongoing support?
4. What are your personal reasons for adopting the use of clickers in the class?
5. How much time is required on a daily basis to prepare to use clickers in a class session? Is your use of clickers pre-planned or spontaneous?
6. Where do you find clicker questions for use in your teaching? What type of questions do you make use of when using clickers in your lessons?
7. Given that having students respond to and discuss clicker questions takes class time, do you as a teacher using clickers find it difficult to include as much content in your lessons as you would without clickers?
8. How much time do you give students to submit their answers to a clicker question?
9. At what point do you use clickers in a lesson?
10. Is there anything new that you have started doing in your teaching and assessment of the subject as a result of using clickers?
11. Most students find science very challenging, did you notice any changes in students' attitude towards the subject as a result of using clickers in your lessons? Is there evidence of high motivation, interest in the subject?
12. Have you been able to assess the impact of clickers on students' knowledge retention? What are the results?
13. Do you think the use of clickers in your lessons helps to improve students' academic performance/ achievement? What makes you think that?
14. How do students respond to use of clickers in your lessons? What do they typically appreciate about clickers? What do they not appreciate?
15. Are there any problems that you have encountered with the use of clickers in your teaching and assessment of the subject? How do you deal with technical difficulties that arise in the classroom?
16. From your experience, how can a teacher interested in using clickers for the first time get started?
17. Is there anything else that I have left out that you think can be useful concerning the use of clickers in the classroom?

Appendix 4: Interview questions for students who had VLE lessons

1. What do you think about using computers in lessons?
2. What did you think about the VLE lessons?
3. If a close friend of yours was about to choose between a VLE module and a traditional module what advice would you give them?
4. What makes you say that – what are the differences between the two types of lesson?
5. Do you think the VLE lessons helped you prepare for examinations better, worse, or the same compared to teacher-led lessons?
6. Would you say that science lessons are more or less interesting when they are led by the teacher, compared with VLE lessons?
7. Did you manage to access the VLE lessons whilst at home?
8. Do you feel the teacher provided enough support for you to manage VLE lessons on your own?
9. Would you be happy to try VLE lessons with other science topics?
10. Is there anything that you would want to see changed for VLE lessons to be more helpful and more enjoyable?
11. What would you say was the main reason for abandoning the use of VLE lessons in the topic “Behaviour in humans and other animals”?

Appendix 5: Interview questions for Midshire LA Science Consultant

1. What are the circumstances which led the LEA to decide to promote the use of a VLE in the schools? Did you have funding for new projects? Government policy? What were your expectations?
2. How were the participating schools identified? Any statistics/log tables to show position of these schools?
3. What kind of support was put in place for the participating schools? Were there any incentives for the participating staff? Is there anything you think could have been done differently?
4. How did you monitor the progress taking place in schools?
5. What do you think contributed to the failure of this project to take root in the participating schools?
6. From here where do you go? What is the next step for the LEA? Will you try this elsewhere?
7. Is there anything else that I have left out that you think can be useful?

Appendix 6: Interview questions for education professional from Singapore

1. What is your job title?
2. What does the job involve?
3. How widespread is the use of new technologies in schools in Singapore? Science classrooms?
4. What type of a VLE are you using? Is it an open source? Why did you choose that?
5. What are the circumstances which led to the adoption of a VLE usage in your department? Whose initiative was it? How did you get involved?
6. Did you have any staff development?
7. What was the response of the students? Other staff members?
8. How do you evaluate the use of a VLE in your institution?
9. What do you think makes you successful?
10. What has been the students' attitude towards use of a VLE by the tutors?
11. How do tutors deal with less independent students?
12. Do you think home access to a broadband is an issue?
13. How do tutors manage assignments especially with students without access to broadband at home?
14. If students use library, has this necessitated any logistical changes?
15. What advice would you give to a science department wishing to start using a VLE?
16. Is there anything else that I have left out that you think can be useful?

Appendix 7: Interview questions for teachers using VLEs in centres identified by BECTA as being centres of good practice

1. What are the circumstances which led to the adoption of a VLE usage in science lessons? School initiative or LEA? When was that? Which groups? How did you decide this? How did you get involved? Did you get any training? Name of the VLE in use? Why did you choose that? What was the response of the students? How did you assess their reactions?
2. How widespread is the use of VLE in your Department? School?
3. Are there any problems that you have faced with the use of a VLE in your lessons? How did you solve them?
4. I have been given your school name because you are known to be successful with the use of a VLE, why do you think you have become known as being successful?
5. If you were planning/scheming work for September. How do you decide whether or when to use a VLE?
6. Have you found usage of a VLE in your assessment of children's learning?
7. Are there any specific topics/activities that have turned out to be easier with a VLE?
8. What has been the students' attitude towards use of a VLE in your lessons?
9. How do you deal with less independent students?
10. Do you think home access to broadband is an issue?
11. How do you manage homework especially with students without access to broadband at home? If students use library, has that necessitated any logistical changes?
12. What advice would you give to a science department wishing to start using a VLE?
13. Is there anything else that I have left out that you think can be useful?

Appendix 8: Questionnaire for students using Electronic Voting Systems

Thank you for taking part in this important **University of Sheffield** survey!

I am interested in your views about learning in science using clickers. The survey questions on the next page are a set of statements. You are asked to say how strongly you agree or disagree with these statements. You can answer by putting an **X** in one of the boxes next to each question. To make the survey safe for everybody I will not use your real names in any part of the project.

How to fill in your answers

Key: SD-strongly disagree, D-disagree, N-neutral, A-agree, SA-strongly agree, P-pass (not clear/doesn't apply)

So if you think the answer to Q1 is "Agree", put **X** in the 'Agree' box like this:

	Statement	SD	D	N	A	SA	P
1	I liked the lesson because it was fun				**X**		

If you are not clear about what to do please ask your teacher or myself for help.

If you make a mistake delete the cross and mark another box. Make sure that it does not look like you have two boxes for one question.

Please answer all questions.

Key: SD-strongly disagree, D-disagree, N-neutral, A- agree, SA-strongly agree, P-pass (not clear/doesn't apply)

	Statement	SD	D	N	A	SA	P
1	I like using clickers because they make science lessons fun						
2	I know enough about using clickers for the science lessons						
3	I would take more science lessons involving use of clickers if they were offered						
4	I am not satisfied with my use of clickers in science lessons						
5	I like lessons where we do not use clickers better than those involving use of						
6	I need the teacher's help to understand the use of clickers						
7	I enjoy competing with my friends for correct answers when using clickers						
8	I often feel the need for more time to respond to questions when using clickers in						
9	Discussing clicker questions with other students helps me understand course						
10	I feel comfortable when my name is not shown against my responses to questions						
11	I remember things more when I use clickers in the lesson						
12	I am unable to learn at my own pace during science lessons where clickers are						
13	Clickers have helped me to learn more from my friends						
14	Using clickers makes me feel as though I am in control						
15	I would love it if clickers were to be used in all subjects in the school						
16	I always have a sense of achievement in lessons where we use clickers						
17	Clicker questions make class more lively and engaging						
18	Using clickers makes me feel angry						
19	I believe that the more teachers use clickers the more I will enjoy science						
20	I would work harder if I could use clickers more often						
21	I can participate more when I use clickers						
22	Clickers help my teacher focus attention on things we don't understand						

1. What do you like most about using clickers?

2. Is there anything you dislike about use of clickers in the science lessons?

3. Is there anything else you'd like to tell me about your use of clickers in the science lessons?

Thank you very much for your thoughts!

Appendix 9: Interview questions for VLEs Focus Groups

1. What did you think about the VLE lessons?

2. What did you like most about the VLE lessons?

3. What did you dislike about the VLE lessons?

4. What would you say was the main reason for abandoning the use of VLE lessons in the topic ‘Behaviour in Humans and other animals’?

5. Will you be happy to try VLE lessons with other science topics?

Appendix 10: Ethical approval letter

The University Of Sheffield.

FAO Gladson Chikwa

Head of School
Professor Peter Hannon

Department of Educational Studies
388 Glossop Road
Sheffield S10 2JA

Telephone: +44 (0114) 222 8088
Fax: +44 (0114) 279 6236
Email: c.m.gaffney@sheffield.ac.uk

21 May 2009

Dear Gladson

Phd Research Proposal:

Thank you for your application for ethical review for the above project. The reviewers have now considered this and have agreed that you can go ahead with your research project, with the following conditions:

............None ....

This is subject to receipt of a signed hard copy of Part B (Declaration) of the School of Education Research Ethics application form which is available at http://www.sheffield.ac.uk/education/ethics. This hard copy is then held on file and ensures that we comply with university requirements for signatures.

Yours sincerely

C M Gaffney

Chris Gaffney
Taught and research programmes manager

Appendix 11: Raw data generated from the questionnaire administered to 150 students who were using EVSs.

	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Q 13	Q 14	Q 15	Q 16	Q 17	Q 18	Q 19	Q 20	Q 21	Q 22
Sch F, Yr 7 Girls																						
STU1	4	4	3	1	3	1	3	1	4	5	4	1	3	3	5	4	3	1	3	3	3	4
STU2	3	4	4	3	3	3	5	5	4	5	2	1	3	4	1	3	3	3	2	3	3	4
STU3	4	4	3	1	3	1	3	1	4	4	4	1	3	4	5	3	2	2	3	3	3	3
STU4	5	5	3	2	2	1	4	2	4	4	3	2	3	3	5	4	3	1	3	3	4	4
STU5	3	4	3	2	3	2	2	6	6	4	4	6	3	3	3	3	4	1	6	6	4	4
STU6	4	5	4	3	3	1	5	4	1	5	3	4	2	3	3	2	2	2	3	3	4	5
STU7	4	5	2	2	3	1	1	2	1	2	4	2	2	5	3	4	2	1	2	2	4	5
STU8	3	5	2	3	4	1	3	3	3	4	2	1	4	1	3	2	2	3	3	2	2	4
STU9	4	4	3	2	2	2	5	3	4	4	5	2	3	3	5	3	4	2	5	3	6	5
STU10	2	5	2	6	4	1	3	4	6	4	2	2	1	6	2	3	2	6	2	1	3	6
STU11	4	3	3	2	3	1	6	3	1	3	3	6	3	6	3	6	6	6	6	3	3	6
STU12	2	4	4	2	3	1	3	5	4	5	2	2	5	4	5	3	4	2	4	3	6	4
STU13	3	5	2	1	3	1	5	3	3	5	2	2	4	2	3	2	2	2	2	2	2	4
STU14	4	5	4	1	3	1	4	2	5	5	5	1	3	3	4	5	4	1	3	3	4	3
Sch F, Yr 7Boys																						
STU15	4	3	3	2	3	2	4	2	3	4	3	2	4	3	2	3	3	1	3	3	6	4
STU16	4	3	4	2	3	2	4	2	4	3	4	2	4	3	2	3	4	1	3	3	6	4
STU17	5	4	5	2	2	2	4	2	3	4	4	2	3	4	4	3	2	1	3	3	6	4
STU18	4	4	5	1	2	1	5	2	6	3	5	1	5	4	5	5	4	1	5	5	4	5
STU19	4	4	5	1	2	1	5	2	6	3	5	1	5	4	5	5	4	1	5	5	4	5
STU20	5	5	5	1	3	1	4	2	5	3	5	2	4	5	5	5	4	1	4	4	4	4
STU21	5	5	4	1	1	2	3	2	3	3	4	1	2	4	5	4	3	1	4	4	5	6
STU22	4	5	2	3	2	2	3	2	4	1	3	2	4	3	5	4	3	1	3	3	3	4
STU23	5	5	3	4	4	1	4	5	4	5	3	6	3	3	1	2	3	3	1	2	1	2
STU24	4	4	3	2	2	2	4	2	4	1	3	2	2	2	5	4	3	3	3	3	6	6
STU25	4	6	4	3	3	2	4	3	4	6	4	3	5	3	4	6	2	1	6	6	6	6
STU26	4	5	3	1	2	1	5	2	3	1	4	3	4	4	5	3	3	6	4	3	3	4
STU27	5	5	5	2	4	3	5	3	4	5	6	3	4	6	5	3	6	4	3	5	4	6
STU28	4	5	2	2	4	1	3	1	5	1	5	1	1	1	1	4	5	1	1	1	1	1
STU29	4	5	2	2	1	1	3	1	3	1	5	1	3	4	4	5	2	1	5	3	4	5
Sch H,Yr 9 (boys and girls mixed)																						
STU30	5	5	5	1	1	1	5	3	4	4	4	3	4	4	5	4	3	1	3	2	3	2
STU31	5	5	5	5	1	1	5	2	5	1	3	2	3	4	5	3	3	1	3	3	5	2
STU32	4	4	3	2	2	2	5	5	5	4	3	4	3	5	4	2	2	2	3	3	2	4
STU33	5	5	4	3	3	5	5	4	5	4	3	3	3	2	5	4	3	1	5	4	3	2
STU34	4	4	4	2	2	2	4	4	3	6	4	2	6	6	4	3	4	2	4	4	4	4
STU35	5	5	5	1	1	1	5	1	5	3	5	1	4	5	5	5	5	1	5	5	5	5
STU36	5	5	4	4	2	2	5	3	4	4	3	2	4	5	4	5	4	1	4	4	5	4
STU37	4	4	6	2	6	2	1	5	4	5	2	4	2	2	3	6	2	6	1	2	2	2
STU38	5	4	4	1	1	1	4	2	4	5	4	4	3	4	5	4	4	1	5	3	5	3
STU39	2	2	4	4	4	3	1	1	3	6	1	3	2	4	4	2	3	4	3	4	3	5
STU40	5	4	5	1	1	1	5	5	5	5	4	2	1	3	5	3	5	1	5	2	5	3
STU41	5	4	5	2	2	1	4	2	4	5	3	2	4	2	4	5	3	6	4	3	5	4
STU42	5	4	5	4	1	2	5	4	5	5	5	2	5	3	5	3	5	1	5	4	5	2
STU43	5	5	5	1	1	1	5	2	4	4	3	2	4	3	5	4	3	2	4	4	4	5
STU44	4	4	4	2	2	2	4	3	3	3	2	3	5	4	4	4	5	1	4	5	5	4
STU45	4	3	4	3	3	2	3	3	4	5	4	3	3	3	5	4	4	2	4	4	5	3
STU46	4	3	4	2	3	2	3	3	4	4	3	2	3	3	3	3	4	1	5	3	3	2
STU47	4	4	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
STU48	3	4	3	3	4	2	2	5	2	5	2	4	2	2	3	2	2	1	1	1	3	1
STU49	4	4	4	2	2	2	4	4	3	3	4	2	4	2	3	4	4	2	4	4	4	3

STU50	5	4	5	2	2	2	4	4	4	5	4	2	3	3	4	4	4	1	5	3	5	3
STU51	3	4	4	3	4	1	2	2	2	2	1	2	2	1	1	1	1	5	1	1	1	1
STU52	5	6	2	2	3	1	5	1	4	4	3	2	2	3	2	4	3	1	2	2	2	4
STU53	5	4	3	3	1	1	5	1	5	3	5	2	5	5	5	5	5	1	5	5	5	5
STU54	5	5	5	2	1	2	5	3	3	4	4	1	4	4	5	4	5	1	5	4	4	5
STU55	5	5	5	1	1	1	5	1	5	5	5	1	5	5	5	5	5	1	5	5	5	5

Sch E, Yr 9 Teacher PC (Boys and girls mixed)

STU56	4	4	5	2	1	2	5	3	3	2	2	2	2	5	5	4	5	1	5	4	4	4
STU57	5	4	5	1	2	2	4	4	5	4	4	2	3	4	5	4	4	1	4	5	5	4
STU58	4	4	3	3	3	1	4	3	2	3	1	4	1	5	2	1	4	3	2	2	2	1
STU59	5	3	5	2	1	2	3	4	5	3	4											
STU60	5	4	3	2	3	2	4	2	4	2	4	4	2	3	2	2	4	4	2	3	4	2
STU61	3	4	4	2	2	1	4	2	4	2	4	2	3	4	4	4	4	1	4	3	4	2
STU62	3	4	4	2	4	1	4	2	3	3	3	3	2	2	4	4	3	1	4	3	4	4
STU63	5	3	5	2	2	1	5	1	5	2	5	2	4	3	4	4	5	2	5	5	5	3
STU64	5	6	5	4	6	4	3	6	4	3	4	3	4	4	4	4	4	1	4	5	5	4
STU65	5	6	5	5	6	1	5	5	5	3	5	1	5	5	5	5	5	1	3	5	5	5
STU66	5	4	5	4	1	2	5	2	3	3	4	1	3	4	5	4	5	1	5	5	4	5
STU67	4	4	3	2	2	1	3	2	3	4	4	2	3	3	3	4	4	1	3	4	4	3
STU68	5	6	4	1	2	2	6	3	3	1	3	1	3	4	3	4	4	1	3	3	3	3
STU69	4	3	4	2	2	2	3	3	4	2	3	2	3	4	4	5	5	1	5	4	4	4
STU70	4	2	3	3	2	2	4	3	4	3	4	2	3	2	5	4	4	1	5	5	5	4
STU71	5	6	5	1	1	2	5	2	5	2	3	4	3	3	5	4	5	1	5	5	4	3
STU72	4	5	5	4	1	1	5	2	3	3	4	2	3	4	5	4	5	1	5	5	5	5
STU73	5	2	5	2	3	4	4	3	3	3	4	3	3	5	5	3	4	2	4	5	5	5
STU74	5	4	5	1	1	2	5	4	4	4	4	2	6	4	5	6	6	1	4	6	4	5
STU75	5	4	5	1	1	2	4	4	4	4	4	2	6	4	4	6	5	2	4	6	4	4
STU76	5	4	3	6	2	2	4	3	6	6	3	3	3	6	4	3	4	1	4	3	4	6
STU77	5	4	5	4	1	3	5	4	5	5	4	2	4	5	5	5	4	5	5	4	4	5
STU78	4	5	5	4	1	1	4	2	3	2	4	1	3	4	5	4	4	1	4	5	4	4
STU79	4	4	5	1	1	2	5	4	4	5	4	4	5	3	4	4	4	4	4	4	4	4

Sch E, Yr 9 (Teacher MG)

Girls

STU80	4	4	4	2	2	2	3	2	6	2	4	2	3	6	3	3	3	2	4	3	4	3
STU81	5	4	5	2	2	2	4	3	4	1	4	2	4	4	4	4	4	2	5	5	4	3
STU82	5	5	5	1	1	1	5	4	5	3	3	3	4	4	5	3	4	1	5	4	5	4
STU83	4	4	5	2	2	2	4	3	3	3	4	3	3	3	4	4	4	2	3	4	4	3
STU84	5	4	5	1	1	2	4	3	3	3	4	2	6	3	5	4	4	2	4	4	5	3
STU85	4	4	4	2	1	2	4	3	4	3	3	2	3	4	4	4	3	1	3	3	3	4
STU86	4	4	3	3	6		4	4	4	3	1	5	3	3	3	3	2	3	2	2	2	1
STU87	5	4	5	6	1	2	4	6	3	3	4	2	4	4	5	4	4	2	5	6	4	4
STU88	4	4	3	2	2	3	4	4	6	3		3		3	4	3	6	2	3	3	3	3
STU89	5	4	4	1	3	2	5	4	5	4	5	3	5	5	5	5	4	1	4	5	4	4

Boys

STU90	5	4	5	1	1	2	5	3	4	3	5	2	5	5	5	5	4	1	4	4	5	4
STU91	4	4	4	3	3	2	4	4	3	3	3	3	4	4	4	4	3	2	4	4	4	4
STU92	5	4	3	2	1	1	4	3	3	3	3	2	4	3	3	3	4	2	4	4	4	4
STU93	5	5	5	1	1	1	5	1	5	1	5	1	5	5	5	5	5	1	5	5	5	5
STU94	5	4	4	2	1	2	3	2	3	3	4	1	3	3	5	3	3	2	4	4	3	2
STU95	4	4	3	1	2	1	4	4	3	3	5	4	6	3	5	4	4	1	4	4	5	3
STU96	5	4	6	2	1	3	4	3	4	2	6	2	3	4	5	4	4	6	5	4	4	3
STU97	5	4	5	3	6	1	5	4	2	4	3	6	4	4	5	4	3	1	5	4	4	5
STU98	5	4	3	4	3	3	4	4	3	3	4	3	2	2	4	2	1	4	3	3	3	3
STU99	5	5	5	5	2	1	5	3	5	1	4	1	4	4	4	4	4	1	3	4	4	4
STU100	5	3	5	4	1	1	5	3	4	1	5	1	4	4	5	5	5	1	5	5	5	4
STU101	5	5	5	1	1	1	5	3	4	3	4	1	4	5	5	5	5	1	5	5	5	5
STU102	5	4	3	2	2	1	5	4	4	2	4	2	4	4	3	4	5	1	5	6	5	4
STU103	4	4	2	3	2	2	4	3	4	3	2	3	4	4	4	3	2	1	4	1	4	3
STU104	5	5	5	1	2	1	5	1	5	1	4	1	5	5	5	5	5	1	5	5	5	4
STU105	5	4	5	2	2	2	5	3	4	3	4	2	4	4	5	4	4	1	5	4	5	4

STU106	5	4	5	2	2	2	5	3	4	3	4	2	4	4	5	4	4	1	5	4	5	4

Sch E, Yr 10 (Boys and girls mixed)

STU107	3	4	5	3	2	1	4	4	4	4	2	2	1	3	4	3	2	5	2	2	3	4
STU108	5	3	5		3	2	4	5	4	3	3	2	4	4	5	4	5	1	5	4	5	3
STU109	5	3	5	3	1	4	4	5	3	3	4	4	6	6	5	4	4	6	5	3	6	4
STU110	5	3	5	3	2	4	5	4	4	2	3	2	2	4	4	3	4	1	4	2	3	3
STU111	5	5	6	4	1	2	4	3	6	2	4	4	4	4	5	3	4	1	5	4	4	3
STU112	5	5	5	3	2	1	5	4	2	5	4	1	1	4	5	4	4	1	4	3	4	3
STU113	5	5	3	2	2	1	4	2	4	3	3	3	3	4	4	3	4	2	3	3	4	3
STU114	4	4	4	3	2	2	4	4	4	3	3	3	3	4	4	4	3	3	3	3	4	3
STU115	4	4	4	3	2	2	5	4	3	4	2	4	4	4	5	2	4	4	3	2	4	4
STU116	5	5	3	3	2	1	5	4	3	1	3	3	3	3	4	3	3	1	3	3	3	4
STU117	5	4	5	6	2	3	5	3	4	3	4	2	5	4	4	5	4	2	5	4	4	4
STU118	5	5	5	3	1	2	5	4	5	3	5	3	5	5	5	5	5	3	5	3	5	5
STU119	4	2	2	2	2	2	2	4	2	4	3	4	3	3	4	2	4	4	2	2	4	4
STU120	5	3	2	2	2	2	4	6	3	2	4	2	4	3	3	4	5	2	5	4	4	4
STU121	5	5	4	3	2	1	4	4	3	3	4	3	2	4	4	4	5	1	5	4	4	4
STU122	4	4	3	2	2	2	4	4	3	2	3	3	5	4	4	3	5	1	3	2	3	4
STU123	4	3	2	3	4	3	5	3	2	3	1	4	2	3	1	2	4	3	2	1	3	2
STU124	5	4	5	6	3	2	5	4	3	4	2	4	3	4	5	4	5	1	5	4	3	2
STU125	4	4	5	3	3	1	5	4	2	2	3	2	1	4	5	4	4	3	4	1	4	1
STU126	4	4	1	3	4	1	3	4	2	3	1	4	2	3	1	2	4	2	4	2	4	2
STU127	5	4	3	3	2	2	3	3	3	2	3	2	3	3	4	3	4	1	3	3	4	3
STU128	5	4	4	4	2	2	5	4	3	1	3	4	4	4	4	3	5	6	3	4	2	4
STU129	4	4	4	2	2	2	4	2	3	3	3	2	3	3	4	3	4	2	4	3	3	3
STU130	5	4	5	4	3	2	5	3	4	3	5	1	5	5	5	5	5	6	5	3	5	3

Sch E, Yr 12 (Boys and girls mixed)

STU131	5	5	5	1	3	2	4	2	3	3	4	2	4	5	5	4	5	1	4	5	5	4
STU132	5	4	4	2	3	2	3	2	3	3	3	2	3	2	3	2	5	2	3	3	4	2
STU133	5	4	5	5	2	4	4	3	4	5	4	3	3	3	5	4	4	3	4	3	4	4
STU134	5	5	5	2	2	2	4	2	4	4	3	2	2	3	4	3	5	1	4	3	4	4
STU135	5	4	4	6	2	3	4	3	4	4	3	2	4	4	4	4	5	1	4	3	5	4
STU136	4	4	4	2	3	2	4	3	3	3	3	3	3	4	4	4	4	2	3	4	4	4
STU137	5	5	2	2	1	4	4	2	3	3	4	2	3	4	4	3	4	3	3	2	3	4
STU138	5	5	4	1	3	1	3	1	4	3	3	2	4	5	4	3	4	5	3	2	4	4
STU139	4	4	4	4	3	2	4	2	3	3	3	3	3	3	4	4	4	1	3	3	4	4
STU140	4	4	4	3	3	2	4	4	4	4	4	3	3	2	4	4	4	2	3	3	4	4
STU141	5	4	5	1	1	1	3	2	4	4	3	2	3	3	4	3	5	1	4	3	4	4
STU142	5	5	2	3	3	1	3	1	2	2	2	2	2	3	4	2	4	1	2	2	2	3
STU143	5	4	5	1	1	1	4	1	5	5	5	1	4	4	5	5	5	1	5	4	4	5
STU144	4	4	4	2	3	2	3	2	2	3	2	2	2	2	2	2	4	2	3	2	4	4
STU145	4	4	3	2	3	2	3	2	4	3	2	2	2	2	2	2	4	1	6	2	3	2
STU146	5	5	5	1	1	1	4	2	4	3	4	2	4	3	5	4	5	1	4	3	4	4
STU147	5	5	5	2	2	2	4	2	3	1	4	1	2	2	3	3	4	1	3	3	4	5
STU148	4	4	3	2	3	1	4	3	3	3	4	3	3	4	4	4	5	2	3	3	2	4
STU149	4	4	4	3	3	2	4	2	3	6	3	3	2	3	3	4	4	3	3	4	4	2
STU150	5	4	5	1	1	3	3	2	4	4	3	2	3	3	3	2	4	1	3	3	2	5

Key

Strongly Disagree = 1
Disagree = 2
Neutral = 3
Agree = 4
Strongly Agree = 5
Pass (Not clear/doesn't apply) = 6
STU=Student