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Student Perceptions of ELMO Technology in a Physical Science Classroom

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STUDENT PERCEPTIONS OF ELMO TECHNOLOGY
IN A PHYSICAL SCIENCE CLASSROOM

A thesis submitted in partial fulfillment
of the requirements for the degree of
Masters of Education

By

PHILIP JAMES KIRBY

B.A. Integrated Science Education, Cedarville University, 2005

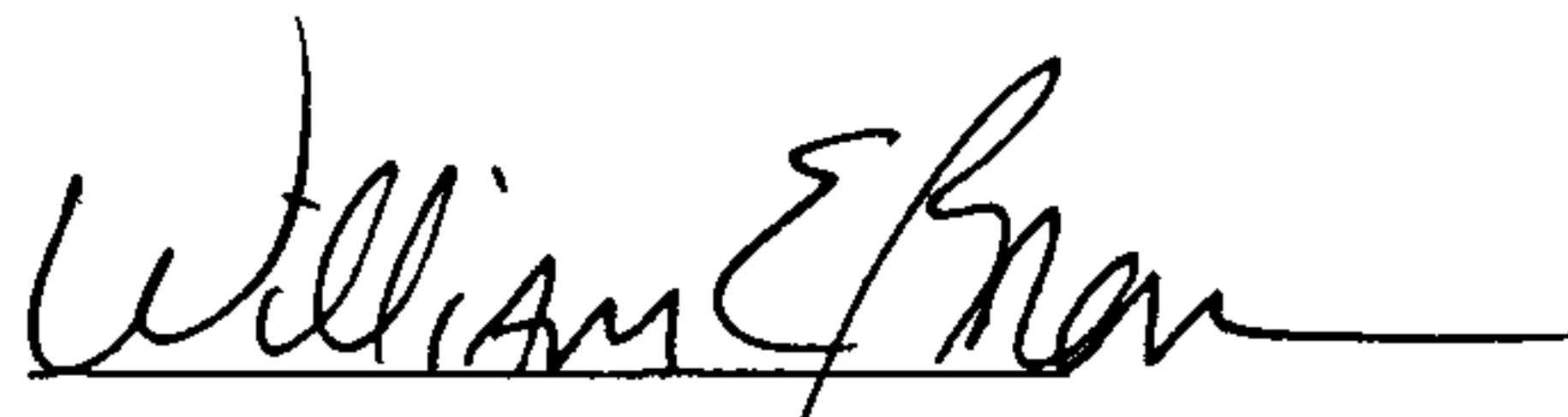
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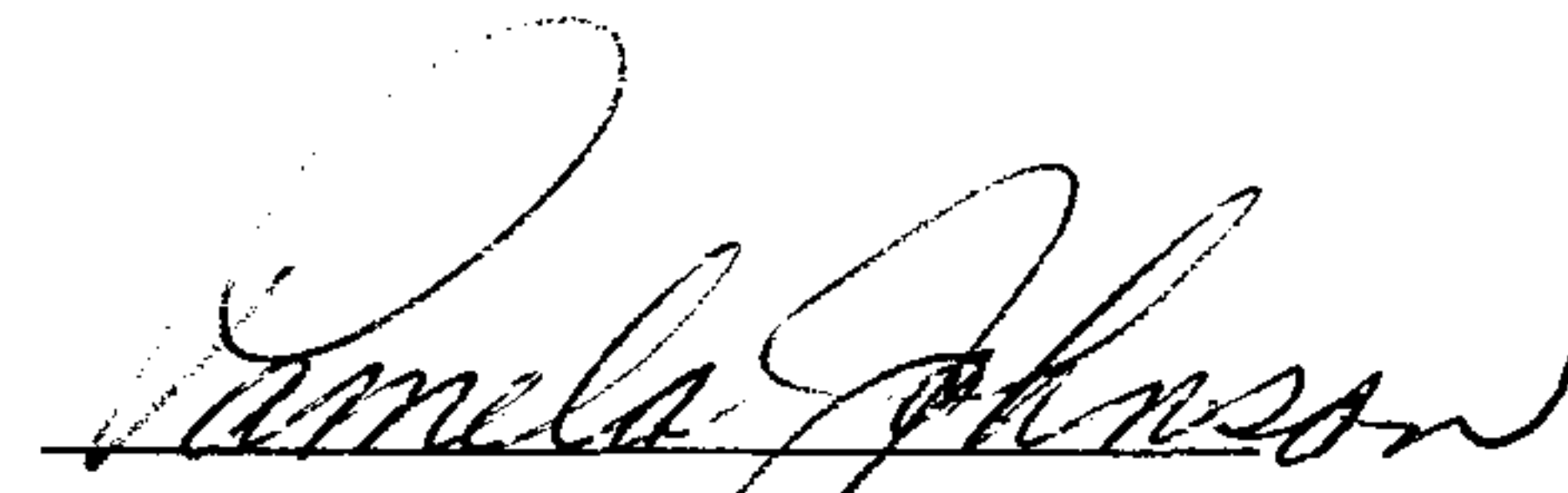
Cedarville University


CEDARVILLE UNIVERSITY
SCHOOL OF GRADUATE STUDIES

May 5, 2009

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Philip James Kirby ENTITLED Student Perceptions of ELMO Technology in a Physical Science Classroom BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF Master of Education.


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ABSTRACT

Kirby, Philip J. M.Ed., Education Department, Cedarville University, 2008. *Student Perceptions of ELMO Technology in a Physical Science Classroom.*

This qualitative study provides student perceptions of digital visual display camera (ELMO being the specific one) use in a secondary physical science classroom. The use of the ELMO was alternated with the overhead projector, using ABAB and BABA designs in two classrooms. The study was based on semi-structured interviews of fifty-six individuals, representing a sample of suburban, high school students. Interview questions focused on three constructs: benefits, limitations, and suggestions for improvement. Analyzing the results ascertained that students found the ELMO to be interesting because it was engaging and new technology. Students also reported the ELMO to improve instruction through enhanced visuals and notes. Limitations and areas for improvement also were noted. These results can be used to inform educators on possible applications of the ELMO's use.

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Chapter 1

Introduction

Educational technology has slowly filtered into American public school classrooms. Kleiner and Lewis (2003) reported a ratio of one computer used for instructional purposes for every five students in the U.S. Many schools have budgets and monies designated specifically for purchasing new and cutting-edge technology on a yearly basis. Integrating this technology into K-12 instruction has become a national imperative, initiated by *The No Child Left Behind Act* (2001). Although the act mandated the use of classroom technology, contemporary curricular materials sometimes do not harness technology's potential and teachers often do not appreciate their innovative applications (Lawrenz, Gravely, & Ooms, 2006).

Different kinds of technology exist in both the business and educational sectors of American society. Most technology found in the educational domain falls into the category of instructional and communicative technology (ICT). The computer is the starting point for ICT, yet any type of technology that enables the handling of information exists in this category (Orlikowski & Iacono, 2001). Examples include CD-ROMs, webquests, distance learning, and use of the Internet. ICT is visually evident in classrooms and multiple studies have evaluated the benefits, limitations, and uses of ICT.

Prominent use of ICT in classrooms leads to a necessary evaluation of its value (Williams, Coles, Wilson, Richardson, & Tuson, 2000). Problems have arisen in regard to this undertaking because few universal instruments designed to measure the value or the amount of technology integration exist. Further, the complexity of technology eliminates

the potential of using a single assessment tool for effectively measuring its usefulness (Hogarty, Lang, & Kromrey, 2003). Proctor, Watson, and Finger (2003) mention a similar concern, reporting that there is no shortage of ICT initiatives, but until a clear, more sophisticated definition of ICT arises, full integration of technology in the classroom likely will not be achieved.

Teachers, in general, express positive feelings toward technology integration in the classroom. Mueller, Wood, Willoughby, Ross, and Specht (2008) attribute this phenomenon to teachers typically being familiar with its use. They recognize the potential for technology to heighten engagement of students in instructional activities and to help solve complex problems (Bell & Garofalo, 2005). In addition, technology can be used in order to help support the visual learning strategies which have long been recognized as successful methods for helping students organize, retrieve, and extend their knowledge. O'Bannon, Puckett, and Rakes (2006) reported that, in comparison with traditional print formats, technology can enhance visual learning strategies due to the speed and ease with which translating, updating, and modifying information can occur.

Teacher training at the college level continues to contribute positively towards the success of ICT in teachers' classrooms. Technology integration, it seems, starts at the foremost institutions of education. A case study by Gulbahar (2002) illustrated that pre-service teachers can be willing to use technology in their classrooms but the inadequacy to facilitate its use during their instructional courses was emphasized as being a problem. Universities need to implement classes and formal training for teachers in order for them to feel confident with integrating technology into their respective classrooms. Teachers readily have used the Internet for web-based instruction (Walker & Kelly, 2007).

However, traditional pedagogy does not appear to be the major application for web-based instruction. Rather, Vodanovich (2005) found rudimentary use of web-based teaching in the classroom he appraised. The overwhelming use of technology's applications were for posting syllabi and communication via e-mail.

Some might argue that teachers lack the learned skill or acquired interest for integrating technology. While there is ample research to support a view of integration deficit (e.g., Frye & Dornisch, 2008; Parker, Bianchi, & Cheah, 2008), many teachers are highly skilled with technology (Carroll & Morrell, 2006). The problem for them extends beyond the mere lack of interest or skill. Rather, Bauer and Kenton (2005) reported teachers identified three impediments that limited their potential use of technology: a lack of time at computers, a lack of the adequate time needed to plan the incorporation of technology in lessons, and a lack of up-to-date hardware and software. Another limitation included students' lack of familiarity and skill with the technology. Bauer and Kenton identified the difference between technology's presence and technology's use: integrating technology into meaningful instruction as opposed to using it as a flashy way to deliver information.

One piece of technology has not changed amidst faster, more powerful computers. In fact, it is virtually the same since its initial creation. The overhead projector allows the user to display information to groups which reduces the number of individual copies needed for each student in class. Projectors also provide an interactive focal point as teachers write on it and use it within their classrooms (Crandall, 1995). Those are the two prime aspects of its usefulness that have stood the test of time and likely why overhead projector use continues today.

Constant, competitive technology creation spurred a new device which incorporates the useful aspects of an overhead projector and adds additional, helpful functions. ELMO Company Ltd. services the surveillance and digital camera/captioning field. They coupled the emerging visual technological advances with classroom needs and created the ELMO Digital Visual Presenter (ELMO). The main function is virtually the same as an overhead projector, except the ELMO object is projected live stream through a digital camera housed inside the unit. This distinguishing feature allows ease of use and better functionability. ELMO machines possess autofocus, so that the need for manually focusing, as with the overhead, is eliminated. The ELMO also has a digital zoom function which allows the user to zoom in and enlarge objects in order to fit the specific size-needs of the classroom. The zoom is powerful enough to view microscopic slides normally viewed under a microscope. These functions, combined with its projection display for all in the classroom to see, make it a valuable tool in the classroom.

Since ELMO Digital Visual Presenters are relatively new, their use in the classroom is still on the rise. Present scholarly investigations assessing these machines in the research literature is virtually non-existent. As a marketable product for potential purchase, some product reviews exist in the literature concerning its use. The use of the ELMO is believed to be effective in helping students facilitate peer cooperation and teamwork (Gill & Hu, 2006). It also is believed to be effective in helping students maintain attention and encouraging participation. Interactivity in the classroom previously has been known to lead to greater engagement and more enjoyment in classroom activities (Price & Rogers, 2004).

Definition of Terms

CD-ROM- an optical disc that stores information in a read-only-memory format and makes use of laser storage technology to distribute software easily and cheaply (Baker & Bowen, 2005)

Distance Learning- accessible education not limited by time, place, location, or pace, including education making use of the Internet, phone lines, CD-ROM, or other audio, visual, or computer technologies (Mangan, 2001)

ELMO Digital Visual Presenter- versatile digital viewer that interfaces with a computer, video monitor, or projector for large screen presentations (ELMO USA, 2008)

Hardware- the physical parts of a computer. Generally, hardware has the central processing unit, memory, power supply, graphics card, mass storage drives, and interface controllers to peripheral equipment (Lockard & Abrams, 2001)

Information and Communication Technologies (ICT)- technologies enabling the handling (i.e., capturing, storing, processing, communicating, and displaying) of information and the networks that use these technologies (Orlikowski & Iacono, 2001)

Instructional Technology- theory, development, utilization, and evaluation of technology concerned with achieving an instructional goal used alongside the teacher (Earle, 2002)

Internet- a worldwide system of interconnected media, computer, and telecommunications networks for the purpose of linking social, political, academic, and governmental entities together (Shelly, Cashman, Gunter, & Gunter, 2003)

Learning Types- different strategies used by students to help them construct knowledge. Generally, there are three types, including audio, visual, and kinesthetic (Lombardi, 2008)

Liquid Crystal Display (LCD) Projector- enables video, images, or computer data to be projected onto a flat surface for mass viewing (Lockard & Abrams, 2001)

Multimedia- the combination of two or more digitized media types simultaneously used in a synchronized manner. Media types include speech, images, text/graphics, audio, video, and computer animations (Puri & Chen, 2000)

Software- the symbolic language that controls the functioning of a computer and directs its operation (Lockard & Abrams, 2001)

Webquest- an individual or small group lesson on the World Wide Web (WWW) designed by a teacher for a specific purpose which incorporates problem solving, research, and application of basic skills through pre-selected Internet links (Kelly, 2000)

Statement of Issue

Since ELMO is part of emerging technology, presently no research has yet been published concerning its use. Knowing the perceptions of the students at the secondary level is needed as ELMO technology is very expensive and administrators often must choose where best to spend limited funds. Assessing the effectiveness of technology application in school settings remains a concern since both teachers and administrators are increasingly responsible for student-learning outcomes. All factors influencing potential classroom learning should be appraised for their value and contributions to successful student learning.

Chemistry is the specific subject area where I focused the present study. There have been few teaching methods reported in the research literature regarding the incorporation of technology into the chemistry classroom (Evans, Leinhardt, Karabinos, & Yaron 2006). This is due, in part, to the nature of a chemistry class having labs and

demonstrations (Carvalho-Knighton & Keen-Rocha, 2007). The introduction of computers into the classroom led to computer-assisted instruction (CAI). Generally taking the form of drill-based instruction, technology integration was limited in this regard and defaulted to teaching essential skills in a relatively non-interesting way (Venezky, 2004). As technology improved, multimedia became more advanced as well (Vail, 2003). Today, CD-ROM software predominate the interactive elements in technology. Virtual labs, electronic books, and simulations continue to be helpful and engaging (Gabric, Comstock, & Hovance, 2005).

The mainstreaming of the Internet into classrooms during the 1990's added many more instructional teaching methods and practices for science educators (Girwidz, Bogner, Rubitzko, & Schaal, 2006). It also has helped to enhance visual representations of abstract concepts as well as provide a source of pictures containing microscopic objects undetectable to the human eye that normal high school students would not be able to interact (Wu & Shah, 2003). Other popular uses for the Internet in the classroom have included webquests and web-based learning environments (Web-LE). Webquests are activities designed specifically by a teacher that make use of the Internet to learn information or solve problems (Kelly, 2000). A scholarly assessment of the connection between on-line content and teaching problems has yet to be established. Wang and Reeves (2006) reported the harmful potential of simply placing content on the Internet, devoid of proper learning theories and instructional strategies.

Scope of the Study and Delimitations

In this study I collected data regarding students' perceptions of benefits and limitations of the ELMO's use in a physical science classroom. Also, I assessed areas

where students communicated needs for improvement in its use. The setting of the study was a suburban, public high school with an enrollment of roughly 2800 students. The student population consisted of 86% Caucasian, 6% economically disadvantaged, and 10% diagnosed as learning disabled. This project focused on two physical science classrooms. Physical science is a standard-level class that consists mostly (98%) of freshmen and occasionally some sophomores who repeat. In reference to the ELMO, all science teachers in the school received one machine for classroom use around the end of the 2007-2008 academic year. No upcoming freshmen have previously experienced a class with ELMO technology.

This project focused only on physical science students' perceptions of the ELMO. Additionally, neither teacher perceptions nor other subject areas were included in the study. Because the project occurred during the first semester of the year, the chemistry portion of the physical science curriculum was covered. Since the emphasis of the study is on students' perceptions, I did not track specific academic gains relative to the ELMO's use or disuse.

Elementary and middle school students were not considered for participation in this study because the science curriculum during those early education years is not distinct but, rather, integrates with all the other subjects. Furthermore, these students are not as scholastically adept to appraise, assess, and communicate their own perceptions regarding classroom technology as are high school students. As opposed to younger students who lack the development of higher order reasoning and thinking skills, freshmen begin to exhibit the thinking capacities afforded them by the backdrop of their developmental stage in life (Lawson & Wollman, 2003). Finally, I eliminated the private

school setting for study because the social stresses facing a public school freshmen as they adjust to 2800 other students generally are not aptly comparable to the private school experience. Financial resources for supporting ELMO technology also likely would differ substantially between the public and local private schools.

Significance of the Study

With the increasing pressure to incorporate emergent technology such as the ELMO in the classroom, it is essential to measure its utility. The particular ELMO model (the TT-02) used as part of the present study represents a significant investment of money relative to the science department's budget. For example, the ELMO can range from \$700-\$1000. This only includes the ELMO itself. Upgrades and accessories cost extra. A computer, though not entirely necessary to use the ELMO, enhances the ELMO's capabilities. Computer costs range from \$600-\$1500. A projector also is needed, and these can cost \$1200 or less (Bell, 2005). In sum, purchasing a fully functional ELMO setup can total \$2500-\$3700. As a result, educators must understand the educational value of ELMO technology to students. It is vital to research students' perceptions of the ELMO's benefits and limitations at the secondary level, and the present study will contribute to that end.

Educators should explore the perceived benefits of the ELMO. If students do not readily realize the ELMO's potential worth, then its utilization in a classroom should be reevaluated or more direct instruction regarding its proper use should be undertaken. If, however, the opposite is true, namely that the ELMO is perceived as a positive and valuable piece of educational technology, then administrators may find the expense better justified. Research concerning students' perceptions of general technology use exists at

the post-secondary level (e.g., Bahr, Shaha, Farnsworth, Lewis, & Benson, 2004) while explicit research on the use of ELMO at the high school level addressing students' perceptions is minimal because thorough research study in this same area does not exist. It is imperative, therefore, to investigate secondary students' perceptions of the ELMO's benefits. Every piece of technology innately has benefits and drawbacks when used. It is important to examine the potential drawbacks and weigh them against the perceived benefits. By doing so, both reduction and potential elimination of the weaknesses can be achieved. Identification of ELMO's limitations during the present action research may prove useful, not only to other physical science teachers, but also to any teacher implementing the technology.

A key component to the present ELMO research study was to identify potential areas of improvement for classroom use. Important to this process is providing students with opportunities to offer constructive feedback regarding the effective use of the ELMO. Students are uniquely qualified to recognize potentially poor implementation of teacher planning and technology. Giving them an opportunity to share their insights reveal possible weaknesses and problems that I do not see as a classroom instructor.

Methods of Procedure

Research Questions:

1. How do physical science students perceive the benefits and limitations of the ELMO when compared to traditional instruction?
2. In what areas do students see needs for improvement of the ELMO's use in the physical science class?

This action research (Waters, Burns, & Smeaton, 2004) focused on students' perceptions when I used the ELMO during classroom demonstrations. The research was conducted in a qualitative manner, using a quasi-experimental design. It involved an inductive approach where I collected the data and then coded it and eventually extracted themes that represent the students' consensus. The data collected was in the form of students' written journals and individual interviews with them. In analyzing the data, I assessed themes regarding perceived benefits and limitations of the ELMO. I also examined areas where students communicated needed classroom pedagogical improvement. As a field study, the research was conducted in the natural environment of the physical science classroom (Proske, Narciss, & Körndle, 2007).

The sample consisted of two physical science classes which contained a majority (79%) of Caucasian freshmen along with 6 African-American, 2 Latino, 2 South Asian, and 1 Middle Eastern freshmen. I had no sophomore students in either class, and the students had been pre-assigned to my respective classes. Classes A and B were capped at 30, following the high school's general policy on class sizes. I collected journal and interview data from every student.

The study lasted 8 weeks and was conducted using an ABAB design. I alternated my use of the ELMO between the five classes equally. The following pattern was established:

Class A: 2 weeks ELMO/ 2 weeks no ELMO/ 2 weeks ELMO/ 2 weeks no ELMO

Class B: 2 weeks no ELMO/ 2 weeks ELMO/ 2 weeks no ELMO/ 2 weeks ELMO

Each class met daily for 54 minutes. The classes contained identical content, methods, and assessments. The only variable that changed was the use of the ELMO. The

main use of the ELMO during lessons included note taking, capturing and sharing images in real time, and viewing microscopic images without each student needing a microscope. For the class where the ELMO was not in use, transparencies, drawings on the whiteboard, and handouts supplemented my teaching.

Throughout the 8 weeks of collecting data, I directed the students to write in a journal at least three days per week. It was not necessarily default to Monday, Wednesday, Friday each week, but students' journaling coincided with days when the use (or not use) of the ELMO was a major portion of class. I kept the journals in class and coded them by class. The journal entries always had the same major discussion topics covered. Topics included what we did that day (activities), particular teaching or learning strategies that helped them, and any suggestions for improvement. After the 8 weeks of journal data collection, I conducted individual interviews with each student. The interviews focused on three major themes: perceived benefits, limitations, and improvement suggestions. All interviews were tape recorded and transcribed for later analysis.

Maxwell's (2005) inductive process of coding was used in order to derive categories and themes from the data. The first round coding assessed transcripts for repeated words and phrases, making use of constant comparison analysis (Fereday & Muir-Cochrane, 2006). Adding emerging codes and removing codes inconsistently found occurred in order to create a master list of codes (Bereska, 2003). Having a master list enabled assessment for repeated findings throughout the participants' interviews. Themes from the coding process only were reported when most participants expressed the sentiments.

Internal validity for the study was enhanced through a number of means. The ABAB design allowed each group to be its own control (Yin, 2008). This provided students with apt comparisons of their classroom experience with the ELMO, as compared to their classroom experience without it. Low-inference descriptors (Patton, 2001) throughout the analysis of the data provided the closest words to what the students actually voiced. Direct quotes from the students also were used in order to support the conclusions drawn from the study. Internal validity was supported through multiple means of data sampling (Silverman & Marvasti, 2008).

Internal validity also was supported through triangulation of information sources (Liamputtong & Ezzy, 2005). This means that I did not rely on one, sole, means of data collection in order to build the present study. Rather, I used three means: (a) student journals, (b) individual interviews, and (c) focus groups (Silverman & Marvasti, 2008). Consequently, confidence in the study's overall outcomes are strengthened through reliance on data coming from multiple means—not just one.

The data was collected in two waves (Firmin, 2006). This is a qualitative research technique whereby the researcher collects data from all participants in the study, comprising the first wave. Then, particular individuals are targeted for follow-up interviews, gauging specific questions and probing for clarification, elaboration, and elucidation vis-à-vis the participant's initial feedback. This process helps to provide plenary interviews on which the study is based and contributes toward the rich-and-thick descriptions (Seidman, 2006) when relating the study's results.

Data audits (Merriam, 2002) also enhance the study's internal validity. This entailed generating outlines whereby the findings were grounded in specific citations in

students' transcripts. This process helped to ensure that the conclusions drawn from the study aptly reflected the consensus of the student participants.

Member checking (Marshall & Rossman, 2006) was another means of supporting the study's internal validity. This involved relating the study's results to various participants in the study and garnering their feedback. The point of member checking is to see if one's conclusions aptly represent the views of the individuals who were interviewed. Each of the students whom I contacted provided assurance that the results reported were valid representation of their own sentiments and perspectives. Consequently, this helped to strengthen the study's internal validity.

Saturation (Neuman, 2006) occurred during the data collection and analysis process. This is a qualitative research construct that addresses sample size. Saturation happens when adding new individuals to a sample ceases to increase the quantity of data that is useful for the qualitative study's intended purpose. In other words, the law of diminishing returns works and adding new individuals to the sample does not result in new findings or substantially contribute to the quality of the existing ones. Since this happened with the 28 individuals used for the present study, based on qualitative experts such as Bogdan and Biklen (2006) and Creswell (2006), I concluded that my sample size was large enough in order to accomplish the study's intended aim.

Maturation was reasonably thought to be the only potential threat to internal validity. Many freshmen students go through significant physical and mental change during their first year of high school. These possibly could have influenced their thoughts or perspectives throughout the study. Other threats to internal validity included scarce amounts of data from a small portion of the participants who did not answer interview

questions in depth and the possible waning of a novelty effect since the ELMO was new to the participants. Threats to external validity included a lack of random sampling and heterogeneity.

Chapter 2

Plenary Literature Review

The infrastructure of American society depends more on technology each passing day. ELMO digital visual presenters (ELMOs) exist in the larger context of a rich, dynamic technological history. In the basest sense, technology in some form existed millennia ago. Computer technology's history is not so old, but the brief 60 year history is no less exciting or influential. Students' daily lives are influenced and so closely intertwined with advancements in technology that some take for granted its presence. This is a testament to technology's subtle infusion, both inside and outside the school classroom. A historical perspective gives context to ELMO technology.

History of Educational Technology

When the federal government report *A Nation at Risk* (1983) appeared, it offered recommendations in the areas of content, standards and expectations, time, teaching, and leadership and fiscal support of schools. The growing use of technology was addressed briefly in the section addressing "indicators of risk," which listed examples of deficiencies in education as compared to the forecast needs of the work force, in particular "highly skilled workers in new fields." The report offered the following examples of the technologically changing workplace: 1) Computers and computer-controlled equipment are penetrating every aspect of American life — homes, factories, and offices, 2) One estimate indicated that, by the turn of the century, millions of jobs will involve laser technology and robotics, 3) Technology is radically transforming multiple American occupations. They include health care, medical science, energy

production, food processing, construction, and the building, repair, and maintenance of sophisticated scientific, educational, military, and industrial equipment. The report quoted John Slaughter, a former director of the National Science Foundation, who warned of “a growing chasm between a small scientific and technological elite and a citizenry ill-informed, indeed uninformed, on issues with a science component” (p. 12).

In the excitement of educational technology during the 1980s, a handful of early adopters pushed for bottom-up change and the adoption of computers in schools. The Apple Corporation began a study to foster an educational environment that routinely made use of technology (Apple, 1995). Throughout the next decade, Apple enlarged its research and augmented its voice in the educational sphere. Many factors came together, such as the adoption of technology into the private business sector as well as the acceptance of PCs and the Internet into many homes. This created a pressure on schools to better understand and accept that technology was soon to become a required standard method by which they would provide or augment student instruction (Williams & Kingham, 2003). This pressure, coupled with additional requests from school boards, parents, and students created a need to rapidly deploy technology hardware and software that would enable student access to future technology classes (Hadley, Eisenwine, Hakes, & Hines, 2002). Many teachers resisted, seeing this as one more trend that might potentially pass as a fad. Numerous reports were published by Apple that presented the positive effects of technology on both teachers and students. These findings became a cornerstone on which technology in schools later was to be built. By the late 1990s, higher education began to see first-generation technology users (those having lifelong computer exposure) with high-tech learning expectations. Their learning styles were

influenced by the immediacy and visual richness of the environment in which they had grown up, particularly television and the Internet. These students expect to be engaged by their environment, with participatory, sensory-rich, experiential activities and opportunities for input. They are more oriented to visual media than previous generations and prefer to learn by doing rather than by telling or reading (Kumar & Altschuld, 2002).

The Internet proliferation during the 1990s changed the contour of classroom technology as computers became networked around the world (Stallard & Cockard, 2001). It was during this same time that teacher training in technology became an area of educational concern as well. The lack of pre-service teacher training in technology led many institutions simply to add the use of technology to education classes without equipping pre-service teachers with the knowledge of its use. However, The National Research Council (1999) has argued that the use of technology in teacher education involves much more than simply adding technology to an existing course structure. As teacher training increased, technology expansion continued in schools.

In recent years, the percentage of public schools with Internet access and the availability of the Internet to students has increased. According to the National Center for Education Statistics (NCES, 2005), nearly 100% of public schools in the United States had access to the Internet in 2005, compared with 35% in 1994. Continual exposure to a computer by students is becoming a reality as well. The NCES (2005) reported the ratio of students to instructional computers with Internet access in public schools to be 3.8 to 1, a decrease from the 12.1 to 1 ratio in 1998, when it was first measured. The 2005 ratio of 3.8 to 1 also represents a decrease from 2003, when the ratio of students to instructional computers was 4.4 to 1.

Technology Implementation

Incorporating technology into teachers' practice allows obvious and dramatic changes in classroom organization and management, yet changes in teachers' pedagogical thinking have been slow and measured. Nordkvelle and Olson (2005) assert that teachers use ICT instrumentally in their practice mostly "to amplify preferred, pre-existing instructional practices" (p. 7). In the U.K., interview and observational studies indicate that a gradual but perceptible process of pedagogical evolution appears to be taking place (Hennessy, Ruthven, & Brindley, 2005). This involves both pupils and teachers developing novel strategies and ways of thinking in response to new experiences and the lifting of existing pedagogical constraints. This line of previous research also has highlighted many factors which may have an impact on teachers' motivation to implement, continue to develop, or to share innovative practice. Perceptions about the usefulness of ICT in aiding and extending learning and challenging pupil thinking are influential (Cox, 2004) as is the belief that an innovation should offer "added value" above and beyond existing practice (Hennessy, et al., 2005). New approaches also must be compatible with existing pedagogy and be perceived as meeting a demonstrable need. Teachers might additionally expect sustainable and transferable innovations to be user-friendly, adaptable, and applicable to other classroom contexts. Some studies (e.g., Beets, & Lobingier, 2001; Dickerson & Kubasko, 2007) have pointed to the practical constraints operating within the working contexts where teachers currently find themselves. Cuban, Kirkpatrick, and Peck (2001) suggest that the cellular classroom organization, tight time scheduling, and departmental boundaries that characterize high schools, along with the

demands of curricular coverage and assessment, may both inhibit use of technology in classrooms and also impede widespread changes in teaching practices.

Innovation and adaptation are costly in terms of time; developing effective pedagogy around ICT involves significant input in terms of planning, preparation, and follow-up of lessons (Cox et al., 2003). Other contextual factors that can act as barriers to pedagogical development include: a) lack of confidence, experience, motivation, and training; b) access to reliable resources; and c) classroom practices which clash with the culture of student exploration, collaboration, debate, and interactivity within which much technology-based activity is said to be situated (Becker, 2000; Dawes, 2001). Some writers distinguish between school level and teacher level barriers, with teacher level factors such as pedagogical beliefs, technical skill, and confidence being viewed as particularly influential (Mumtaz, 2000). BECTA (2003), on the other hand, focuses on barriers to using ICT, highlighting the complex relationships between external or first order influences, such as access to reliable technology, and internal or second order influences. These include school culture, teacher beliefs, and skills. Tearle's (2004) work purports that availability of resources and whole school characteristics (culture and ethos) are all highly influential toward innovation and adaptation. Similarly, in a comprehensive review of literature concerned with factors that enable teachers to make successful use of ICT, Scrimshaw (2004) cites the central role of school leadership and whole school strategic planning. At the same time, however, he notes how, at teacher level, perceptions that link ICT with promotion of a student-centered pedagogy may, in fact, deter some practitioners whose preference is for a more teacher-centered model. Pedagogical adaptation may thus represent a more difficult transition for many teachers than does the

process of acquiring new technical skills (Fabry & Higgs, 1997). Dawes (2001) describes how teachers develop professional expertise and the motivation in order to evolve from being potential users (through the stages of participant, involved, and adept) to integral users ultimately; hence, potential obstacles may affect different individuals and groups of colleagues to varying degrees.

Finally, the use of classroom technology should not fall to teachers alone, as is generally the case. High school faculty who teach in particular departments act as ideal communities of practice where sharing resources, approaches, cultural values and aims, and collaboratively-developed schemes of work take place. Departments that work effectively together as teams generally constitute robust communities of practice within which innovations involving ICT may be readily shared (Ruthven, Hennessy, & Brindley, 2004). However, research indicates that practice develops over time and this process is not automatically triggered by simply sharing information with colleagues (Loveless, DeVoogd, & Bohlin, 2001). Rather, it entails developing ideas and trying them out, considering the principles and purposes that underpin activities in particular contexts, and critically reflecting on them. Likewise, Hargreaves (1999) stresses the importance of professional tinkering in the collaborative processes of knowledge creation. At the time of the project, participating teachers spanned the spectrum of developing expertise, but shared a commitment to extending their practice in using ICT in order to support subject teaching. They also worked within a supportive organizational culture, as evidenced by the agreed agenda of schools within their research partnership to focus on developing their use of ICT.

Benefits of Educational Technology

As an instructional tool, technology helps all students, including poor students and students with disabilities, master basic and advanced skills required for the world of work (Mulholland, 2006). As an assessment tool, technology yields meaningful information, on demand, about students' progress and accomplishments and provides a medium for its storage. As a motivational tool, technology positively makes an impact on student attitudes toward learning, self-confidence, and self-esteem (Gerard, Green, & Widener, 1999).

Since its earliest classroom applications, technology has served as a successful and efficient tutor for students learning basic skills (Henderson, 1999). Teachers who employ computer assisted instruction (CAI), for example, can drill students on specific topics for which they need extra help, such as with long division or spelling. Among the attractions of CAI are its ability to individualize instruction and to provide instant feedback. Many CAI applications not only mark student answers as right or wrong, but also explain the correct answers. Since students are able to control the pace at which they proceed through their exercises, they are neither held back nor left behind by their peers. Additionally, the instant feedback motivates them to continue. However, not all applications of CAI have been found to be so successful in all types of settings (Bayraktar, 2001).

Technology offers several advantages over traditional methods of student assessment. For example, multimedia technology expands the possibilities for more comprehensive student assessments that require students' active participation and application of knowledge (Reid-Griffin & Carter, 2004). The immense storage capacity

enabled by technology such as CD-ROMs allows schools to develop electronic portfolios of students' work (Snider, 2002). A single CD can hold exact copies of students' drawings and written work, recordings of the child reading aloud, and video images of plays, recitals, or class presentations. By saving work samples on different subjects at different times during the year, teachers can display them in rapid succession to demonstrate and assess growth.

The use of technology in the classroom can improve students' motivation and attitudes about themselves and about learning (Demetriadis, Barbas, Molohides, Palaigeorgiou, Psillows, et al., 2003). Technology-rich schools often report higher attendance and lower dropout rates than in the past (Yudko, Hirokawa, & Chi, 2008). Students also frequently report being challenged, engaged, and more independent when using technology (Furr, Ragsdal, & Horton, 2005). By encouraging experimentation and exploration of new knowledge frontiers on their own through the use of technology, students gain a greater sense of responsibility for their work, producing higher-quality assignments that reflect the increased depth and breadth of their knowledge and talent (Higgins, Cavendish, & Gregory, 2007). Technology also can positively energize students, since they sometimes know more about its operation than do their teachers.

Technology can help teachers improve their classroom practice by expanding their opportunities for training and by fostering collegial work with other teachers and professionals (Kabonoki, 2008). For example, videodiscs and CD-ROM multimedia presentations are being used to show prospective teachers how contrasting styles of teaching affect student engagement and achievement (Rogers & Finlayson 2004). The quality of graphics has dramatically improved since educational technology originally

began, and this advancement has produced clarity to many complex concepts (Gabric et al., 2005). Observably, technology has impacted educational tools used in the science classroom. Similarly, distance learning technologies are being used to deliver staff development courses. These courses are being led by experts, many of whom are teachers themselves (Chou, 2004). Teacher participants have the opportunity to call in and interact with the experts by telephone, as well as to engage in discussions at each school site led by facilitators. Particularly promising for teacher skill development are electronic networks that allow teachers to overcome the isolation they experience in their classrooms (Miksa, Burnett, Bonnici, & Kim, 2007). By exchanging ideas with peers and sharing experiences and resources with like-minded colleagues across the country, they are gaining enthusiasm, confidence, and competence.

Barriers and Limitations of Educational Technology

Technology often is an extremely valuable addition to the educator's pedagogical toolbox; however, it also possesses limitations. Driscoll (2002), for example, offers four such limitations for teachers to consider. First, it does not replace traditional media or methods of educating. There is still a role for the lecture or seminar, and for the chalkboard or whiteboard. The printed page remains the best way of absorbing dense academic detail. Second, simulations can never replace the benefits of working with real objects. For example, there is no direct substitute for the smell of the chemistry lab and few people, for instance, would wish to be treated by a doctor whose only experience was with virtual patients. Third, technology does not remove the need for work on the part of the learner. It will never be possible to download knowledge directly to the brain. Indeed, the learner-centered model offered by technology means students must take greater

responsibility for their progress, though, in theory, that progress should be of a higher quality. Finally, technology can never replace the human element. The role of instructor is changed, i.e. from “sage on the stage” to “guide on the side,” but not removed.

Learners still benefit significantly from interaction with instructors and fellow students, whether that interaction occurs physically or virtually.

Over recent years, unprecedented government investment in school ICT has been directed at implementing infrastructure and connectivity. Despite increased investments in technology, the descriptive statistics of classroom computer use are somewhat disheartening. Particularly, recent studies indicate that, on average, teachers use computers several times a week for preparation but only once or twice a year for instructional purposes (Russell, Bebell, O’Dwyer, & O’Connor, 2003). The potentially transformative power of technology so widely acclaimed within official rhetoric evidently has not yet moved into the reality of mainstream educational practice. Major potential yields can be derived from embedding ICT in all aspects of learning, teaching, and management, but progress is slow. Day (2004) suggests that as few as 15% of all schools have meaningfully incorporated ICT in these ways across the whole school. Training and support at the school level was key to promoting classroom use of the new tools and more fully understanding the underlying pedagogies (Preston, 2004). Indeed, the continuing importance of providing guidance on incorporating effective, subject-related pedagogy has been widely acknowledged (Cox et al., 2003; OFSTED, 2004).

Although there has been a strong push to place educational technology into the hands of teachers and students, many obstacles to implementation still exist. Groff and Mouza (2008) present some of these. Equipment may not be placed in easily accessible

locations. Hardware and software often pose problems for teachers in the classroom, and just-in-time technical support may be unavailable. Teachers may lack the time and the motivation to learn technology skills. Professional development activities may not provide ongoing, hands-on training for teachers or practical strategies for implementing technology into lesson plans. Initial technology funding may not be sustained and, thus, incapable of providing upgrades, maintenance, and ongoing professional development.

Nonetheless, the push to provide technology in schools has realized some success in recent years. Teachers readily admit that they are not making as much use of technology as they could and that presently is a nationwide focus in teacher education. According to Bellamy (2007), nearly 30% of teachers indicated that their students use computers only one hour per week; nearly 40% said their students do not use computers in the classroom at all. Although technology is more prevalent in the schools, several factors affect whether and how it is used. Tondeur, Valcke, and van Braak (2008) reported that factors such as including placement of computers for equitable access, technical support, effective goals for technology use, new roles for teachers, time for ongoing professional development, appropriate coaching of teachers at different skill levels, teacher incentives for use, availability of educational software, and sustained funding for technology were all cogent vis-à-vis teacher utilization of technology in the classroom.

Technologies can provide powerful tools for student learning, but their value depends on how effectively teachers utilize them to support instruction. Education leaders agree that all new teachers must graduate from teacher education programs with the knowledge and skills that will enable them to integrate technology easily and effectively

into their daily teaching, whatever the setting. Many do (Lui & Szabo, 2009).

Nonetheless, far too many teacher candidates evidently once graduated without adequate exposure to, or experience with, effective teaching with technology (Al-Bataineh, Anderson, Toledo, & Wellinski, 2008). Even the best of teacher education programs need to continually review and renew their programs in order to ensure they are responsive to changing expectations for teachers and to ensure teacher education programs take advantage of the opportunities offered by ever more powerful technologies for teaching and learning. Without a strong foundation in the knowledge and skills for using technology effectively, teacher candidates entering today's schools will fall short of meeting the "highly qualified teacher" expectations set out by the No Child Left Behind Act (2002).

Information and Communicative Technology

Information and communicative technology (ICT) has redefined learning and teaching and may someday change future principles, practices, policies, and underlying epistemological issues that define educational services. The work of Kohn (2004) and Nordkvelle and Olson (2005) has helped to create a picture of the global future influences that ICT may have on education, knowledge, and those lives touched directly or indirectly by learning and teaching. Undoubtedly, ICT is a valuable, useful resource and tool for learning and teaching (Sutherland, Armstrong, Barnes, Brawn, Breeze, et al., 2004), but if ICTs are to cross the threshold from promise to practice, certain minimal conditions must be met (Williams, 2005). There is a need for political leaders to play an active role in creating sound ICT and education policies. At the institutional level there is

a need for clear mission statements incorporating the support of ICT which can be used to guide the development of a strategic plan (Dale, Robertson, & Shortis, 2004).

The world of ICT is broad and often hectic for learners and teachers, whether caused by continual system and software upgrades, viruses, and web site maintenance, or merely by wading through the copious amounts of commercial sidebars and pop-ups on the Internet (Akgul, 2006). For most educators, preoccupation with the daily management of educational life means looking for safe footing, step by step, seldom pausing to look further ahead on the path or even question why certain paths are followed (Hughes, 2005). At a fundamental level, many teachers view technology in terms of products developed to do particular jobs or as devices invented for specific purposes unrelated to classroom education. They give greater emphasis to technologies as products than to technologies as processes (Rowell, Gustafson, & Guilbert, 1999). In spite of this, teachers and learners have used ICT in their educational activities for many years, but the present analysis of what ICT qualities that make a difference to learning has been rather haphazard. The idea of affordance has been seen by several authors as helpful in illuminating the study of ICT's effects on learning (Kennewell, Tanner, Jones, & Beauchamp, 2007).

Butzin (2002) reported that the students using ICTs have consistently scored higher grades on standardized tests than did their counterparts who were in traditional classrooms. Similarly, Guttman (2003) showed that programs in Chile and Costa Rica have been launched through a telecommunications network in order to raise the quality of education using a constructivist approach that would encourage collaboration between

learners to raise cognitive skills. The results in both programs showed significant changes in student attitudes and noticeable increases in creative initiatives by the students.

Student Perceptions of Technology

The teacher is just one member of the educational team present in the classroom; naturally, students are important members as well. The perceptions and attitudes of students must be considered in the use of instructional technology, if teachers hope to use technology in order to enhance and maximize the educational experience of their students (Barak, 2007). For example, Sonnenwald and Li (2003) conducted a study to incorporate the influence of learning styles on perceptions of technology use, both in face-to-face interaction and also with computer-mediated interaction. They found no statistically significant differences in perceptions of the system-based on students' cooperative learning style preferences. In both face-to-face and remote conditions, or alternatively, students were able to compensate equally well. This finding mirrors other research that found no or minimal differences in learning outcomes and students' perceptions of technology based on cognitive information processing learning styles (Lu, Yu, & Liu, 2003; Terrell, 2002).

Certain aspects of ICT are catering to students' natural tendencies. Ellison and Wu (2008), for instance, conducted a study addressing student perceptions of blogging. These students enjoyed certain aspects of blogging—the novelty and convenience of the medium, the less formal writing voice it encouraged, and the interactivity inherent in the assignment, specifically reading other students' ideas and getting feedback on their own. Students believed that gains in understanding were most likely to result from reading other students' blogs as opposed to writing their own entries or reading comments from

others about one's entry. When asked about their perceptions of the blogging assignments, students claimed to enjoy aspects of the assignment, such as the interactive features of the medium, the exposure to the divergent perspectives of their peers, and the access to a wider online audience. Blogging evidently encouraged some students to write in a more authentic voice, which may be perceived as a benefit by some, but also a limitation by others. Blogging, the researched showed, does not independently or autonomously increase student learning. Rather, sound instructional techniques must be developed and practiced in order to achieve increased student learning. As argued by Mishra and Koehler (2006), content, pedagogy, and technology dynamically affect one another in the classroom environment, and instructors must consider each of these respective realms. In short, instructors should utilize instructional blogging in ways that support the particular content area being taught and also represent instruction modalities that are pedagogically and technically sound.

Web-based learning also has become a recent phenomenon in the midst of ICT use. Choi, Lim, and Leem (2002), reported that web-based learning tends to develop a positive attitude towards science education. Reaching to content easily and expending less effort to obtain knowledge can explain differences in attitudes toward some science courses. The web site of the course in their study provided students with opportunities to read and to analyze the content. Students could use many links in which they found related information. These conditions affected the reported progress in their attitudes. In sum, the development of positive attitudes towards pedagogical content was related to accessible involvement of the students in their course web site activities.

In a similar study (Matuga, 2001), students' perceptions about science content, enhanced with a web-based learning tool, were important in understanding the effective dimensions of students' science learning. The study weaved together, both on-line learning through web-based approaches, and classroom interactions primarily for on-line support. Most students in the study perceived download time (how fast the learning tool could interact) as important, since most of the students stated that they preferred to connect to the Internet from their homes as opposed to on campus. Students agreed that the support of classroom meetings were beneficial in addition to the web-based-learning approaches. Particularly, classroom meetings enhanced students learning of abstract content.

Ong and Ruthven (2009) assessed ICT-based science programs regarding their effects on student achievement. They purport that any significant effect on attainment due to ICT must be viewed alongside other smart teaching elements such as constructivist practice, mastery learning, self-accessed, self-paced and self-directed learning. As Lewis (2003) observed, "Evidence that the use of ICT has any significant effect on attainment [and attitudes] remains elusive. There is much anecdotal evidence of improved attainment [and attitudes] being linked to effective use of ICT, but little published research" (p. 42). Equally, the attitudinal outcome in this study is consistent with the meta-analytic findings of Kulik (2003), where computer-based instruction contributed to a development of favorable attitudes towards school science.

ELMO Digital Camera Presenter

Historically, technology integration into classroom settings has been a slow process. In 200 years of public American education, adoption of technology generally has

been gradual. For example, it took nearly 50 years after their 1801 arrival for chalkboards to become a classroom staple, paving the way for teachers to provide instruction to large classes, eliminating the need to hand-copy materials for each student (Bell & Garofalo, 2005). Since then, just one presentation technology has enjoyed the same level of acceptance: the overhead projector (Cooper & Yoder-Wise, 2003). And despite how overhead transparencies have made it practical for teachers to prepare notes and drawings ahead of time, it took 40 years to place the technology into most American classrooms. Current presentation technologies far surpass the potential usability of overhead projectors, but none to date has seen ubiquitous classroom adoption.

The digital camera presenter¹ is a cost-effective, easy-to-use device that works in conjunction with a projector, television, plasma screen, or monitor to display documents and 3-D objects. Capable of capturing images and video to upload to a computer for use in multimedia projects and web pages, some models even allow users to share the screen display or freeze and annotate images. Ultimately, digital camera presenters appeal to end users because they are easy to operate and similar to familiar tools such as overhead projectors. While it takes less than an hour to learn basic use of an ELMO, the advanced features are what make it an effective teaching tool (Mabry & Snow, 2006).

Sustainable Classroom Project (n.d.) reported how the ELMO had changed the teachers' pedagogies of mathematics in their classrooms. Particularly, the teachers identified four major changes. The first was more class time devoted to discussions of

¹ ELMO is a specific brand of digital camera presenter and is the one used in the present study: Throughout this thesis, the term ELMO is used as being synonymous with digital camera presenter.

students' written work and thought processes. Second, teachers perceived increased numbers of students, especially English language learners, sharing and explaining their work. Third, there was a growing student confidence in their mathematical abilities and better comprehension of concepts. Finally, the teachers increased their understanding of students' thought processes.

Ideally, a technology adoption should change something meaningful about the way teachers teach or children learn (Nicolle & Lou, 2008). Levin and Wadmany (2008) discussed a progression of technology use and possible explanations for it. Some teachers first will be excited by a technology that enables them to do something in a different way in their classroom. Teachers new to ELMOs often focus first on the fact that the equipment makes it easier for them to show objects or text to students, or to demonstrate a lesson. It sometimes is not until later that the teachers fully embrace those capabilities that facilitate the shift from teacher-centered to student-centered learning environments. Eventually teachers should ensure that the students take the initiation for their learning, using the ELMO for presentations and peer teaching. However, more research is needed in order to determine how these new technologies can be incorporated into the classroom as pedagogically sound practices. It is especially important that teachers engage with this issue now to avoid the common practice of adopting new technologies without gaining large-scale educational outcomes (Ehrmann, 2002).

Need for the Present Study

With the rising use of ELMOs in the secondary education classroom, it is crucial to assess its value. Presently, little empirical research has been conducted on the ELMO's educational effects. The research conducted mainly has addressed teachers' perceptions

of its use. The view of secondary and primary level students may differ. The question of how students perceive the ELMO's use at the secondary level remains unanswered, and thorough studies of American secondary level students' perceptions have not been conducted to date. Therefore, it is necessary to explore secondary students' perceptions of the ELMO's benefits and limitations.

In addition to researching the general effects of technology on education, it is also imperative to investigate effects in specific subject areas. Research has been conducted on students' perceptions of technology in the science classroom (Donaldson, 2001; Spicer & Stratford, 2001). However, the ELMO has not been specifically considered in the research conducted. The only subject that has been studied with respect to the classroom use of the ELMO is mathematics. Since there is a remarkable lack in the area of secondary level students' perceptions of the ELMO and in the area of science, this calls for the present necessary research. Science encompasses many facets including chemistry, physics, biology, geology, and astronomy. Their distinctive contents result in each requiring its own unique pedagogical methods. Therefore, this present study concentrated on ELMO in the context of the chemistry aspects of teaching science.

Chapter 3

Methodology

For this study, action research was performed using a qualitative protocol within the context of a quasi-experimental design. The goal was to assess students' perceptions of an ELMO digital visual presenter in classroom use. In order to achieve this goal, I taught two classes using ABAB and BABA designs. During the first phase, A, I taught in the traditional manner. Then during the second phase, B, I used the ELMO in my teaching. Phase A was used as a baseline so that the students could effectively compare the ELMO's use with traditional instruction. The alternating design permitted a comparison of students' reflections for a certain lesson with and without the ELMO. The design allowed each class to serve as its own control as well. The entire study lasted 8 weeks, with each phase lasting two weeks. The following pattern was established:

Class A: 2 weeks ELMO/ 2 weeks no ELMO/ 2 weeks ELMO/ 2 weeks no ELMO

Class B: 2 weeks no ELMO/ 2 weeks ELMO/ 2 weeks no ELMO/ 2 weeks ELMO

Dates of Phases:

August 25 - September 5th 10 days

September 8 - September 19 10 days

September 22 - October 3 10 days

October 6 - October 17 10 days

The classes met daily for 54 minutes. The lessons covered during the eight weeks of physical science included the scientific method, standards of measurement, kinetic theory, properties of fluids and gases, the composition and properties of matter, and the structure of the atom. Each class contained the same content, methods, and assessments. The ELMO was used in order to enhance visuals and clarify handouts. In class sessions without the ELMO, I used the overhead projector and whiteboard drawings to supplement the visuals. I have used this traditional method in the past.

During these 8 weeks, students wrote journal entries 3 times per week in order to describe that day's class experiences with respect to technology. At the end of the 8 weeks, all students were interviewed and asked about the perceived benefits and limitations of the ELMO. I also asked for areas where they saw needs for improvement in the ELMO's use.

Rationale for the Method

Educators complete action research commonly because it focuses on problem-solving and discovering new knowledge to inform pedagogical decisions (Johnson & Christensen, 2004). I focused on the educational issue of the ELMO's value in the classroom. Assessing students' perceptions provided the means of gauging this issue, and the results are better able to inform physical science teachers' future uses of the ELMO.

As noted earlier, a dearth of current research has been conducted on students' perceptions of ELMOs, especially at the secondary level. Consequently, I proposed to ask a "how" question. Namely, I wished to know how students came to think of their classroom ELMO experiences. By doing so, I sought to unearth and explore how students perceived the ELMO's use in my physical science class. Qualitative research in which

thematic analysis was applied via transcript examination provided the best way to meet this goal.

Population of the Study

The population of the study consisted of freshmen physical science students. Particularly, the results have some degree of external validity for suburban, secondary public high school students. The results of the study are most applicable to Caucasian students in the Midwest and of average-to-above-average socioeconomic status.

Sample

Sample criteria. The participants used in this research were the students assigned by normal administrative scheduling to my physical science class. I collected data on all students in both classes. Class A contained 28 students and class B contained 28 students. Physical science is standard level science course. There are no prerequisites for this class other than passing 8th grade.

Rationale for sample. I used my assigned physical science classes because that is the most realistic population for this study. As a teacher, it is not a viable option to achieve a random sampling of students due to the nature of the high school setting. Since I only studied two classes, I collected data on all my students in order to attain a reasonable *n* of 28 students for each class. The total number of students achieved enough data collection to provide saturation (Charmaz, 2005) which will be described in more detail later in this thesis.

Methods of sampling. Sampling from the population occurred through class assignment. The guidance offices from each of the three units selected and assigned students. No sampling occurred in the data collection process since data was collected

from all students. Naturally, my classroom sections constituted a sample from all suburban, public, Midwest high school physical science students.

Procedure

Instruments. The instruments used for data collection involved student journals and interviews. The student journal prompts were provided to students and were the same each day. For each prompt, students were asked to write a minimum of two sentences daily. Following were the prompts:

1. How was technology used in today's class activities?

Benefits:

2. If the ELMO was used today, how was it helpful to you? Explain.

If the ELMO was not used, what types of visuals were used, and how were they helpful?

Limitations:

3. In regards to technology, what did you not like or was not helpful about today's class?

Improvement:

4. How could have technology been better utilized in today's class?

Interview questions were prepared beforehand around the major constructs of benefits, limitations, and improvements (Appendix A).

Pilot study. The pilot study occurred after the first AB cycle four weeks into the study. During this time, I conducted semi-structured interviews with 5 students from each class in order to field test the interview questions. These students were randomly selected

for the interviews. The information from the resulting interviews allowed me to revise the interview questions in addition to gauging the amount of time needed in order to accomplish my goal of 7-10 minute interviews.

Data collection methods. Two main types of data collection occurred: journals and interviews. First, students wrote in a journal three times a week. The students kept these journals in their science binders specifically for this purpose. I gave the students time at the end of each class to comment on that day's class in regards to technology use. The journal prompts were typed and distributed to the students to put in their binders and extras were always available if a student could not find their own. Students dated each entry and responded to all prompts each time they wrote in the journal.

The second set of data consisted of semi-structured interviews that I conducted. Each student's parents or guardians gave permission to conduct the interview (Appendix A). I completed all interviews within two weeks of the end of the study. Each interview lasted 7-10 minutes. After the first round of interviews was completed, I selected certain students from each class and conducted a second interview with each of them (Firmin, 2006). My choice was based on the nature and quality of the data those students provided as well as emerging themes from the original transcripts. This second round of interviews occurred within 3 ½ weeks of the ABAB teaching design.

Relevant ethical considerations. This action research created no harm to the students involved. I taught in a normal style and approach. The only change included adding the ELMO as a treatment to measure students' perceptions of its benefits and limitations. Since the students involved were minors, I obtained informed consent from the students' parents or guardians (Appendix B). They granted permission for their

respective student to participate in the interview and have it taped and transcribed. I also received assent from the students who agreed to participate. Both parents and students were informed that confidentiality would be kept throughout the process. I was the only person who knew their identity. All names used in the write-up for reading clarity are pseudonyms.

Treatment variable. The treatment variable was the use of the ELMO. This was manipulated within the two classes. The assessed variables were the students' perceived benefits and limitations of the ELMO. Areas from which students saw improvement needs also were noted.

Methods of data analysis. All of the journal entries written by the students were organized by date. This allowed me easily to compare reactions of ELMO use and traditional teaching for each entry. Each interview was transcribed and organized according to the respective questions.

Data analysis involved coding (Auerbach & Silverstein, 2003), which involved assigning category names to segments of data. Coding involves asking questions of data, perhaps most fundamentally, "Of what is this an example?" Subsequently, these codes and the associated data in the document are compared to discover consistencies of meaning and distinctions between different codings. When consistency is found, the result was a coding category, which became more precise by making additional comparisons with other data from the site. The first round of coding transpired by comparing reoccurring constructs throughout the data. Doing this allowed me to add emerging codes and remove other codes that did not frequently appear. This produced a

master list of codes. Subsequently I evaluated the data for those codes from which the themes eventually emerged.

Safeguards to internal and external validity. I conducted this study in my classroom which allowed me to engage in self-reflection (Shank, 2005) continually throughout the process. Throughout that time, I continually monitored my perceptions and impressions through personal notes. This self-monitoring, as well as the extended period of observing allowed me to correct misconceptions and observe the many varieties of the responses considered. In addition, I included in the results a discussion of how my background may have influenced the research. I also note in several places my surprise at certain findings, another indication of self-monitoring and thus internal validity. I also engaged in negative-case sampling to contest researcher bias (Mahoney, 2006). This strategy makes use of purposefully looking for examples in the data that disconfirmed my prospects.

The students assigned to my physical science class represented a range of abilities and attitudes toward the established academic system. This potentially could have affected their perceptions of the ELMO. To help strengthen the study's validity, the ABAB design allowed each group to be used as its own control (Wiersma & Jurs, 2009). This supplied the students with a natural comparison of their class experience with the ELMO and their class experience without it. Furthermore, to increase the validity of my findings I used low-inference descriptors in the analysis of the data (Kemmis & McTaggart, 2008). This means I used words that closely aligned the student's voice. I also incorporated many direct quotes from the students to communicate their perceptions clearly.

Triangulation also helps strengthen the internal validity of qualitative research (Schram, 2005). Triangulation involves obtaining multiple perspectives of the same event. When those perspectives coincide or are similar, this suggests some degree of validity. I enhanced internal validity specifically through data triangulation. In particular, I used more than one method of data collection, having students keep reflective journals of their perceptions and also interviewing them individually. Consequently, the conclusions drawn from this study do not hinge on a sole data source.

Additionally, I conducted multiple interviews in two waves (Firmin, 2006). Conversational interviews are most useful when multiple interviews are conducted with each participant. The benefits of multiple interviews include enhancing rapport and providing opportunities for the researcher to check understanding. The participants engaged in member checks (Hatch, 2002). This is where those interviewed are asked to verify, dispute, or revise categories and other emergent findings. After the first wave of interviews, I had the participants look over my findings. I clarified some of the findings and the participants agreed with them. Additionally, I communicated my tentative conclusions with a focus group. I reflected afterwards on their feedback and how they perceived my stated results. My results made sense to the participants, and their feedback was compatible with my conclusions. This further ensured internal validity. Ultimately, qualitative internal validity is established by evidence of the findings. Believability, including sufficient raw data in the report, such as quotations from participants, remains so that readers are allowed to reach conclusions on their own and generalize to their own individual settings as appropriate. I provide numerous citations of students in later chapters, including raw data as evidence for my conclusions.

Another means of confirming the trustworthiness of qualitative research is by using an "audit trail." This involves the researcher archiving research materials. Gibbs (2002) describes how audit trails can occur in a number of ways: 1) raw data in the form of videotapes or handwritten field notes, 2) the products of data reduction and analysis such as theoretical notes, indications of data synthesis and reconstruction such as reports and descriptions of category structure development, 3) notes on the process of research such as methodological notes, documents that reflect dispositions and intentions such as personal notes and the research proposal, and 4) information about instruments used such as forms and schedules. These can then be made available for an external audit. I have kept a personal journal throughout the study, as well as the transcriptions of the interviews, which constitute an audit trail that can be examined. In conclusion, it can be noted that internal validity for the present study is addressed in many different ways by qualitative researchers. Several of these were considered in my research. The establishment of internal validity involves the degree of confidence placed upon findings, not absolute determination.

Reliability is more difficult to assess in qualitative research because its goal of developing and describing categories, rather than counting behaviors in those categories, precludes rigorous measurement procedures (Bogdan & Biklen, 2006). The concern for reliability within the quantitative paradigm can be contrasted with the desire for divergence (developing many categories and elaborating or refining them) within the qualitative paradigm (Rubin & Rubin, 2004). Reliability describes the consistency of the measuring instrument, and the instrument in qualitative research is the researcher.

However, some qualitative researchers (e.g., Berg, 2008; Wolcott, 2008) suggest that a

degree of reliability is desirable. Reliability is fostered by using low-inference descriptors; comparing multiple observers viewing the same events, which is inter-rater reliability; asking peers to examine findings; or mechanically recording data.

In this study qualitative reliability was fostered both interpersonally and mechanically. I developed and revised major categories of responses listed by students interviewed in my classroom study. In the process, I discussed with fellow science department teachers these categories at length, particularly in relation to what responses belonged to which categories. After numerous discussions and changes in categories, over several days' time, I eventually achieved categories and responses within those categories. In addition, qualitative reliability was addressed mechanically using audiotaping interviews. These were analyzed for reliability through complete transcription.

The results of this study are not generalizable to a large population because random sampling did not occur. External validity of the research is negatively influenced because of this, though, generalization was never the main goal. The greater intention was to provide information and inform educators of the ELMO's use in the particular classroom I studied. In spite of the fact that the results cannot be completely generalized to a greater target population, the results can, to a lesser degree, be generalized to analogous groups of students with teachers who possess comparable characteristics to the individuals in the present project.

Chapter 4

Results: Qualitative Analysis

Overview

This study analyzed students' perceptions of the ELMO's use in a physical science classroom. To compare student responses, the overhead was used as a pedagogical control. Throughout the phases where the ELMO was employed, I developed specific demonstrations to be used with the ELMO's digital camera. These included reactions on a small scale for safety issues and microscopic slides to be used in conjunction with the zoom function of the ELMO. When using the overhead, the same notes and activities were employed. However, the notes were written on transparencies or the glass itself with colored markers and then wiped off. Pictures and diagrams were drawn as well or copied onto a transparency. Similar review games and other activities were kept the same. As much as possible, the classes remained similar, except for the use of technology. To help insure this, each student was asked during his or her respective interview to compare the way the teacher taught the material when using the ELMO compared to the overhead. Most students replied that the teaching did not change at all or very little.

Examining the students' perceptions of the ELMO's use, as compared to the overhead, resulted in perceived educational benefits for the ELMO's use by the students. I found that the ELMO increased the interest level in the classroom and made instruction more engaging. Students described the ELMO as interesting because it was new technology they had never seen which invoked a heightened sense of curiosity about the

content. Instruction also was perceived as improved by presenting clearer, more engaging visuals and notes. Students expressed areas of caution in the ELMO's use. Limitations such as autofocus, brightness adjustment, and auto color adjustment were noted.

Similarly, the students detailed areas for improvement in the ELMO's use. These included more student interaction with the ELMO and increasing the use of more visuals.

Results

Interesting Aspects of the ELMO

Stimulating. Students clearly articulated that the stimulating aspects of the ELMO was one of its main benefits. Reasons for this perception included increasing their attention span, being a new and interesting piece of technology, and providing more interaction during classroom instruction. During interview discussions with the students, many commented that the ELMO was not boring, as they sometimes described the overhead projector—in comparison. For example, Jonny stated: “The overhead, it’s just a plain overhead. You always have those, so it’s the same old same old and not that interesting. The ELMO, that’s a lot more interesting.” This sentiment was echoed by another student, Dave, who stated: “I’m more excited to use the ELMO than the overhead because I use that in every other class.” Students’ desire to learn and their ability to stay focused longer were noted as being connected to the ELMO being interesting and not as boring. Despite the identical content being taught in both classes, students consistently indicated superior focus on days when the ELMO was used. For instance, Joy remarked: “The ELMO’s more fun just because it’s different than what we’re used to, so I do pay more attention when we’re using the ELMO.” This idea was substantiated by multiple students such as Jenifer who stated that the ELMO “is easier to pay attention to for sure,”

and Megan who stated: “Yeah, I feel like I pay attention more when you’re using the ELMO.”

The fact that the ELMO was a new piece of technology, as compared to the overhead, also engaged the students. Many students verbalized that they had habituated to the overhead’s frequent use in school. Therefore, having a new piece of technology to operate increased their interest in this particular class. The dynamic was illustrated by Penny: “I had a higher interest level because the ELMO is new and I’ve never seen it before.” George echoed this thought, simply stating: “It’s sweet technology. It’s something new.” In sum, a consistent response when questioned about the ELMO’s use in the classroom was the novelty aspect, adding interest to the course presentations.

Realtime. Students also found the ELMO interesting as a result of the realtime feel vis-a-vis digital camera. This included mainly the interaction elements of the equipment. The ELMO allowed all to see the unhindered distribution of concepts. It also provided a means to show the students the step-by-step process as I, the teacher, did the work with them. For example, Bobby stated: “I think the ELMO helped my understanding in how to use certain equations because it actually showed me how they’re done.” Sam similarly commented: “You get to learn more because you’re writing it and doing the steps.” Having the same piece of paper placed on the ELMO, as the students possessed in front of them, engaged them and provided a perceived connection that the overhead did not. Rachel summed the sentiments of most students in the class when she stated: “Well, with the ELMO we can actually see where you’re filling in blanks...like the actual spots. It’s the same, real paper we have.”

Students also mentioned the realtime nature of the ELMO as being helpful because it reduced the concepts into simpler, more chunkable pieces to which they could connect previous learning. Jessica conveyed this thought when she stated: “The ELMO helps you focus on specific pieces of information. A large idea is broken down to a size I feel more comfortable with. Those smaller pieces are easier to see where they came from.” Specific concepts in which the realtime nature of the ELMO clarified their conceptual understandings included most math intensive concepts such as Boyle’s law, Charles’ law, and isotopic averages as well as some relatively abstract concepts. Zach related this perception when he stated: “When we’ve been doing all the combining and adding atoms, it has made it easier because that’s kind of hard to understand. So having the ELMO, you can see what’s going on a lot easier.”

One aspect of the realtime nature of the ELMO that is distinctly different from the overhead is its ability to show motion pictures. From a teacher’s perspective, this ability allows a simple demonstration to be viewed by all students without having to risk the danger of every student working individually (as occurs in a laboratory setting). The ELMO allows reactions to be seen close up, even though students are at a safe distance away. Not being able to perform the demonstrations themselves seemingly did not detract from students’ continued interest. Alice summarized the thought when stating: “It’s easier just to demonstrate things on the ELMO where the whole class can see, rather than all of us going up there and some people won’t be able to see because there’s so many people in the class.” Bobby, referring to a demonstration, similarly stated: “When you put the ELMO on that beaker of water and you filled it up, that helped me see what’s actually going on.”

The realtime aspect not only helped students in understanding the concepts, it also was viewed as helpful to aid teacher explanations. The students voiced a need to think aloud the construct's process in order for them to better comprehend. Doing so trains the students mentally to work out the scientific procedure. Mitchell summarized the consensus of the class when he stated: "I think the ELMO helps me learn when you talk through the problems as we see them. It's cool how you show us what to look for and how to do the problems as we're doing them." Visually, students saw the work coupled to the thought process when the ELMO was used. Students asked questions throughout the procedure and the teacher quickly and efficiently clarified potential misconceptions. Alice perceived the process in this way, when she stated: "Using the ELMO makes you go more in depth." In short, the ELMO's use was described by students as helping to solidify their learning and to facilitate their understanding at deeper-levels that likely they would otherwise.

Enhanced Instruction

Improved visuals. The ELMO proved to be a useful tool in enhancing classroom instruction when compared to the overhead by enhancing both visuals and notes. Visuals were described as brighter, clearer, and more colorful on the ELMO. As a result, these higher quality visuals were said by students to enhance their learning. When asked about the visuals on the ELMO, all students preferred them to overhead transparencies. The color, brightness, and sharpness of the ELMO's visuals were affirmative attributes frequently mentioned by the students. Mark, for example, described the ELMO's attributes, stating: "The ELMO...it's clearer, easier to see, sharper, great quality, and you can zoom in." The colors were said to make the visuals easier to see for the students and

to capture their attention more than the transparencies did when colored pens were used on the overhead. Many students mentioned the pens as being blurry and faded. Julie mentioned her frustration in this regard, stating: "I don't like the overhead because the markers can get kind of smeary so you can't really see everything." Summarizing, students believed that the color and image quality of the ELMO improved the visuals by increasing their interest and focusing their attention on the lesson being taught in class.

Students also perceived the ELMO's ability to elucidate greater visual detail. The students overwhelmingly preferred pictures and diagrams retrieved from the Internet over the teacher's handwritten pictures and diagrams when using the overhead. Ryan spoke for the students when he stated: "Everyone likes the pictures over your drawings. They are way easier to understand." With the Internet hosting an inexhaustible supply of sites where pictures and diagrams can be found, the ease to generate these drawings posed no additional hassle. By placing the pictures on a secure digital card, they could be viewed exactly as they were found on the Internet. The secure digital card also allowed videos to be saved and shown, not only from the Internet, but from cameras as well. This aspect of interest (video from camera) allowed students to record their own experiments at home and bring them in to show the class.

In discussing the potential benefits of the ELMO, many students referred to specific concepts and procedures in which the quality of the picture or diagram aided their understanding. This was illustrated by George's statement:

In science class, if a teacher wants to show me a diagram, the ELMO allows them to just put the picture up there from the textbook so it's easier for me to learn. On

an overhead, the teacher would have to draw out the diagram...it's just easier and more helpful on the ELMO.

The ELMO also was perceived as more useful for pictures and diagrams because it did not deter students from their train of thought, even when the visual changed. The ease of transition between non-visual concepts and illustrations helped to enhance instruction.

Rose mentioned this idea in her statement:

The ELMO helps me learn because I can understand the concepts more clearly and in a better fashion. The ELMO's ability to connect to the computer, where the overhead can't, gives us pictures which help explain things better. You don't even have to move anything...you just touch a button and we're back to the idea again.

The ELMO eliminated the distracting aspect of changing transparencies. Students' perceptions of undistracted instruction changed little using the ELMO, while the use of the overhead caused distractions.

Improved Notes. In addition to the improvement of visuals, the students also perceived the ELMO to improve note taking during classes. Students commented that the notes were easier to follow and less confusing than when they were when presented on the overhead. Kristen mentioned this aspect of note taking when she stated: "You can see the notes, actual diagrams, and worksheets on the ELMO that you're working with and it's the same sheet." The students preferred seeing the same piece of paper that they had in front of them instead of a transparency. The students also mentioned the perceived neatness (or lack thereof) of the teacher's handwritten notes as important to them.

Stephanie, for instance, described her note taking experiences with this statement: "The

overhead is messier and with the ELMO you have the notes right there. Sometimes you're filling it in as we go...I know exactly where we are."

The notes on the ELMO also were easier for students to view from their seats than were the notes on the overhead because the students perceived the notes to be larger (due to the zoom function) on the ELMO. The overhead posed a problem because in order to make the notes larger, the entire projector needed to be moved further back from the screen. Rachel's statement illustrated this issue: "When we use the overhead, if you're sitting in the back of the room it's hard to see because it's out of focus or just smaller. With the ELMO, you can zoom in on the paper and see everything." The zoom function also allowed the students' attention to be focused specifically on one particular concept instead of being distracted by other parts or pictures also present on the paper. Zooming in to a proper size for students to see made this tendency to occur naturally. Phil summarized the sentiments of most students in this regard: "Well, the ELMO...you can zoom in to different words and like the definitions so it focuses my attention right where we're at better."

Instruction Suggestions

Limitations. Limitations inherently exist in any piece of technology; the ELMO is no exception. To assess this, students were asked to explain any potential problems or distractions that they particularly noticed regarding the ELMO's classroom use.

Technical problems, though minimal, were unanimously noted as one of the issues. Many students mentioned the ELMO's tendency to shift colors in order to adjust to different colored paper. This shifting would change the color of other objects in view (e.g., the teacher's hand) as well as wash out or lighten the page too strongly so the text could not

be seen. A simple matter of manually readjusting the brightness typically would fix the problem. Rodger described the distraction in this way: “Sometimes the color fades in and out when adjusting the ELMO or when you’re moving the paper around, but the ELMO fixes itself most of the time.” No student mentioned the occurrence as a major distraction and seemingly habituated to it over prolonged use.

The zoom function, previously stated as being positive, also was perceived by some students to be a distraction. Depending on the format or size font of the worksheet or sheet of notes being used, the zoom function was employed in order to ensure all students could see the work easily. How proximal or distal the zoom needed to be was sometimes an issue of debate among the students. Paul illustrated this phenomenon when voicing his frustration:

The only thing I would see wrong with the ELMO is the few minutes each time you want to use it there is a disruption over having it at different zoom levels.

You can never make a room full of children happy. There are a thousand different possibilities you can have with the ELMO with its technology. I think the teacher should set it at one level they are comfortable with and move on.

This class debate among students, although minimal in time, added up over the course of the week and was an unnecessary distraction.

Improvements. When exploring possible improvements, the majority of students articulated the desire to interact with the ELMO themselves. In regards to interaction, Penny stated: “You could let us do more things than we actually do with it. Instead of just watching you could let us do more activities with it.” The ELMO appealed to students as a new piece of technology that is both interactive and hands-on. Joy stated this: “I think

the fact that the ELMO is new and not a lot of people have used it draws interest to us.”

The more interaction students had, the more familiar and comfortable they were with using the ELMO. Allowing this to occur, students can peer-assess and problem-solve efficiently and productively.

Students also requested additional demonstrations so that the ELMO’s video capabilities could be utilized. Dave stated the advice offered by most in the class: “Put more examples and demonstrations under it. Take advantage of the fact that you can put anything under it and see it on the board.” The students desired these demonstrations because they offer a practicality and connection to the sometimes abstract concepts being taught. Phil related the suggestion that summarized the sentiment of most students on this point: “You could like do experiments under it for what we’re covering right now so we could actually see it and connect it to the notes.”

Summary

In sum, the study offered insight into the student perceptions of the ELMO in the physical science classroom. The benefits of the increased engagement-level of students, improving visuals, and improving notes clearly emerged from the garnered data. Students perceived the ELMO in an overall positive light and being able to aid in learning. When asked about the overhead, students perceived it more as a distraction and hindrance to their learning than an engaging piece of instructional technology. Students also perceived the ELMO to bring a cohesiveness to the classroom that the overhead did not. Paul mentioned the idea when he stated: “With the overhead, you’re not on the same level as the students. With the ELMO, you’re right there with us.” The limitations of the ELMO observed by students mostly were minimal and not perceived as major instructional

distractions. Most ideas mentioned to improve the ELMO's use involved increasing their own interaction in the classroom or increasing demonstrations.

Chapter 5

Discussion and Implications

After appraising the results of this action research, it is clear that the ELMO has the ability to be a valuable educational tool across many classroom settings. Most teachers would desire the potential benefits the ELMO offers such as engaging students, increasing interaction, and improving visuals. The limitations voiced by the students are seemingly outweighed by the potential benefits and could be overcome with increased support and training. The reported results lead to practical applications and also can be used in further studies.

Interpretation of the Results

Catered to the technological interest of students. In the present study, students frequently referred to the novelty and technological facets of the ELMO. The present world of most students is riddled with technology. Beyond the confines of the classroom, students are bombarded with a plethora of stimulating mediums such as television, the Internet, cell phones, I-pods, and video games. The ELMO also offers a certain variety of stimuli that can be used to engage students. In particular, the ELMO may increase the attention of those who are easily distracted by traditional lecture style teaching environments and non-interpersonal activities. Almost all students mentioned the ELMO's live video streaming in their interviews and journals. This lends credence to their desire for types of stimuli that align with their lives outside of the classroom.

Increased satisfaction and interest level of students during class. The ELMO also was observed to raise student satisfaction and interest level during class. For example,

many students purported the visuals and notes as being more enjoyable on the ELMO versus the overhead. The overhead was viewed as blurry, loud, dark, large, and boring. The ELMO, in contrast, was observed as being bright, compact, and engaging. This reportedly increased students' concentration levels in class. The unique experience offered by the ELMO was mentioned frequently by students as well. They have not interacted with the ELMO before now and so it still offers a sense of intrigue. Overall, students enjoyed the uniqueness of the ELMO which resulted in a more interesting class time. Also, the video function increased their engagement, for many students referred to the live video capabilities as increasing their attention and interest in class.

Increased understanding of physical science concepts. More enjoyment was not the sole perceived benefit, for many students noted that the visuals, demonstrations, and interactive elements increased their understanding of physical science concepts. Seemingly, the ELMO drew on two learning styles: visual and kinesthetic. Students perceived that visual learners were better served with the ELMO than the overhead. Visuals on the ELMO were described as being more colorful, sharper, and realistic. Consequently, students saw this to increase the understanding of the concepts at hand. Students also mentioned demonstrations that allowed emphasis to be drawn to the real-life aspects of conceptual frames of reference. When not using demonstrations, complex chemical reactions were written out in a sequential fashion, and the students had to visualize the reaction on their own. When using demonstrations with the ELMO, the students could actually see the chemical reactions occur. This appeared to clarify and deepen understandings. The demonstrations allowed for greater discussions and aided students in recollecting information as well.

In addition to the visual elements, the ELMO also increased student understanding through its kinesthetic components. Students reported involvement with the material, which helped to clarify their understandings. Also, students noted that personal involvement increased their engagement levels. This further served to increase comprehension, as students must be engaged in the material for the learning process to begin.

Improved teacher instruction. The ELMO not only offered student benefits, but it also improved teacher instruction by augmenting the available educational resources. In this study, the students perceived the ELMO to facilitate more orderly lessons. This was not an inherent benefit of the ELMO, but it was a secondary result of teacher planning and utilization of the ELMO's resources. For instance, many students mentioned the focusing nature of the zoom function used by the teacher as useful for instruction. The ability of the ELMO to display pictures and videos from multiple resources such as the Internet and secure-digital cards was seen by students to increase the quality of visuals. Students also noted the typed notes on the ELMO, eliminating the issue of reading the teacher's handwriting.

Useful education tool with available infrastructure and support. Given the multiple educational benefits and relatively few reported limitations, the ELMO, overall, seems to be a potentially beneficial addition to teaching classrooms with the proper infrastructure and support. Based on the present study, one problem noted by students was the auto-brightness adjustment. However, this can be minimized with turning the auto-feature off and adjusting brightness manually. Since the auto-brightness adjustment

changes with different colors of paper, keeping a uniform color of paper would serve to minimize the brightness issue as well.

Limitations voiced by students also provide evidence of other infrastructure elements to be considered. For instance, placement of cords should be well thought-out. Students noted the teacher or fellow students could trip on the cords that extended from the desk to the outlet on the wall. This may pose a safety issue in classrooms. It could also cause damage to the educational technology equipment as well.

Other problems stated by students can be minimized with a greater understanding of the ELMO's functions. For example, some students mentioned having difficulty with the focus. This distraction can be solved with practice and instruction with the ELMO's use. Some students noted minor technical difficulties, and most of these could be alleviated with proper training or technical support.

Potential Applications of the Findings

Carefully consider the available space and the ELMO's potential use. Teachers need to consider the available classroom space when deciding how to arrange the ELMO. Often classrooms are crowded and, if an ELMO is being added, then its placement needs to be carefully assessed. Issues to consider include available outlets, proper viewing mediums, and space for the equipment and cords. This will help determine the ELMO's physical placement and the type of equipment to purchase. If resources exist, a mounted projector or TV is ideal. Teachers need to have a student-free area to extend cords or a method to secure them. Having the ELMO encourages increased student involvement. Therefore, the placement of the ELMO so that all students can access it and easily view it is important.

Invest adequate time and resources. In addition to deciding set-up issues and potential applications of the ELMO, training should be implemented for teachers. The company from which the ELMO is purchased provides valuable online resources and strategies for proper use. This will allow the greatest educational benefit to be gained. Once trained, teachers need to practice using the ELMO and allow time to create and search for quality usable materials. In the present study, much teacher time was afforded in researching various small-scale demonstrations to be viewed with the ELMO.

The relatively substantial price of ELMOs also must be considered. If adequate resources are not available, schools should research grants or consider buying a limited number of ELMOs to be placed in general education classrooms. In the present study, a specified number of ELMOs was obtained particularly for use in the science classrooms.

Increase organization and presentation of lessons. Using the ELMO can allow for greater organization and better flow of class time. For example, when using the overhead and computer conjointly, I would have to unplug the projector and move it in order for the overhead to be plugged in and situated for all to see. The time necessary to make those changes was both tedious to me and distracting to the students. Since the ELMO interfaces with the computer already, changing from the computer to the ELMO and visa versa allowed the students to stay focused on the material at hand.

When using the ELMO, it is important to ensure that the zoom is set close enough to be viewed by the entire class, for ease of viewing was a benefit of the ELMO mentioned by many students. For example, many students mentioned that the notes on the ELMO were easier to see because they were larger. Students also were reportedly

drawn to the color of the ELMO, so teachers need to experiment with different color backgrounds and contrasts for attraction and ease of viewing.

Increase variety in the classroom. The ELMO can easily serve to increase variety in the classroom. Interfaced with the computer, the teacher can easily move back and forth from PowerPoints, Word documents, excel spreadsheets, or graphs and tables to movies and pictures stored on secure digital cards housed in the ELMO itself. Another useful function of the ELMO is displaying tests, worksheets, or labs in the ELMO as the teacher reviews the instructions or answers. This allows the students to follow along on their own document as the teacher emphasizes key words or instructions on the ELMO.

Another positive addition mentioned by students that the ELMO brings to the classroom is the ability to view demonstrations that could otherwise not be seen from their seats. These quality demonstrations were indicated to improve student understanding and clarify explanations. The present study also found these demonstrations to engage the students and aid the learning process. They serve significant roles in visualizing the complex chemical concepts such as single-displacement, double-displacement, acid/base, synthesis, and decomposition reactions. The demonstrations can be used to introduce the subject, aid in teaching, or as a review. Searching for quality demonstrations is time consuming. It is important to find demonstrations to fit the academic level of the class being taught. Some demonstrations may be too dangerous regardless of how far the students are away.

Increase involvement of students in the classroom. Finally, the ELMO can serve to increase student involvement in the classroom. In the present study, many students suggested they have more opportunity to personally use the ELMO. This would continue

to increase their interest and engagement. One way this can be accomplished is by having students answer questions at the ELMO in front of the class. Another way to increase involvement could occur by assigning a topic to groups to research, and then have them use the ELMO to teach the subject. However, for this to be successful much time may have to be allocated for training in the ELMO's use.

Biblical Integration

As a Christian educator, integrating technology, such as the ELMO, into the classroom also must be analyzed from a Christian perspective. Since Creation, God has called us to be stewards with what He has provided. God gives three clear commands in Genesis 1:28: be fruitful, fill the earth, and subdue it. Being fruitful involves procreation and proliferation, filling the earth involves adding value, and subduing involves taming the creation. Later in Genesis 2:15 these commands are reiterated as God stated that Adam and Eve were to “cultivate and keep [the garden].” Cultivate could be translated culture, and keep could be translated to take care of. Therefore, this command, then, can be interpreted that Adam and Eve were to create culture and take care of it. Adam and Eve were to be stewards of all that was entrusted to them, and being a steward involves adding value. This is exemplified in the parable of the talents in Matthew.

In education, adding value includes using the available tools to further enhance the educational process. A proper, Biblical response to technology must be formulated if any enhancements are to occur. Technology and all of its effects must be a servant and not a master. In 1 Corinthians 9, the Apostle Paul described the importance of keeping a goal in front and what it then takes to achieve a goal; in this case, he wrote about spreading the gospel to as many as possible, and then states in verses 25-27: “And every

man that striveth for the mastery is temperate in all things. Now they do it to obtain a corruptible crown; but we an incorruptible. I therefore so run, not as uncertainly; so fight I, not as one that beateth the air: But I keep under my body, and bring it into subjection: lest that by any means, when I have preached to others, I myself should be a castaway.”

When there is a main goal, everything else is to be subject to that goal. Furthermore, the goal itself is to be worthy of this attention. In the life of the Christian educator, all is to be subservient to following after Christ. If this is to be true, then all matters of technology must also be subject to a life of discipleship under the headship of Christ.

Going further, the use of technology should bless one’s spiritual life. Perhaps it may seem odd to think in this manner, yet, Christians have most likely been blessed by the presence of the printed Scriptures in his home. Over 500 years ago, the printing press was invented, and soon printed materials became readily available to people. Today most North American homes have not one but several printed copies of the Bible. Have not these Bibles, so readily available, been a source of great blessings to God’s people? So yes, technology can be a blessing to one’s spiritual life. Another idea is technology should be used to enhance the witness of the church. When radio became popular in the twentieth century, many people were enamored with the technology and listened to many programs. Christians used this interest to begin broadcasting Christian material, especially sermons and Bible teachings. A great number of unchurched and unconverted people listened to these programs, and the witness of the church grew to include many people who otherwise might not have entered the door of a church.

I believe one principle from Proverbs is the key in relating to technology: Keep thy heart with all diligence; for out of it are the issues of life. (Prov. 4:23) This is really

the crux of the issue. If one's heart is not kept safe from evil and harm, it will lead to enormous problems in life. Nearly all the disadvantages, the dangers and the problems associated with misuse of technology are caused by not being diligent to keep one's heart safe. It is for this reason one must apply appropriate safeguards and restrictions, given the weakness in the human heart. With one's very spiritual life at stake, there is little room for error.

With both the culture and educational process having embraced technology, I must wisely use technology in instructing my students. Clearly, all Christian educators can take the Biblical principles of stewardship and diligence and apply them to education. Technology is rapidly increasing throughout society, and this must be reflected in the classroom appropriately. I believe that with proper training and consideration, Christian educators can successfully use technology to engage students in the learning process further.

Relation of the Results to Literature

Analyzing the results in light of the current literature gave insight to student observations of the ELMO. Previous research studies support the present finding that the ELMO increases the engagement level of students. In the current study, students generally referred to the overhead as dull and referred to the ELMO as new and exciting. Similarly, students using technology in Furr, Ragsdal, and Horton's study (2005) believed that the multimedia engaged and held their interests. Interestingly, students commented that an overhead is boring and causes them to fall asleep a phenomenon mentioned by the students in the present research as well. Wellington's (1999) study of multimedia instruction in chemistry classes found comparable results. He reported that

multimedia elements increased the enjoyment of students and grabbed and maintained their attention.

The finding that the ELMO increased student understanding also is supported by previous research. In the present study, the improved visuals were viewed as a key element for increasing understanding. Research by Wall, Higgins, and Smith (2005) also reported visuals promoted learning. Students positively mentioned science and noted the elements of “realism” that the ELMO allowed. Many students in the current study also viewed the visuals as being colorful, in-depth, detailed, and realistic. Wellington’s (1999) study on multimedia instruction reported similar results regarding the added value of technology. He found that technology offered attractive graphics and dynamic images and animations. In addition, Gabric et al.’s (2005) findings were congruent with the present research which indicated that quality visuals and animations improved student understanding of biological concepts. In contrast to other studies, the perceived value of animations was a prominent issue discussed by students in the present research. Previous research minimally mentioned the student perception of animations. Also, Wellington (1999) mentioned that technology aided understanding as a result of the movement of visuals.

The ELMO not only affected student enjoyment and learning, but it was found also to affect teacher instruction. Students in the current study perceived the ELMO to improve teacher explanation and organization. Similarly, Wall et al. (2005) found that the technology used helped teachers explain concepts and caused them to be more enthusiastic and innovative. Gerard et al. (1999) also reported teacher improved organization skills and presentations. Students in the current research also perceived the

ELMO to aid instruction. I found that students mainly observed lessons to be more organized as result of my use of the ELMO.

Strengths of the Study

This project involved action research which resulted in seemingly robust findings that can be applied to other educational settings. The ABAB design of the study allowed each class to serve as its own control. Each class received a total of four weeks of both overhead and ELMO instruction, on an alternating schedule, consequently students were able to clearly differentiate each instrument's instructional effects. Most students had no exposure to the ELMO before this study. Therefore, their previous experiences and bias were minimal factors in analyzing the results.

This research focused on the ELMO's use in one classroom and, thus, drew attention to its effects on physical science instruction. The ELMO was the only mediating variable in the two classes. As much as possible, other variables such as instructor, activities, assessments, and labs were kept constant between the groups. Therefore, this allowed students to draw relatively focused conclusions on their differing perceptions of class time with the use of the overhead and the ELMO. Also, addressing one subject area allowed greater detail and depth of discussion, especially in regards to the ELMO increasing student understanding of concepts. The reported results are most applicable to the physical science classroom setting.

The study was strengthened by the use of multiple qualitative methods: individual interviews, individual member checks, listening to audio recordings, and to a minor extent artifact collection, such as reading students' journals. The methods of data collection involved triangulation which strengthened the study's internal validity.

Saturation occurred in the interviews, suggesting that the sample size was adequate for the study's intended purpose. Having the students write in journals 3 times a week allowed their daily views to be analyzed. These then were compared to their final views as voiced in the interviews at the study's completion. All students were interviewed which provided a rich data set. The interviews were transcribed, and the participant checks of the themes reported in the thesis provided verification and added confidence in the study's internal validity. Particularly, after the results were analyzed and common themes were found, I discussed the findings with a focus group of 5 students for one class and 6 students for the second during their second interview. The data from these interviews further confirmed the findings. Analysis of the journal entries and transcripts showed consistent and repeated results. Saturation was apparent as additional data collection likely would not have produced novel results.

Limitations of the Study

Remaining threats to internal validity. A wide range of information offered by students, both in depth and detail, resulted from the use of student journals and interviews. Many students afforded a wealth of data in journals and interviews, but a few students provided relatively little in comparison. Interviews with the latter proved to be shorter as these students sometimes failed to expound upon their replies to questions when prompted. In one instance, a foreign exchange student had a difficult time both understanding my questions and expressing his opinion. However, given that I interviewed all students, enough data was collected to provide ample findings that represented the groups' consensus.

From the observed results, the ELMO was new to most of the students in the study. It was not new to me as the teacher as it was provided during the last quarter of the previous academic year. Since the study was conducted during the beginning weeks of school, this was the first exposure of the ELMO for many students. As a result, the study captured the students' fascination with this new piece of technology. However, the novelty of the ELMO may subside later in the school year. The possibility of this effect could not be studied given the time constraints of the present research.

Remaining threats to external validity. Random selection could not occur in class formation as a result of high school scheduling. Most of the students involved in the study were average students but varied greatly within that average category. The diversity of the students was also limited. All but ten students were Caucasian and all lived in suburban settings. As a result, this study was highly focused on a select group of students, and, therefore, the results are not entirely generalizable to all grades in the United States. Namely, one cannot take the present findings and generalize them across multiple high school populations. Nonetheless, beneficial educational information still can be gleaned from the study and applied in many classrooms sharing similar demographic characteristics.

Suggestions for Future Research

For future research, this study should be expanded to include a greater number of schools with diverse groups of students. Also, how students perceive the ELMO needs to be analyzed in different types of science classes such as biology, chemistry, physics, and the earth and space sciences to draw comparisons among the sciences.

Since this study focused on qualitative issues and drew the conclusion that the ELMO had an overall positive effect on students' experiences, the next logical step would be to analyze these effects quantitatively. For example, students in this study perceived that the ELMO improved learning. Next, actual academic effects that the ELMO has on learning should be assessed. This would further the qualitative findings reported in the present research, promoting theory development and formal hypothesis testing.

Another area for future research involves analyzing the perspectives of teachers who regularly use the ELMO in their classroom. This would further inform areas of effective pedagogical methods and practical suggestions for limiting problems and seen distractions. Such research likely will become feasible as more classroom teachers adopt this technology in their respective classrooms.

APPENDIX A

INTERVIEW QUESTIONS

1. Compare the ELMO to the overhead. What do you like about each and why.
2. What do you dislike about each (ELMO overhead) why?

Potential Benefits

3. Everyone learns differently. Some like visuals, auditory, or movement. In what ways do you think the ELMO helps you learn, compared to the overhead? Give specific examples.
4. Compare your interests/ engagement level in the class when using the ELMO versus the overhead. Does it change? If so, explain how?
5. Why do you think it changes in this manner (as mentioned above)?
6. Can you think of a specific instance when the ELMO changed your engagement level? Explain how the ELMO was used and why it changed your engagement.
7. Compare the way the teacher teaches the material when using the ELMO compared to the overhead. Does it change? If so explain.
8. Compare how notes are given in class when using the ELMO compared to the overhead.
9. Would you prefer the overhead or the ELMO for notes and why?
10. Many visuals and diagrams are often shown in class. compare the quality of these with the ELMO versus the overhead. Be specific in the differences.
11. Think about the concepts we learned in biology so far this year (nature of science, chemistry, cells, photosynthesis, cells, genetics...). Explain two concepts in which the ELMO helped your understanding. How did the ELMO help?

Potential Limitations

12. What do you not like about the ELMO?
13. What problems have you noticed with the ELMO? Give specific examples of any problems that have happened in class.

14. Have you been able to use the ELMO? If so, how easy or difficult is the ELMO to use? Explain.

Improvements

15. Explain two things that your teacher could do with the ELMO to make lessons more interesting.

16. Do you have any other teachers who use the ELMO? If so...
Compare how I use it to how your other teacher uses the ELMO.

17. What makes a teacher “good” at using the ELMO? Explain.

18. Please give a final summary statement on the comparison of the ELMO and the overhead.

APPENDIX B
PARENTAL CONSENT FORM

August 20, 2008

Dear Parent/Guardian,

I hope that you had a wonderful summer and your student is ready for an exciting year in Physical Science. This summer I was working towards my Masters in Education at Cedarville University. This has been a beneficial experience, and I will be using many of the methods and ideas gained in class.

As I near the completion of my masters, I will be working on my thesis this year; this is my final project. I will be researching students' perceptions of the ELMO. This is an awesome new piece of technology that the science department received. Since it is a recent addition in the classroom, it is important to measure its effectiveness and the value students place on it in my physical science class. The results of this research will inform future instruction and use of the ELMO.

To achieve this goal, I will be alternating use of the ELMO with the overhead projector for the first eight weeks of school. Both of these are effective teaching methods. During this time, your student will keep a journal on the use of the ELMO and his/her perceptions. At the end of the eight weeks, I will conduct a 20 minute interview with each student. This will occur from October 20th – 27th. Most of these will be conducted before or after school. Some interviews will be able to be completed if your student's lunch or study hall coincides with my prep. Your student will receive extra credit for participating in the interview. There is also the possibility of a focus group being formed to garner students' collective ideas regarding the ELMO.

At this time I am requesting your permission for your student to have his/her interview taped and transcribed. All information from the interview will be kept confidential and names will be changed in any reports. Please sign and return the permission slip below by August 22nd. I appreciate your cooperation. Feel free to email me if any questions arise.

Sincerely,

Mr. Kirby

I give permission for my student to participate in an interview regarding his/her perceptions of the Smart Board. I also grant permission for the interview to be taped and transcribed. I understand that confidentiality will be maintained.

Student's name: _____

Date: _____

Parent's signature: _____

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