

**The Design, Development and Evaluation of a Problem-Based Learning Module:
Implications for Teaching Digital Technology Skills to Middle School Students**

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ABSTRACT

With the call for a change in the way students are prepared to meet the demands of the 21st century, new teaching methods are under investigation. Problem-based learning is one such method believed to encourage the skills students need to succeed. The purpose of this study is to outline the implications for using this approach to teach digital technology skills. Through this developmental study, a learning module was designed and developed for instruction in an eighth grade technology class. The research study also included an expert review and evaluation of the module through implementation in a middle school in southern New Jersey. The findings are presented and implications include the need for a shift in several aspects of education; a shift in how students are taught, a shift in the role teachers assume through this approach, and a shift in how teachers are trained to implement this teaching approach. Finally, recommendations are made for instructional designers seeking to develop a model for instruction in a problem-based learning environment.

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Chapter 1: Introduction and Background

The Rising *Millenials* in the 21st Century

The National Education Technology Plan (NETP) of 2004 was the result of a “request from Congress for an update on the status of educational technology” (p. 10). Researchers revealed findings that educational technology was prominent and available, but that its application within the public schools was not. The problem, as identified in the NETP, is that, as a nation, the potential of technology within education has not yet been realized. Additionally, “providing the hardware without adequate training in its use – and in its endless possibilities for enriching the learning experience – meant that the great promise of [Internet] technology was frequently unrealized” (p. 10).

Ultimately, the NETP was able to help identify those students currently most significantly impacted by education, as well as their needs and preferences. *The Millenials*, to which this generation is often referred, are more aware of what they want through their education and their personal goals and plans are clear. For example, some of the statistics mentioned in the NETP referring to this generation include: (a) 90 percent of children between ages 5 and 17 use computers; (b) 76 percent want to learn more about the world; (c) 49 percent say they may be interested in pursuing a career in technology; and (d) 96 percent say that doing well in school is important to their lives (p. 17). These statistics suggest that the students in the current generation have an intense drive to become successful people and citizens of the world. To strengthen this

idea, statements describing our “Nation on the Move” refer to a distinct concentration on improving the future of both economic standing and education with the purpose of helping the United States citizens get ahead within competitive areas such as math and science (USDOE & OET, 2004, p. 9). This improvement will occur as students are more adequately prepared to perform as 21st century learners and citizens (USDOE & OET, 2004). This movement is not only noted within research from the United States government, but through independent companies among the modern workforce (“Are they,” 2006; CEO Forum, 2001b). It is evident 21st century employers will be anticipating employees who have been prepared to meet the challenges of participating in global competition, not only with strong technology skills, but higher-order thinking skills as well.

The Challenge Across the Nation

The No Child Left Behind (NCLB) Act, which began in 2002 as a product of the Bush Administration, was designed to close the achievement gap among diverse students, with a target year of 2014 (USDOE & OET, 2004). Title II-D of the NCLB Act, with a focus on “enhancing education through technology,” sets guidelines for school districts regarding how technology can and should be used to “improve student academic achievement” and “assist every student in becoming technologically literate by the end of eighth grade” (United States Department of Education [USDOE], 2002, p. 85). Thus, states have been challenged in finding ways to incorporate technology into the curriculum, assessing students with regard to technology literacy and making sure all students are adequately prepared for their lives beyond K-12 education.

The methods through which states are addressing this challenge vary in the individual definition of standards, approach to teaching the skills and unique methods of assessment. For

example, schools in some states, such as North Carolina and Indiana, concentrate on addressing skills that comply with the demands of the 21st century workforce such as problem-solving, productivity and creative thinking. Schools in other states, such as Arizona and New Hampshire, continue to focus on instructional methods that emphasize skills-based activities, but exhibit definite progress toward including elements of 21st century skills. Still, schools in other states, such as Massachusetts and Michigan, continue to address teaching technology primarily through skills-based instruction with little to no apparent focus on higher-order cognitive skills. For additional information about the overview of these state technology plans and others, see Appendix A.

New Jersey's Response

The Department of Education within the state of New Jersey recognizes that its programs should be addressing methods of teaching technology skills to better prepare students to meet the requirements of the United States government while addressing the concerns of the future workforce. In response, they have developed the New Jersey Technology Assessment Program (NJTAP), which is designed to help identify and develop methods of instruction that encourage both teachers and students to interact as problem-solvers and higher-order thinkers. In addition, participants in the program have also been working to locate resources on ways to appropriately and successfully assess such skills. Participating members, from the several school districts throughout the state that are currently involved in the program, have been working collaboratively to determine best practices to fully prepare their students as problem-solvers. Within one district, a pilot study of the technology courses resulted in recommendations for how to proceed with future instruction and assessment. In response, members within the district have

proposed taking a problem-based learning approach to teaching students with the intention of providing more authentic learning situations and encouraging higher-order thinking skills.

In order to help the district with a further investigation of these recommendations, this research study was designed to address such needs and help inform the direction of the technology courses within the public schools in the state. Chapter two offers a review of literature regarding both current methods of teaching technology and a deeper perspective of the proposed problem-based learning approach. It concludes with a general outline of key elements for a problem-based learning environment along with a statement of purpose for this research study. Chapter three outlines the methodology and procedures used to conduct the research study. In addition, the chapter includes a more detailed description of the participating school district, its students, and the teacher participant, along with methods of data collection and analysis. Chapter four provides a summary of the results of the research study followed by chapter five offering a discussion on the practical implications of the findings, while offering recommendations for further study.

Definitions

It is important to identify and define a few of the key terms used throughout this document. These terms are essential to the research study and are mentioned often in the discussions to follow. The definitions were developed through a review of the existing literature on topics surrounding such terms. Also, while the terms can be found across the literature to mean different things in different scenarios, what is offered here is a summarizing view of the terms as they relate to this research study from the perspective of the researcher.

Technology

The term “technology” has been defined numerous ways over the years. As these definitions vary depending on situation and audience, it is important to more clearly define the term in relation to the purpose and direction of this study.

Researchers continually study technology and its position within our societal operations. In examining definitions as well as applications, a variety of perspectives emerge related to how technology is regarded and the advantages it brings to our seemingly systematic movement through time. Volk (2003) describes his experience of coming across the 1895 version of Webster’s Dictionary, wherein he explicates the way technology has progressed through time. To understand his explanation, a brief comparison of the actual term *technology* is helpful in showing the advancement in perception and application. In brief, the 1895 version describes technology as being “a treatise on the arts” (p. 9) whereas the 2002 version depicts technology as being the “practical application of knowledge especially in a particular area” (p. 9). The definition has transitioned from merely explaining or clarifying a skill to practically applying those skills, thus illuminating a shift from “knowing” to “applying”.

Kerr (1996) refers more specifically to educational technology in its “rational, ordered, controlled aspects” (p. 113) seen as advantageous qualities in regards to national progression (he references railways, phone systems and television) and the American view of “efficiency and progress” (p. 113). He continues by highlighting the importance of examining not only the original intentions of technology but also the communal effects technology brings to our movement within society. Beyond mere societal effects, the International Technology Education Association (ITEA) defines technology within K-12 education as “the innovation, change, or modification of the natural environment to satisfy perceived human needs and wants”

(International Technology Education Association [ITEA], 1995, glossary). In addition, while there is no specific definition of technology noted, the International Society for Technology in Education (ISTE) references technology as being tools used to live, learn and produce in the digital world (International Society for Technology in Education [ISTE], 2003c). As with Volk's comparison, these perceptions of technology fall in line with a shift from *knowing* to *applying*.

Throughout this document, the term *technology* is used frequently. The definition intended for the research study is most congruent to that which is referenced by ISTE, meaning *technology* refers to the actual *tools* used to accomplish a goal or learning task. More specifically, *technology* refers to *digital* tools such as computers, digital cameras, online applications and related software through which students can learn and produce. By declaring this definition, the researcher does not intend to convey the message that *technology* is strictly limited in all circumstances to tools, but rather it is the definition used in this research.

21st Century Skills

Clearly, we must innovate for our country to succeed in this time of rapidly increasing global competition. This innovation is occurring. We see dramatic changes taking place in the educational landscape – a new excitement in the vast possibilities of the digital age for changing how we learn, how we teach, and how the various segments of our educational system fit together – a ferment for reform that is bringing changes undreamt of even five years ago and unparalleled in our nation's history (United States Department of Education [USDOE] & Office of Educational Technology [OET], 2006, para. 3).

To the layman, the 21st century simply references the current era. To educators however, the 21st century takes on new meaning and refers to a dynamic shift in the way teachers are prepared and students are taught. The shift is, in large part, due to the digital revolution resulting

from the end of the previous century that introduced numerous new technological tools. At the start of this century, Brush and Bitter (2000) stated, “Global competition and the explosion of jobs requiring technology skills are transforming the composition of our current and future workforce” (p. 23). As a result, such updates in the workforce and global economy have caused educational systems to make alterations to the way students are learning and being taught. As Don Knezek, the CEO of ISTE, states:

In 1998, it was enough to define what students needed to know about and be able to do with technology. Now, we're defining what students need to know and be able to do with technology to learn effectively and live productively in a rapidly changing digital world” (International Society for Technology in Education [ISTE], 2003c, inset).

Throughout the literature on education and technology (in regards to education), the term *21st century* is often mentioned. In addition, this term often carries with it extensions such as *workforce*, *employers*, *students*, *resources*, *skills*, and *thinking*. While the terms *21st century workforce* and *21st century employers* simply refer to the modern workforce, meaning that which is operating currently, the other terms are not as obviously defined.

With the infusion of technology into the modern workforce and education systems, new ways of learning and thinking have been introduced. In addition, students and teachers are offered a modern set of resources with which to learn and produce. A report posted by The Partnership for 21st Century Skills states, “An overwhelming 80 percent of voters say that the kind of skills students need to learn to be prepared for the jobs of the 21st century is different from what they needed 20 years ago” (“Partnership”, 2007, pg. 1). As a result of this difference, both students and teachers need to develop skills that are essential to the use of such modern resources.

While many of the typical perspectives on *resources* revolve around technology such as personal computers, the resources of the 21st century extend far beyond such equipment. For example, as Roblyer (2000) points out, “the emergence of the Internet as a pervasive presence in education and society” has changed the way standards of learning are derived (p. 135). The Internet has introduced a global perspective to students and teachers who are now exposed to a new realm of resources and information in the classroom. “As a country, we now use the Internet for business transactions, shopping, entertainment, information searches, communication, and of course, learning” (North Central Regional Educational Laboratory [NCREL] & Metiri Group, 2003, p. 6).

The access to such resources and information however, comes with a charge. The students who once learned the basics of reading, writing and arithmetic, are now being provided with the opportunity to extend these basics through communication and access to other cultures, both nationally and globally. Further, with these opportunities, students are exposed to problems beyond the walls of their schools and teachers can use these opportunities to extend student thinking and learning. Again, the way in which students are learning has changed and the way in which teachers are teaching must also change.

With this global access, modern society is now considered a “global digital economy” in which technology is “rapidly changing how people live and work” (CEO Forum, 2001a, p.1). As such, the skills needed to learn and produce are outwardly different than those of years past. Employers of the 21st century have expressed a need to see more “technically skilled workers” who understand “how to employ technology to locate and evaluate information, to learn, reason, make decisions, solve problems, and to collaborate and work in teams will be essential abilities in the rapidly changing world” (CEO Forum, 2001b, p. 3). Thus, 21st century skills not only

involve the operation of technology but also what is learned and produced with that technology.

Through a review of literature and reports, many overlaps occur in perspectives of what the term 21st century skills entails. As a summary of this literature, 21st century skills include the ability to:

1. use and apply technology appropriately,
2. communicate and collaborate effectively with other learners,
3. be creative and innovative in thinking,
4. evaluate resources for usability and credibility,
5. problem-solve and make informed decisions,
6. produce quality products,
7. take responsibility and recognize consequences of actions and decisions,
8. take risks in thinking, and
9. generate a global awareness and develop a personal perspective (ISTE, 2003c; CEO Forum, 2001b; NCREL & Metiri Group, 2003; “Partnership”, 2007)

Throughout this document, the term 21st century skills is used often in the discussion of literature and in defining the purpose of this research study. As is true of the definition of technology, the definition provided here is not necessarily representative of all perspectives, rather it is that of the researcher as it relates to this research study.

Chapter 2: Literature Review

This literature review will address the following topics in order to illustrate current challenges in teaching technology skills, as well as potential solutions for these challenges.

These topics include:

1. outlining the importance of technology skills for K-12 students,
2. describing current standards for and suggested methods of teaching technology in K-12,
3. outlining the need to develop a new approach to teaching technology skills in K-12,
4. defining problem-based learning and its benefits to teaching technology skills,
5. outlining the learning theories associated with problem-based learning, and
6. describing challenges in developing instructional design models for problem-based learning.

The chapter concludes with a summary of problem-based learning, its design features, and support for why it is considered a beneficial approach to teaching technology skills to middle school students.

The Importance of Technology Skills

In the report by the National Center for Education Statistics (NCES), *Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology*, teachers were asked about the availability of, general use of, and teaching with technology. While 99 percent of public school teachers reported having access to computers and/or Internet within their schools, the majority also reported several great barriers to using technology for instruction. These barriers, and the corresponding percentages of teachers reporting include: insufficient number of computers

(78%), lack of time for training (82%), lack of time in student schedules (80%), lack of good instructional software (71%), difficulty accessing the internet (58%), lack of technical support (67%), and lack of training for integration (68%) (National Center for Education Statistics [NCES], 2000). With such reported barriers, the question remains as to why so much time and money is spent on technology, from research on the topic to equipment, training and curriculum changes.

To offer some insight, de Klerk Wolters (1989) performed a study on student attitudes toward technology through which he investigated the importance of perceptions, opinions and interests of students in regards to implementing a technology curriculum. The *Pupils' Attitudes Towards Technology* (PATT) project instrument, developed in 1986, was designed to measure these attitudes among international K-12 students. One of the main implications resulting from the utilization of this instrument is the need to teach students a “broad concept of technology” through which students develop a relationship between the technology they are learning and the society in which they are living (p. 7). de Klerk Wolters (1989) states:

It is necessary that pupils experience that technology is more than equipment and transportations. It is necessary for them to experience that technology is around them. Pupils must have a chance to deal with products of technology, and also to produce technology (p. 8).

Within this view in mind, schools have been making repeated attempts to bring this experience to students. As such, there has been a rapid infiltration of technology within schools and school curriculum over the past few decades. Not only is technology in the schools, but also quickly penetrating the lives of the students, with an increasing interest in technology among them (Smaldino, Lowther, & Russell, 2008). Moreover, the NETP of 2004 echoes this interest

reporting that 49 percent of students say they are interested in pursuing careers in and using technology and 94 percent reported using the Internet for research and school projects. Where television once held the attention of students, Internet use has now outpaced it (USDOE & OET, 2004). Also, within the schools, 92 percent of elementary teachers and 80 percent of secondary teachers reported students using computers at school, with 56 and 72 percent, respectively, using the Internet (NCES, 2000).

Even with such statistics, student technology skills do not appear to be transferring beyond the walls of educational institutions and to the workforce. In a recent inquiry on this topic, employers reported an apparent lack of digital technology skills with new workforce entrants (“Are they,” 2006). Such employers identify these digital technology skills as critical in the overall development of successfully functioning employees in the workforce of the 21st century. The CEO Forum on Education and Technology states:

The emergence of new information technologies, the evolution of the global digital economy, and the global competition for technically skilled workers creates a national urgency to improve our educational system. Schools that functionally reflect the culture of the past, rather than the demands of the future, will not prepare students to thrive in the digital age (CEO Forum, 2001b, p. 3).

Along with digital technology skills, employers are looking for other advanced skills including higher-order thinking skills such as inventive thinking, effective communication, and high productivity (CEO Forum, 2001a). The School Technology and Readiness Report states:

The rapidly changing digital economy will require the workforce to continue to adapt to meet evolving challenges. In essence, today’s students will have to learn how to learn.

The ability to find information quickly and efficiently, to manipulate that information and

apply it to solve problems and inform decisions will be a primary asset in tomorrow's workforce (p. 9).

These statements and the needs expressed by such employers reflect the definitions of technology previously mentioned, with a clear shift from knowing to applying with the added element of increasing productivity.

In this regard, students need to begin viewing technology as purposeful and learn to apply their skills creatively and flexibly (Eisenberg, 2003). Thus, the challenge of technology integration and the need for technologically proficient students is more complex than simply demonstrated mastery of discrete software and hardware skills. It involves highly developed thinking skills, as well as attitude- and perception-altering experiences to help students realize not only their potential, but their potential with technology. The following section outlines how schools are attempting to teach students technology skills and the current focus of several state technology plans.

Current Approaches to Teaching Technology Skills

With the previous section outlining the importance of technology skills, this section outlines how K-12 schools and programs have addressed the inclusion of technology. The current national standards are described along with the variety of current methods being used to teach technology skills. In addition, several of the problems associated with such methods are described along with a proposed approach to address these problems.

The Role of Standards

As in the planning of core curriculum and content, discussions about technology within the realm of education often include the term standards; these terms representing two of the most

prominent in modern, educational discussions (Sage, 2000). National and state curriculum standards are defined in order to set benchmarks for student knowledge and performance and, in striving to meet these standards, instruction demands the application of technology (Sage, 2000). In addition to curriculum standards, both teachers and students are being made responsible for benchmark performance in technology use as well (Foley et al., 2001; Roblyer, 2000; Thomas & Knezek, 2002).

Many states reference benchmark standards outlined by the International Society for Technology in Education (ISTE). ISTE has developed digital technology integration standards, the National Educational Technology Standards (NETS), for all levels of education, from Kindergarten through higher education, as well as for practicing educators and administrators (ISTE, 2003a). Students, teachers and administrators are being held to these standards across the country, which serve as a “target of excellence relating to technology” (ISTE, 2003a, para. 1). As mentioned previously, until recently much of the focus of the standards has been on distinct and isolated skills related to technology use; however the latest version of the NETS for students (NETS-S) focuses more on how and what students perform and produce with such skills (ISTE, 2003a). This change in focus once again highlights an apparent shift toward skills related to the application of technology to student learning, the thinking and communication involved, as well as ethical and appropriate uses, thus showing a response to the needs expressed through employers of the 21st century.

Current Approaches

The method through which technology skills should be taught has been a matter of debate. Roblyer (2000) describes such a debate as being a struggle between viewpoints on both constructivist teaching approaches and direct teaching. Some teachers and technology experts

feel that technology should be used as “resources and applications primarily to promote problem-solving, critical thinking, and collaboration” while other perspectives “make a case for a mixture of these and more directed resources and applications” (p. 135). Professionals like teachers and administrators experience frustrations and difficulties as a result of these debates that, in turn, create problems in receiving needed support such as training and funding. With this debate in mind, this section presents several approaches to how technology skills are being taught currently in K-12 settings, as well as a glimpse into how several individual states are managing to incorporate technology standards into their existing curriculum.

The search for existing literature regarding current approaches to how technology skills are being taught is challenging when focusing solely on empirical research. Existing research in this area has a tendency to include only information on attempts to make suggestions or changes to existing methods with little discussion on the outcomes of such attempts. Also, many of the books written in regards to technology and education have been written with a focus on guiding teachers through integration techniques with minimal focus on actually teaching technology to students. With that in mind, this discussion stems largely from approaches suggested through state boards of education, state-wide and national technology associations designed to inform educators, and suggestions for teachers in regards to instructional strategies.

In a recent, updated version of *Instructional Technology and Media for Learning*, Smaldino, Lowther and Russell (2008) include information on the role technology is playing in K-12 education. The authors indicate that educators now take into account new methods of communication (such as e-mail, blogs, and videoconferencing), additional parties involved in instruction (such as technology coordinators and media specialists), and the meaning of these changes for new methods of instruction. While this book was not designed specifically to address

teaching technology skills, it does reference learning situations that include teaching with technology as a support. In the chapter on instructional strategies, the authors outline several strategies for classroom instruction and present both the advantages and disadvantages of each, along with a section on integration ideas for how technology can serve to enhance the instruction.

The discussion includes many traditional techniques of instruction, such as presentation, demonstration, drill-and-practice and discussion approaches. Also included are sections on cooperative learning, games, discovery and problem-solving. Therefore, the range of instructional strategies varies from teacher-centered approaches to student-centered ones. While no single method is promoted, the authors simply refer to the strength of well-planned instruction and state, “well-planned instructional strategies incorporating technology and media promote learning regardless of the subject matter, the learners, or the learning environment” (p. 23). Thus, the perception is of the authors promoting each method equally and not identifying one approach as more beneficial than the others.

The Big6 is another approach to learning that is being applied in many educational contexts (Big6 Associates, 2005; Eisenberg, 2003; Jansen, 2007; Kasowitz, 2000). This approach presents an “information problem-solving strategy” where “students are able to handle any problem, assignment, decision or task” (Big6 Associates, 2005, para. 1). Although, while the creators and promoters of the approach claim it is “an information and technology literacy model and curriculum” (Big6 Associates, 2005, para. 1), the researchers and authors of Big6 materials present technology as an afterthought or accessory to learning, rather than providing guidance and curriculum on using the Big6 method for actually teaching technology literacy (Big6 Associates, 2005; Eisenberg, 2003; Jansen, 2007; Kasowitz, 2000).

The International Society for Technology in Education (ISTE) is one of the leading organizations in the world for “providing leadership and service to improve teaching and learning by advancing the effective use of technology in education” (ISTE, 2003a, Page Heading). The publications, conferences and even performance standards are centered on providing schools, teachers and students direction for effectively using technology to educate. A portion of their mission is to “extend beyond giving technology to students. The impact...is to ensure that technology empowers educators to help more students achieve their full potential” (ISTE, 2003b, para. 7). Thus, materials and conferences are designed to encourage this empowerment through items such as case studies, recommendations for integration, and training and professional development opportunities and materials. The conference materials and workshops show a distinct concentration on implementation strategies for preparing learners in the 21st century. It is clear the focus of ISTE-related work is shifting from skills-based items to those with a more application and idea-generating focus.

ISTE is not only a resource for professional development and training, it is author of the National Educational Technology Standards (NETS) for students, teachers and administrators.

The primary goal of the ISTE NETS Project is to enable stakeholders in PreK-12 education to develop national standards for educational uses of technology that facilitate school improvement in the United States. The NETS Project will work to define standards for students, integrating curriculum technology, technology support, and standards for student assessment and evaluation of technology use (ISTE, 2007, para. 2). Until recently, the focus of the NETS has been a skills-based approach; however, as mentioned earlier, ISTE has developed and released a new set of student standards to include more 21st century skills in 2007 and plans to release a compatible set of teacher standards in 2008 (ISTE,

2007). With the former, skills-based version, many states have considered or fully adopted the NETS in their state technology plans. Through an examination of several state technology plans, it is evident some states are taking more individualized approaches to incorporating the teaching of technology skills to their students, while other states have chosen to completely adopt the NETS indicating a continued concentration on discrete skills. The state departments of education that have either adapted the standards to meet their own needs or devised their own set appear to be taking a more application- and production-based approach to teaching technology skills where students use technology to produce and/or extend their learning. The table in Appendix A provides an overview of several state technology plans and includes individual definitions of technology, as determined by each state's department of education. While there is no distinct rationale for including each state in the table, one goal was to use a combination of states that would support a variety of perspectives. Also included is the degree to which the NETS have been adapted, adopted, aligned or referenced within individual state standards (International Society for Technology in Education, 2003). While there is still a strong representation of skills-based approaches and concentration on teaching technology skills, there is also an apparent shift toward application and production with a focus on 21st century thinking.

The Need for a New Approach

As noted in the previous section, many state boards of education have indicated a need to focus on different type of skills when it comes to technology, schools, students and teaching. For example, the Department of Public Instruction [DPI] in North Carolina has focused its state educational technology plan around the development of 21st century skills that, according to the state technology plan, include “areas of digital literacy, inventive thinking, effective

communication and high productivity” (Department of Public Instruction [DPI], 2007, p. 5).

Further, the plan outlines that:

Students must be taught and given ample opportunities to experience technology not only as an enhancement device but as a tool to master current subjects and topics. In addition, students must be challenged to utilize tools to produce evidence of learning that express higher order thinking, collaborative efforts and the global reasoning required in our current society (p. 5).

Thus, the DPI is working to prepare students to become more globally competitive. A portion of the vision statement says:

In order to become leaders in a global market, North Carolina students and their teachers need 21st century resources and skills as part of their educational preparation. Technology is a tool that enables teachers and administrators to work more productively, offering solutions for time management, student monitoring and intervention, and interesting and effective lessons and classroom activities (DPI, 2007, p. 2).

In its educational technology plan for 2003-2009, the Virginia Department of Education [VDOE] also elucidates an intense drive to prepare its students to be productive members of society in the 21st century. In the introduction to its plan, the authors make reference to how and why the state should develop a plan to prepare students to be part of the Virginia workforce:

Virginia’s leaders have prepared the state to be attractive to companies and investors by providing the technology infrastructure and skilled workforce today’s businesses require. Critical to the commonwealth’s ability to capitalize on this advantage is the extent to which Virginia’s schools prepare the next-generation workforce for knowledge-based jobs that utilize cutting-edge information technology (Virginia Department of Education [VDOE],

2003, p. v.).

In response to these states, and many others, researchers are communicating a succinct need for altering the way students are taught (Brush & Bitter, 2000; Meyers, 1986; Sternberg & Spear-Swerling, 1996; Swartz & Perkins, 1990; Thomas & Knezek, 2002). Educators and curriculum designers realize and understand this issue and are working to address the needs and concerns articulated by modern employers. For example, the focus of the current paradigm on education is standardization where every learner is taught the same thing at the same time, and Reigeluth (1999) makes the point that “assembly line workers acting as automatons are becoming an endangered species...the current corporate restructuring movement’s emphasis on quality combine to require ever-increasing numbers of employees who can take initiative, think critically, and solve problems” (p. 18). As such, designers of instructional approaches for courses designed to teach students digital technology skills should take into account such demands and needs (Brush & Bitter, 2000; Eisenberg, 2003).

Savery (2006) states, “the bar has been raised as the 21st century gathers momentum and more than ever, higher-order thinking skills, self-regulated learning habits, and problem-solving skills are necessary for all students” (p. 18). As described previously, the skills of the 21st century not only include technology, but also critical and creative thinking, problem-solving, and teamwork and collaboration skills, which would account for the higher-order thinking needs (“Are they,” 2006; CEO Forum, 2001b; Torp & Sage, 1998). The concerns for student preparedness are being recognized across a range of educational departments, from within the national and state departments of education to the preparation of new teachers. Thomas and Knezek (2002) report a concern that “traditional educational practices no longer provide

prospective teachers with all the necessary skills for teaching students who must be able to survive economically in the global workplace” (p. 16).

In addition, such concerns are also being recognized and expressed beyond the realm of education and into other facets of society. As mentioned in several ISTE/NETS publications, students should eventually be empowered to participate and thrive in a more demanding technological society (ISTE, 1998; Thomas & Knezek, 2002). The call not only comes from within the schools. Society, as a whole, is responding to the need for more empowered students:

Parents want their children to graduate with skills that prepare them...to get a job in today’s market or advance to higher levels of education and training...Employers want to hire employees who are...able to reason, communicate, make decisions, and learn...Communities want schools to prepare their children to become...productive members of society...National leaders...recognize the essential role of technology in 21st century education (ISTE, 1998, p. v.).

Teachers, in this respect, are the “key individual[s] in helping students develop these capabilities” and are responsible for “establishing the classroom environment and preparing the learning opportunities that facilitate student use of technology to learn, communicate, and develop” (Thomas & Knezek, 2002, p. 16).

While standards for education of technology skills continue to serve their purpose of providing a sense of accountability and creating guidelines to determine adequate student performance (Roblyer, 2000), a shift in pedagogy for how these skills are taught and applied is surfacing within the literature. This shift, primarily driven by constructivist views, is showing movement toward more student-directed activities and technology-based productivity, as opposed to standard drill-and-practice activities with direct instruction (Neiderhauser &

Lindstrom, 2006). As a result of this shift, evidence of movement within curriculum standards, including ISTE/NETS, is apparent as well. Once again, these changes in both standards and pedagogy illuminate a movement to support the needs expressed by the modern workforce and include a new level of student learning and thinking skills. With that in mind, the following section offers a recommended approach for addressing the needs to complement the described shift in pedagogy and focus.

A Proposed Approach: Problem-based Learning

The first object of any act of learning, over and beyond the pleasure it may give, is that it should serve us in the future. Learning should not only take us somewhere; it should allow us later to go further more easily (Bruner, 1960, p. 17).

Background of Problem-based Learning

Problem-based learning (PBL) is a fairly modern approach (within the past 30-35 years) to instruction that helps students develop both independent and collaborative thinking skills vital to problem-solving while examining their metacognitive abilities. This approach was initially developed, over 30 years ago, as a general model for instruction for students in the medical field and replaced traditional instructional approaches, such as lecture (Savery, 2006; Savery & Duffy, 1995; Savin-Baden & Major, 2004; Torp & Sage, 1998). In such cases, students attended to a situation in which a *real* problem is presented and collaborated to “seek out a variety of resources, technological and otherwise, to help them arrive at possible solutions” (Driscoll, 2005, p. 405). After intense growth in medical education, other disciplines, such as schools of law, business and education began adopting the model in their own approaches to learning (Savery, 2006; Savery & Duffy, 1995; Torp & Sage, 1998). As with any approach to learning, there are

many perspectives and perceptions of the role of PBL in instruction and a concrete, standard definition is difficult to avow. In the next section, several of these perspectives are presented and synthesized to establish a definition within the context of this research study.

Defining Problem-based Learning

Novices in school are trained only to work on problems that are, by nature, decontextualized and well structured, while problems in everyday and professional contexts are complex and ill structured (Jonassen & Hernandez-Serrano, 2002, p. 2).

The definition of PBL has evolved through extensive research across several educational realms and concentrations. In his discussion and synthesis of several PBL studies, Barrows (2002) denotes a level of difficulty in determining the meaning behind PBL. He states, "...PBL is almost meaningless these days as it is attached to a myriad of differing methods...[it is] difficult to understand the value of something called PBL unless you know what is actually going on" (p. 122). However, with regard to research, Barrows (2002) more conclusively defines PBL as a "distinct educational method aimed at giving the learner effective skills in problem-solving, self-directed learning as a life-time habit and team work, all while acquiring an integrated body of knowledge from many different subject areas or disciplines" (p. 119).

Savery and Duffy (1995) considered several models and definitions and presented an instructional design based on Barrows' (1998) model. They focused their synthesis of the PBL environment on several key elements such as (a) learners engaging in authentic environments, (b) learners being active within that environment, (c) learners constructing knowledge relevant to the context, and (d) learners functioning metacognitively. In addition, one of the most important distinctions made between PBL and similar learning strategies is that learners are "cold," (Savery

& Duffy, 1995, p.34) meaning they approach a problem without any prior coverage of the context or topic.

Savery (2006) offers a brief synthesis of several researchers' uses and methods of PBL. Through this synthesis, he outlines these key components to creating a true PBL environment within a learning environment:

1. Instruction must be learner-centered; learners take on responsibility for their own learning.
2. Problems must be messy and ill-structured; this models problems in the real-world that are often hard to define and the goal is often unknown.
3. A tutor/mentor must be present to facilitate learning; generally the teacher fills this role and is available to help with metacognitive components and questioning strategies, and does not provide information or resources.
4. The experience should end with a debriefing and evaluation of the problem, learners and solutions; this helps learners process the experience and come to understand what they have learned.

Sage (2000) and Torp and Sage (1998) also mention the function of PBL as being an investigation of messy, ill-structured problems. This statement stands in agreement with several other researchers in that the problems involved do not entail clearly defined goals and/or conclusions (Barrows, 2002; Hmelo-Silver & Barrows, 2006; Savery, 2006); rather, within a PBL approach to instruction, students are situated in the problem and work collaboratively to define the problem, locate and use resources and present a solution to the problem, based on their conclusive perspectives. Additionally, Anderson (1980), as cited in Jonassen (2000) defines problem-solving (a component of PBL) as "any goal-directed sequence of cognitive operations"

(p.65). Jonassen (2000) further clarifies by outlining two significant features being “mental representation” and “activity-based manipulation,” through which a learner begins by defining existing mental models of the “problem space” and interacting within that problem to outline a solution or answer (p. 65). Park, Ertmer and Cramer (2004) employed a PBL approach for their curriculum through elements such as authentic problems and contexts, allowing the learner to seek resources, requiring the learner to set personal goals and encouraging individual approaches to problem-solving. Through their design, they also included elements of modeling, hands-on activities and collaboration.

Kumar and Natarajan (2007) present their own synthesis of definitions after a review of several other researcher perspectives. Their definition contains themes found within these multiple perspectives and includes the following elements:

1. PBL approach begins with a problem or question.
2. Tackling the problem requires the harnessing of a variety of resources and the integration of multiple perspectives.
3. PBL is an iterative process to solve problems where learners work in groups for collaborative study and where social negotiation of meaning is required during the problem-solving process.
4. Learners are required to think critically and creatively.
5. The process encourages reflection, an important meta-cognition aspect of PBL.
6. A teacher’s role changes to one of being a cognitive coach who facilitates, guides, probes and supports the learning taking place (p. 90).

This synthesis of several definitions helps to define PBL within the context of individual needs and purposes. It is apparent PBL is a messy and ill-structured process where a learner

takes on primary responsibility for learning, actively collaborates and seeks out resources; where teachers become models and facilitators; and where designers carry the burden of framing the problem in authentic contexts and determining relevance and applicability for the learner.

Problem-based Learning Versus Project-based Learning

As the nature of PBL is centered on ill-structured and authentic problems, this approach is often confused with another instructional method referred to as PBL, or *project-based learning* (Cognition and Technology Group at Vanderbilt [CTGV], 1993; Savery, 2006; Torp & Sage, 1998). Through definitions of *problem-based learning* presented above, a clear distinction between the two can be made. Table 2 is included to highlight these distinctions with the purpose of more clearly defining the goal of this research study as it is centered on *problem-based learning*.

Table 1

A Comparison of Problem-Based Learning and Project-Based Learning

	Problem-Based	Project-Based
Focus	Process of problem-solving	End-product
Content	Embedded in process	Taught beforehand
Learning goals	Defined by learner	Defined by teacher
Problem	Ill-structured	Well-structured
Resources	Sought by students	Presented by teacher
Teacher role	Coach	Provider

Some of the key differences that are shown include the difference in focus (process vs. product), the definer of learning goals (learner vs. teacher) and the role of the teacher (coach vs. provider). These differences are important to consider in designing instruction to meet the purpose behind PBL (problem-based learning), being careful not to defeat the purpose by falsely representing the learning approach. As with any approach to instruction, PBL is not without its limitations. While the surface description shows promise for the future of education, several struggles and concerns in regards to design and implementation have surfaced throughout the years.

From the Medical Field to a K-12 Setting: Struggles and Concerns

The medical field adopted the PBL approach over thirty years ago as a method of reform to the then current approaches of preparing medical professionals, primarily the large number of medical schools inadequately preparing these professionals (Barrows, 2002; Savery, 2006; Savin-Baden and Major, 2004). At that point in time, the conventional approach to preparing

medical professionals involved lectures that were discipline-specific (Savery, 2006). Researchers in PBL and educators in the medical field sought to “develop in medical students the ability to relate knowledge they had learned to the problems with which the patients presented, something...that few medical students could do well” (Savin-Baden & Major, 2004, p. 17). While this approach was increasingly adopted through the medical field as well as other professions (Savery, 2006; Savery & Duffy, 1995; Savin-Baden & Major, 2004), it has also been met with some challenges and opposition (Savery, 2006; Savin-Baden & Major, 2004).

Savery (2006) references opposition regarding the preparedness of students under the PBL approach; some medical schools “questioned whether or not a physician trained using PBL was as well prepared for professional practice as a physician trained using traditional approaches” (p. 10). To address this question, the author presents findings from several meta-analyses to indicate that while PBL may be preferred among students and yield stronger problem-solving skills, there is no evidence in terms of actual knowledge gains. In addition, the author also describes the gap in research as a result of the lack of “well-designed research studies” and indicates the need for further study (p. 11).

With more specific reference to the design of PBL instruction, other medical schools failed to adopt the approach due to the intense changes to the curriculum that would be required for adoption; however, the attempt to adopt resulted in adapting the model. This occurred in schools such as the University of New Mexico and Harvard University who combined traditional approaches of instruction with PBL to align more specifically with curricular and program needs (Savin-Baden & Major, 2004).

In the K-12 setting, the PBL approach has yet to reach widespread adoption (Ertmer & Simons, 2006). In considering this approach within a K-12 setting several concerns and areas of

struggle have surfaced. Ertmer and Simons (2006) raise these concerns in a discussion on how best to provide support to K-12 teachers working to create a PBL environment in their classrooms. These concerns are expressed as challenges such as creating a collaborative environment, altering roles within the classroom, supporting performance, and student learning (Ertmer & Simons, 2006). In addition, other researchers raise concerns about the best context in which to present material and curriculum time constraints (Cognition and Technology Group at Vanderbilt, 1993; Savery, 2006; Savery & Duffy, 1995; Torp & Sage, 1998).

In the medical field, the certainty of the direction in which most students will proceed is well-known; they will continue to pursue a career in medicine, the field in which they were trained. In a K-12 setting though, the general life direction students plan to pursue is most often unknown to teachers, parents, and even the students themselves. Therefore, teachers and designers are forced to make predictions on the general needs and interests of students and make judgment on how the learning will be applied, which helps to define under which context would be best to present the learning situation (the medical field is known and well-defined). The challenge, then, is determining a method to generally prepare students based on what they know and what is known of them. At the early stages, it is best to prepare them with problem-solving skills enabling them to be thinkers and doers in future situations (Torp & Sage, 1998).

In addition to this issue, teachers are often under intense time constraints due to state mandated curriculum and district-designed pacing guides, which create difficulty in adopting a PBL approach (Cognition and Technology Group at Vanderbilt, 1993; Savery, 2006). In considering this issue, the following section contains a brief overview on well-known theories of learning followed by how these theories might best apply to the design of instruction with a PBL

approach. This discussion carries with it suggested strategies for teaching and learning in a PBL environment.

The Application of Learning Theories and Strategies

In order for teachers and learners to design effective learning experiences, it is essential to understand both how the learning occurs (learning theory) and what action is needed to best facilitate learning (instructional design theory) (Ertmer & Newby, 1993; Morrison, Ross & Kemp, 2007; Reigeluth, 1999). As such, learning theories and research on these theories are important to consider in the process of instructional design and development of PBL environments. Ertmer and Newby (1993) outline three important reasons for focusing on learning theories as being: (a) “learning theories are a *source* of verified instructional strategies, tactics, and techniques,” (b) “learning theories provide the foundation for intelligent and reasoned strategy *selection*,” and (c) “*integration* of the selected strategy within the instructional context is of critical importance” (p. 51). Therefore, gaining a general background and basic understanding of learning theories can help in the overall development of instruction and justification of elements therein.

PBL has been identified as a primarily constructivist learning environment through which a learner is made responsible for the construction of his or her own learning (Savin-Baden & Major, 2004); however, the approach also lends itself to several different theories of learning. In reviewing several of these theories, the case can be made for how the inclusion of certain inputs, means and instructional methods to the design, development and implementation of the PBL environment will support learning through multiple theories. The table in Appendix B is included to illustrate the correlation between a broad range of learning theories and the PBL environment.

Instructional Design Theory

In outlining learning theories and strategies and identifying how they might correspond to problem-based learning, instructional designers build a basis for how learning will occur, as the design of instruction will focus on the informed application of such strategies. As mentioned earlier, Reigeluth (1999) labeled the current paradigm of instruction as standardization, which takes into account the needs of all learners at once – same content, same time, same place. Reigeluth (1999), though, suggests a shift from standardization to customization, which helps to surface a “learning-focused paradigm” (p. 19). This change requires:

...a shift from passive to active learning and from teacher-directed to student-directed learning. It requires a shift from teacher initiative, control, and responsibility to shared initiative, control, and responsibility. It requires a shift from decontextualized learning to authentic, meaningful tasks. And, most importantly, it requires a shift from holding time constant and allowing achievement to vary, to allowing each learner the time needed to reach the desired attainments (p. 19).

To do this will also require a shift in the role of the teacher, students, and resources used in learning contexts. Thus, the teacher no longer becomes the provider of information but rather the facilitator of information, allowing the learner to construct knowledge and meaning. The teacher uses instructional-design theory to inform how best to teach and facilitate learning through such conditions. Reigeluth (1999) outlines a theory that offers guidelines and informs teachers regarding when and how a learner should:

1. be given initiative;
2. work in teams on authentic, real-world tasks;
3. be allowed to choose from a diversity of sound methods;

4. best utilize the powerful features of advanced technologies; and
5. be allowed to persevere until they reach appropriate standards (p. 20).

Instructional approaches, such as PBL, lend themselves nicely to addressing this shift.

With an understanding of the required shifts in roles, resources and tasks, several researchers have made attempts at implementation in a K-12 setting. As mentioned earlier, PBL began as an instructional method for medical schools for students with clear purpose and personal goals; however it has also been known to cause some problems in both its intended and alternative applications. The following section is a brief synopsis of some unique PBL implementation within K-12 settings.

Problem-based Learning in K-12

Problem-based learning is currently being used sporadically throughout the K-12 learning environment. The application of this approach is being done in several different ways, from classroom-based approaches with standard resources to technology-based strategies with online resources. The researchers studying this approach present results and provide several perspectives regarding the effectiveness and implications for further development.

Sage and Torp (1997) frame their research on PBL as a professional development opportunity for teachers in Illinois. Through the Center for Problem-Based Learning at the Illinois Mathematics and Science Academy (IMSA), teachers received training on how to facilitate learning in a problem-based environment. Throughout the year, teachers actively participated in designing and implementing PBL lessons in their classrooms and collaborated on the design and development of learning activities. From this intensive training, teachers communicated their conclusive thoughts regarding impact on both the students and themselves. Conclusions included: (a) “problem-based learning was a powerful strategy for motivating

students, for developing skills in critical thinking and problem-solving, and for deepening student understanding of significant content,” (b) teachers noted “a substantive and surprising depth of understanding from their students when they explored fewer topics in integrative and more authentic ways (p. 34),” (c) teachers learned to make the transition from provider to coach which enabled them to use the “language of thinking” and better manage student activity (pp. 33-34).

This professional development attempt was not without problems, however. Teachers realized the need for: (a) support from other teachers (in this case, team members) for designing and implementing, (b) positive support from teachers and administrators, and (c) time to plan and collaborate. Additionally, teachers experienced problems with changes to their classroom and teaching strategies in which “change is difficult and the fear of change was common...[teachers] reported experiencing almost a paralyzing fear of letting go of a comfortable teaching style and trying to learn a new style that shifted classroom control from teacher-driven to problem-driven” (Torp & Sage, 1997, p. 35).

Brinkerhoff and Glazewski (2000) implemented a hypermedia-based PBL program for upper elementary and middle school students. The learning unit was designed around model concepts developed by the Center for Problem-Based Learning at the IMSA and employed scaffolding techniques recommended by Hannafin, Land and Oliver (1999). As students proceeded through the hypermedia unit, they were provided with scaffolds to guide conceptual understanding and approaches to the learning task. Teachers were provided with both procedural and conceptual scaffolds to support their transition to becoming facilitators as opposed to instructors. Through their results, the researchers discovered that while the hypermedia-based PBL approach may be effective for students, the teachers have great responsibility for creating

and maintaining the appropriate learning environment and their reliance on supporting scaffolds was much greater than that of the students. Overall, observation and interview data were used to show the positive effects of the PBL environment; student attitudes were high, success in obtaining learning objectives was high, and both students and teachers agreed the process was motivating and enjoyable.

Eisenberg (2003) incorporated a problem-solving approach through an instructional model called the *Big6*. This method includes elements typically addressed in PBL as well as essential 21st century skills. Through the implementation of this method, and using technology, Eisenberg (2003) shows that not only are students learning curriculum but also they “are learning to use technology as part of the information problem-solving process to perform better in classroom curriculum” (p. 15). The implications of this method are two-fold; first, students are gaining technology skills and second, teachers are learning how technology can enhance learning. The principles of the *Big6* approach are very similar to those defined through PBL and include the following components:

1. Task definition: define the problem, identify the information needed,
2. Information seeking strategy: determine all possible sources, select the best sources,
3. Location and access: locate sources, find information within sources,
4. Use of information: engage (e.g. read, hear, view), extract relevant information,
5. Synthesis: organize information from multiple sources, present the result, and
6. Evaluation: judge the result (effectiveness), judge the process (efficiency) (p. 14).

Through his results of implementation in K-12 instructional settings, Eisenberg (2003) indicates this problem-solving approach (a) “develops students’ problem-solving, complex thinking and information management abilities”, (b) “enables students to become comfortable

with technology and understand that the technologies are valuable tools to help them perform their work”, (c) focuses students’ attention on using technologies as tools to extend knowledge and to individualize learning”, and (d) assists teachers in changing their roles from presenters of information to learning coaches who offer tools and advice” (p. 15). These results are strongly correlated with the overall desired outcomes and elements of the PBL approach, as defined earlier.

In looking at several applications of PBL in K-12 learning environments, it is apparent that, while not without problems and difficulties, the learning process meshed nicely with the goals for 21st century learners and workers. Although the difficulties arose in regards to understanding a shift in roles and recognizing the need for support, the skills both students and teachers were acquiring were some of those most essential as defined by the needs for the modern workforce. As mentioned earlier, the ability to interact and produce with technology is one of the main components of the needs expressed by modern employers. In an approach such as PBL the higher-order thinking skills and the ability to problem-solve is a focus; however, the role of technology is not as precisely defined and the question remains, “How can technology be used to *enhance* the PBL environment to address these needs?” The following sections are designed to outline how technology fits into a PBL environment and how PBL can be used to more specifically teach technology skills within K-12.

The Role of Technology in PBL and K-12

PBL involves solving ill-structured problems where learners seek information and resources to help make decisions toward solving a problem. In this sense, technologies can serve as tools to enhance the process of searching for information and tools to use to solve the problems (Park et al., 2004) and provide a “sufficiently rich informational environment to

support problem-based inquiry” (Brinkerhoff & Glazewski, 2000, p. 30). Additionally, technology can be used as way to present a problem, organize resources and information and even present the outcome or solution to the problem (Sage, 2000).

Sage (2000) presents several PBL activities involving the application and interaction with several forms of technology. One problem, developed through the IMSA, introduces students to a problem involving the use of land in some of the plains states. Through the problem, students become engaged in a problem-solving process to determine and make suggestions for possible solutions. To help them in this process, students are given access to online resources and engage in dialogue about appropriate resources and the credibility of information. An important point made is that the participation in such a problem “...lends itself well to a discussion of the nature of bias on the Internet and in other means of communication. It also allows interdisciplinary collaboration between social studies and technology teachers” (Sage, 2000, p. 10). Thus, through one such example, student engagement with a content area (such as social studies) is apparent, in addition to engagement within a technology curriculum. As students investigate the topic of the problem, they are also engaging with the technology and exploring skills and problems within.

Herrington and Kervin (2007) conducted a recent study on supporting authentic learning environments through the use of technology and note the strength of using technology to “access authentic contexts” which indicates “a whole learning scenario can be presented in realistic and motivating ways” (p. 223). Technology therefore, can help to enable “the use of tools – without which students would have difficulty engaging conceptually with the material” (p. 223). Thus, with the application of technology in a PBL environment, students can function more productively and have more convenient access to tools needed in determining a solution to their problem. As is natural with a PBL environment, learners need to have access to experts on the

topic or problem. Technology is one way to allow contact, which can be done through online tools (such as e-mail, chat rooms, and books) and organize that information using software such as concept-mapping or word-processing programs.

In the case of the Big6 approach mentioned earlier, Eisenberg (2003) highlighted several important implications for the role technology plays in PBL, as well as how problem-solving processes can enhance and encourage the acquisition of technology skills. Through an integrated approach to teaching both curricular concepts and technology skills, both students and teachers realized the potential for using technology as a learning tool. Eisenberg (2003) mentions “we avoid teaching technology skills in isolation when we combine them with the Big6 process and with real subject area curriculum and assignments” (p. 14); however, students and teacher continue to gain technology skills as they remain engaged in the process. Essentially, with such an approach, two objectives can be met; the learning of both technology skills and curriculum, which can address one of the main issues of concern, time.

Teaching Technology Skills Through Problem-based Learning

Determining ways to teach technology skills to K-12 students is an issue with which many teachers and schools are faced. The debates of when to teach skills, how to teach the skills and how much time to spend teaching skills are carefully considered in curriculum planning and student daily schedules. A general concern of teachers is the impact of taking time away from teaching core curriculum skills to teach discrete technology skills. Teachers also realize, however, that once students learn the skills, they can be used to more productively build core curriculum skills (Roblyer, 2000).

PBL is one approach to addressing this issue through the multiple facets of design and implementation. One possibility is designing the actual PBL environment using technology, such

as an interactive multimedia environment (Albion, 2003; Brinkerhoff & Glazewski, 2000; Sage, 2000). With this approach, learners are led through activities to solve problems related to curriculum knowledge while gaining experience using technology tools, such as multimedia elements (movie and sound clips, images, interactive images, etc.), production tools (such as word-processing and presentation software) and Internet applications. Albion (2003) used an interactive multimedia approach to teach teachers how to teach with technology. Essentially, he used technology to teach technology. Within PBL environments, the problem is the focus (Hung et al., 2006) and learners use resources, information and peer support to develop solutions. In this case, Albion (2003) provided the teachers with problem scenarios through the use of videos and used online interactivity to guide learners in their attempts to develop solutions. The purpose was “to encourage students to engage more strongly with the resources in the expectation that this would lead to increased confidence in their ability to work with computers in their classrooms” (p. 254).

The *Buffalo Commons* problem designed by the IMSA is a Web-based PBL environment through which learners engage in a role-playing activity to solve problems. The Web site is designed to lead both students and teachers through the PBL process and use online resources as sources of information and help as they work through the scenario (Sage, 2000). One of the highlights of this problem is the interdisciplinary focus with the possibility of incorporating technology as one of the disciplines; through the use of online tools and resources, the problem “lends itself well to a discussion of the nature of bias on the Internet and in other means of communication. It allows interdisciplinary collaboration between social studies and technology teachers” (Sage, 2000, p. 10).

The design of a hypermedia-based PBL scenario, such as *Up, Up & Away!* (Brinkerhoff & Glazewski, 2000) is another case where learners are actively engaged in an online simulation of a problem scenario. Through the incorporation of interactive scaffolds, learners are led through several steps important to the PBL method and are offered resources to provide help and guidance to help them determine and devise a solution. In this case, learners were interacting and learning with both science curriculum and technology related skills. In considering the approaches of these researchers, technology skills can be nicely incorporated into a PBL curriculum. Within the course design, the designer should consider the approach, the materials, methods of support, and means of interaction while continuing to keep the learning goal of developing technology skills in mind.

Models for Designing Instruction

The Challenge for Instructional Designers

Problem-solving is generally regarded as the most important cognitive activity in everyday and professional contexts. Most people are required to and rewarded for solving problems. However, learning to solve problems is too seldom required in formal educational settings, in part, because our understanding of its processes is limited.

Instructional-design research and theory has devoted too little attention to the study of problem-solving processes (Jonassen, 2000, p. 63).

When it comes to designing instruction with a PBL approach, instructional designers often hit a roadblock in their attempts. Jonassen and Hernandez-Serrano (2002) interpret this issue through the non-existence of design models and state, "...insufficient advice is available to instructional designers to help them to design and develop learning and instructional supports for every kind

of problem-solving” (p. 65). The nature of PBL and problem-solving tasks is centered on ill-structured problems yet can also be a combination of well- and ill-structured problems (see Table 3 for a comparison). Jonassen (2000) calls these *metaproblems*, which “consist not only of clusters of interrelated problems...but also of the regulatory and reflective skills to monitor and solve combinations of problems” (p. 81).

Table 2

Comparison of Well-Structured and Ill-Structured Problems

Well-structured problems	Ill-structured problems
Generalizable	Context/domain specific
Decontextualized	Contextualized
Convergent solution	Multiple solutions
Defined by rules and algorithms	Emergent
Single-discipline	Interdisciplinary
Clearly defined goal	Goal undefined or unclear
Information-processing	Constructivism/situated cognition

Because most instructional design models guide designers to focus on single learning objects or discrete, prescriptive goals that are often decontextualized, designers arrive at problems when trying to apply these designs to more familiar contexts to which PBL lends itself (i.e. abstract vs. familiar). Driscoll (2005) presents an example comparing a problem-based concept taught through both abstract and familiar contexts where the results indicate learners perform better when they recognized the context, thus showing evidence of the need for more contextualized design models. The example was taken from work done at the Cognition and Technology Group at Vanderbilt that “lamented their students’ inability to generate relevant plans for solving problems, which they attributed to a curricular emphasis on memorization of facts and practice on isolated subskills” (p. 369).

Summary

Features of Problem-Based Learning and its Role in Teaching Technology Skills

In looking at the current approaches to teaching technology skills and considering the needs expressed by employers of the 21st century workforce, a proposed approach to addressing such concerns is the incorporation of a PBL environment. The elements of PBL have been highlighted as a possible means through which technology skills can be taught. In the discussion of literature on PBL, the approach has been explored in regards to the design, development and implementation within a range of educational settings; from medical training to K-12, where it was examined to primarily encourage the acquisition of technology skills. While several researcher perspectives were presented, the essentials of PBL are comprehensively summarized as described by Barrows (1998). Barrows is most widely known for his work with PBL in the medical field for the purpose of training new medical professionals; however, in much of his work, he includes implications for transfer to other fields. In the case of this research study, PBL was applied to a K-12 instructional setting for the purpose of teaching technology skills.

Similar to other researchers, Barrows (1998) lists the following as essential components to designing and incorporating a successful PBL environment. He recommends the lesson:

1. be student-centered where students develop their own learning goals, manage their time and resources, manage their thinking and assess their learning and outcome,
2. have teachers as facilitators, to serve as tutors and not providers of instruction, guiding questions and group collaboration,
3. have collaborative opportunities; students develop learning goals within a group, decide on the problem and required information, and report back to the group to devise a solution or conclusion,

4. be interdisciplinary where students can access resources across content areas and draw from other areas of expertise to apply to the problem situation,
5. include reflection, peer- and self-assessment in which students come to understand and know what they have learned, how they came about learning and how they apply what they learned to future situations, and most importantly
6. the problem must be real and presented in an authentic fashion, something learners can relate to and understand as a real problem or concern to which they can contribute help or solutions.

In regards to teaching technology skills, PBL can be applied in a number of ways, through teaching discrete skills to teaching technology through the use of technology. As is also noted throughout the literature, both students and teachers become the focus within PBL environments; the teacher perspective and experience is just as vital as the student perspective and experience. Thus, through a consideration of the research on instructional methods for teaching technology skills, this research study serves to offer suggestions to both teachers and instructional designers for ways to improve the teaching of technology skills and better prepare students to be active and successful members of the 21st century.

Purpose Statement

With this in mind, this developmental research study was designed to discover the implications of a problem-based learning approach to teaching digital technology skills. The focus was on a single teacher as she implemented a portion of an 8th grade technology curriculum using a PBL design.

Chapter 3: Research Methodology

Research Design

This study uses a developmental research approach. The focus of this developmental research study is the creation and implementation of a problem-based learning module that was implemented in an 8th grade technology course. The implications of this research serve to provide guidance for the future design of courses designated to prepare students with digital technology skills.

Developmental Research

Research in the field of instructional design and technology has been criticized for its lack of emphasis on instructional design processes (Briggs, 1982; Driscoll & Dick, 1999). Briggs (1982) stated, "...there is the broader need for whole research programs examining the merits of various elements in models of instructional design" (p. 27). In a later discussion on research approaches, Briggs (1984) defined four categories of literature, that he terms cultures, which are examined in pursuit of our research. While the first three cultures are important to research, he considers the fourth culture to be of dire importance to the field, yet the most sparsely explored. In this "Culture Four" as it is referred, the studies are representative not only of experimental design but good instructional design as well (p. 34). The problem however, is the lack of research conducted, thus making it difficult to reference. In being members of an applied field, researchers in instructional design and technology should seek to merge their research with the instructional design process, as it is defined by the profession, with a focus on the design and development of instructional programs and products (Driscoll & Dick, 1999). Reeves (2000)

states, “if educational technologists want to be more socially responsible, they should pursue developmental goals” (p. 24).

As such, developmental research can serve to guide researchers to address the concerns of research paradigms in the field. Developmental research is an applied research method that is used to create a link between practice, research and theory in addition to providing a solution to practical problems (Richey, Klein, and Nelson, 1996). This attribute is important to the progress of instructional development in that developmental research “attempts to produce the models and principles that guide the design, development and evaluation processes” (p. 1102) through empirical work. Richey, Klein and Nelson (1996) outlined two types of developmental research, the first (Type 1) being context-specific with a focus on a specific program, and the second (Type 2) being more generalized in nature with a generic focus. This research study can be classified as Type 1 in that it addresses the design, development and evaluation of a program through a specified context, a PBL module for an eighth grade technology course.

Instructional Design

The general nature of Type 1 research, as defined by Richey et al. (1996), includes a research methodology very similar in nature to that of the instructional design process. Instructional design (ID), sometimes referred to as *instructional development (ID)* or *instructional system design (ISD)*, is a systematic process for improving instruction and illustrates the design and development of instructional products or programs (Gustafson & Branch, 2002; Gustafson & Tillman, 1991; Reiser & Dempsey, 2002). Similar to PBL, ID involves problem-solving; however, the problem is in the design of instruction which can often be just as messy and ill-structured as other non-instructional problems (Rowland, 1993). Design models have been developed through research and theory on instructional design to provide

guiding principles for analyzing, producing and revising learning environments. In general, most instructional development models include five elements as their foundation and serve to encourage an iterative development process.

As Gustafson and Branch (2002) note, even though any one instructional development model may not satisfy all the needs within a defined setting and purpose, it is important to identify an ID model through its intended purpose. From there, models can be either fully adopted or adapted to meet the needs defined within the context. Along with a historical survey of research and literature in the field of ID, Gustafson and Branch (2002) present a taxonomy for classifying existing models of ID. The classifications include *classroom-oriented*, *product-oriented* and *system-oriented* models. Based on the characteristics, this developmental research is situated in a *classroom-oriented* design model. The assumptions behind the classroom-oriented model include:

1. the size of the planned instructional event will be small,
 2. the amount of resources available will be low,
 3. it will be an individual rather than a team effort,
 4. the teacher is not a trained instructional developer,
 5. the teacher will generally be limited to selecting and adapting existing materials rather than creating new ones,
 6. little time will be devoted to front-end analysis,
 7. the development and learning environments will likely be relatively low-tech,
 8. the amount of tryout and revision will be limited, and
 9. the amount of dissemination beyond that classroom will be very low, if existing at all
- (p. 15).

This is not to say the instructional program, or module, developed through this research meets all of the assumptions characteristic of a classroom-oriented ID model, as listed previously; however, due to the nature of its orientation within a public school setting, limitations have led the design of this module to follow these lines, in general, as opposed to other classifications of design models. In particular, the program developed is illustrative of the following:

1. The size of the planned instruction is relatively small compared to the scope of the semester and duration of the program, with the instructional program consuming 8 of the roughly 50 classes.
2. The amount of resources are relatively low as students have access to desktop computers and limited Internet.
3. The teacher (study participant) is not trained as an instructional designer rather has a background in business and the formal training required to receive licensure.
4. There was a very limited amount of time devoted to front-end analysis. The study participant met with the group of students for the first time just two days prior to the start of implementation. Prior to this meeting, there was no relationship with these students.
5. In order to remain on schedule with the needs and commitments of both the study participant and the researcher, there was no time for tryout and revision.
6. The results of this instructional program will most likely not be disseminated. The study participant made mention of sharing the program with colleagues as part of a discussion on new teaching styles; however no formal plans for distribution beyond the classroom of the participant have been made.

In following the recommendations of instructional design researchers and theorists, once a program or product is classified, it is also important to narrow the focus by identifying a model. For the design and development of the module in this research study, an instructional-design model was developed through the recommendations found in the models outlined by the Problem-Based Learning Network (PBLN) at Illinois Mathematics and Science Academy (IMSA) (Illinois Mathematics and Science Academy [IMSA], 2007), the instructional design model for ill-structured problem-solving (Jonassen, 1997) and the suggestions for facilitating PBL (Hmelo-Silver & Barrows, 2006), each of which is outlined below. Also considered were recommendations made by several researchers in addressing concerns and issues within the design, development and implementation of a PBL environment, which are later described as well (Brinkerhoff & Glazewski, 2000; Ertmer & Simons, 2006; Hannafin et al., 1999; Jonassen, 1997; Sage & Torp, 1997).

Design and Development Using Problem-Based Learning: Existing Models

The PBLN @ IMSA was established in 1992 as a means to further explore and apply the PBL approach in K-16 educational settings (IMSA, 2007). Their model of designing and developing PBL serves to delineate the key components of such an approach to teaching, as well as guide designers in the process of developing instructional units. The IMSA outlines 15 sequential steps for designers to follow as they design and develop a PBL unit of instruction.

These steps include:

1. Establish the context for problem design
2. Identify several complex issues
3. Map out the conceptual complexities and learning opportunities
4. Identify the problematic and ill-structured

5. Select the problematic center
6. Develop a focus for the chosen problematic center
7. Select the role and situation of most promise
8. Construct a problem statement
9. Define in greater detail the role students will assume
10. Create the actual speech, film, documents, et cetera
11. Review the meet-the-problem materials
12. Conduct a thorough information search
13. Remap the problem
14. Plan for the teaching and learning events
15. Implement with an eye towards reflection and refinement (IMSA, 2007, para. 1)

Stepien and Gallagher (1993) describe a unit designed through this model in which students were actively engaged in the elements of PBL and solving problems of authentic contexts and application. Brinkerhoff and Glazewski (2000) used this model in the development of a hypermedia-based learning unit for elementary/middle school students. Though while both of these situations focus on the education of gifted and talented students, the model they follow is adaptable to other learning situations.

In addition to the design model from the PBLN@IMSA, Jonassen (1997) also articulates several sequential steps to take in designing and developing instruction for solving ill-structured problems. These steps include:

1. Articulate problem context,
2. Introduce problem constraints,
3. Locate, select, and develop cases for learners,

4. Support knowledge base construction,
5. Support argument construction, and
6. Assess problem solutions (pp. 83-86).

For this research, the recommended steps from both models were adapted and used, in conjunction with strategies for facilitating a PBL environment as suggested by Hmelo-Silver and Barrows (2006). These strategies were used to guide the study participant as she engaged students in the PBL module. While not all of the strategies presented by the authors were included, the following were those included in the design and development of the instructional module developed through this research study:

1. Use of open-ended and metacognitive questioning
2. Pushing for explanation
3. Revoicing
4. Summarizing
5. Generate/evaluate hypotheses
6. Encourage construction of visual representation (p. 28).

The Design Model

As described further in this section, three general roles were identified in the design, development and evaluation of the PBL environment for this research study, the role of the designer, instructor (teacher), and student(s). Each member of the PBL environment carried responsibility for executing the steps and strategies related to the ill-structured problem scenario used in this research study. Table 4 delineates each component of the design, development and evaluation process and categorizes each according to each participant's responsibility. A more detailed description of how these roles played out in the course of this research study follows. It

is important to note that for this research study, concentration was on the roles of the designer (in this case the researcher) and the instructor (identified as a study participant).

Table 3.

Design, Development and Implementation of a PBL Scenario: Roles and Responsibilities

Designer	Instructor	Student(s)
Establish the context	Provide domain knowledge	
Identify complex issues within the context	Outline characteristics and roles of learners	
Create a problem statement		
Outline possible solutions	Present problem to learners	Identify the problem; outline learning goals
Create archives, materials and resources	Provide learning materials and resources	Use resources and materials to devise a solution
Create supportive learning materials	Model and support metacognitive and open-ended questioning	Engage in learning and thinking activities
Plan for evaluation	Evaluate learners	Present solution with evidence and support

The role of the designer.

In the design and development phases, the designer, in this case, the researcher, was responsible for carrying out several tasks in order to prepare the program for the implementation phase. The first task was to coordinate with the instructor, teacher or leader of the program and establish a context through which the problem and content would be presented. The context, at this point, allowed the designer to more thoroughly understand the goals and objectives of the PBL module and guided the remainder of the design and development stages. Within the context is knowledge associated with the problem domain, Jonassen (1997) says, “Designers need to

generate an inventory of all the domain knowledge...information about the context in which the problem is naturally embedded” (p. 83). Thus, by carefully examining information, roles, and other aspects of the domain, information needed to solve the problem was outlined and the context was closely aligned with the course objective(s), student interests and skill levels.

To establish a context for this research study, an informal meeting was conducted with several teachers in the participating school district. As this meeting occurred prior to identifying the study participant, all teachers of the middle school technology courses in the district were involved to help generate interest, meet the researcher, and determine willingness to volunteer as a participant. The process through which participant identification occurred is described later in this document.

The initial meeting, held in November of 2007, was designed to help determine an appropriate context through which to develop and present a problem. The teachers involved provided general information about student interests, performance levels and goals of the course. In addition, each teacher provided a syllabus of their course content along with learning materials for content covered earlier in the school year. Also, as part of a prior working relationship with the school district, the designer previously became familiar with the state standards for technology proficiency, which were used to guide the development of objectives and goals for this instructional module. In reviewing and considering all of this information, a general direction and scope for the problem was determined. Through a consensus among the teachers, it was determined the problem would focus on the local animal shelter and involve students contributing some type of service to the shelter. More specifically, students would help the animal shelter determine ways help compensate for an overabundance of animals thus resulting in an overcrowded shelter.

Once the context was clearly identified, it was necessary to outline several complex issues found within the context. These issues helped identify and more clearly outline the problem with which the learners interacted. The identification of complex issues occurred at the onset of designing the instructional module in early December, 2007. As the problem statement evolved based on input from the teachers, possible solutions were mapped out and hypotheses were made of some of the ideas students would generate. By identifying several key issues, assumptions were also made about how students would interact and possible solutions they would create. These predictions included ideas such as the need to hire more staff, get more volunteers to help, advertising for the shelter, soliciting more donations of food and supplies, along with several others. Through this process, the problem scenario could be more closely aligned with the goals and objectives of the course by anticipating the activities or products students would need to produce to address their solution. For example, should the students determine the need for more volunteers, they would need to develop artifacts such as flyers to advertise, an outline of volunteer responsibilities, an application, or other items deemed important. Through these activities, students would be able to cover several of the course objectives and state standards. With ideas such as this in mind, the problem statement could be more clearly molded around the goals of the teacher and objectives of the course and avoid situations where students would be led away from such goals.

With the context and its related issues identified, the designer worked to create a statement of the problem that was eventually presented to the learners. The statement included details that clearly outlined the context of the problem, the purpose for student involvement, and descriptions of characters involved and the role of such characters within the scope of the problem. The problem statement for this module was:

As a trend, the animal shelter experiences an influx of abandoned or surrendered animals within the first few months following the holiday season. The shelter is seeking assistance in making sure all animals are properly housed and cared for until they are adopted. To encourage community input, the shelter is running a campaign to gather some innovative and creative solutions for helping the animals. They are asking schools to participate and encourage students to enter.

It was important to remember, however, that ill-structured problems do not necessarily have clear-cut goals or a single solution toward which learners should be working. Therefore, a recommendation from Jonassen (1997) was used in that the learners were provided with restrictions or limitations to be considered in the problem solution. These restrictions included defining items such as time frames, budgets, client restrictions, and other guidelines to which the solution must conform (Jonassen, 1997). While the problem statement itself did not clearly identify these restrictions, the method through which the problem was presented did. As students were given the problem statement, they were also presented with a flyer that offered project guidelines. These guidelines were used to help students outline their own goals as they began the problem-solving process. These guidelines were presented in a 5W-H manner and read:

1. Who: We know you're young students with lots of bright, creative ideas. We know you can help us!
2. What: We need ideas for how to care for all of our animals and prepare to take in more animals.
3. When: Our animals need care immediately – we would appreciate your ideas by March 1, 2008.

4. Where: Make this a school project! Get your teacher to allow you time in your class to put together your ideas and prepare them to share with us.
5. Why: We want to make the improvements to the animal shelter a product of community support and ideas. With your creative and innovative ideas, you have the chanced to make a big difference in the lives of our wonderful animals!
6. How: Use whatever resources and information you have available at your school to get us the best ideas possible!

In addition to these guidelines, the students were also provided with a list of *requirements* to be part of the campaign. This section of the flyer read:

What we need from you: When you submit your idea, we want to make sure we get everything right. So, make sure we have:

1. A short letter describing your idea and how you think it will impact our shelter,
2. A step-by-step plan for how we can implement your ideas, and
3. A summary of any costs associated with your plan (i.e. how much money will it take?)

With the problem statement and context in mind, documents and artifacts were created and resources were outlined that were determined to be helpful to the learners as they worked to solve the problem. For an example of such resources, the *Buffalo Commons* problem presented by Sage (2000) was reviewed. For this problem, the designer developed a mock letter written by the President informing the students (who would be assuming roles as members of a presidential commission) of the issue. In this letter, the President charged the students with helping to solve the problem at hand. Other artifacts and resources included a *Buffalo Commons Briefing Book*, which students used to guide them in the process. These items can take any form, as long as they

relate to the problem and context and are helpful to the learners. In regard to the problem used in this research study, students were presented with a mock flyer, as mentioned above, designed and distributed by the local animal shelter describing the campaign. This flyer can be found in the module lesson plans in Appendix C.

In addition to more context-specific resources, the students and the teacher were also provided with supportive learning materials. This could have included items such as a list of helpful Web sites, some books or other items to references, tutorials for using computer programs or peripherals, and even items to help guide thinking and questioning. The teacher and students involved in the implementation of this PBL module received several supportive items. First, the teacher was provided with a collection of Web sites that could be useful to recommend to students as they pursued the problem. In addition, students were provided with several graphic organizers on the first few days of class. These items were developed to help guide the group planning processes as groups set their goals. As students became further engaged in the process and began using online resources to access information and ideas, they were also provided with a list of questions to guide their Internet searching to help avoid fruitless searches. As in any problem, these resources were used to help students and teachers move through the problem and eventually determine and present a solution. These resources can be found in the module lesson plans in Appendix C.

The final component of design was devising a plan for evaluation, both for the PBL module itself, as well as student learning and teacher engagement. In PBL, the evaluation is used to highlight the processes through which students were engaged, the activity of the teacher, the thinking involved, how students and teachers interacted with the resources and supporting materials and, finally, the solution to the problem (Brinkerhoff & Glazewski, 2000; Jonassen,

1997). In this module, the students and the teacher were provided with several evaluative materials at several stages of implementation. First, following each day of implementation, the students were directed to complete a group- and self-evaluation form containing questions to help keep track of their goals, questions and progress. The teacher also completed a reflective journal after each class that addressed questions regarding personal perspectives of student engagement, the types of questions asked, and interesting or peculiar observations from each class. At the conclusion of the learning module, the students were provided with a more comprehensive peer- and self-evaluation form and a rubric was used to evaluate overall participation and success. The teacher also completed two evaluation forms that addressed perspectives of student and personal engagement.

The role of the instructor.

The course instructor, or facilitator, was responsible for several tasks, which were completed along with those of the designer. In this case, the course instructor was also the study participant. To begin, as the designer worked to develop the context, the instructor served as a subject-matter expert and provided the domain knowledge needed to more thoroughly define the problem context. The context served as a basis through which the rest of the problem was developed and learning outcomes were established. To help guide the establishment of context, a sample list of some characteristics, which can be true of the learners involved, as provided by the PLBN was referenced. These characteristics describe typical 12-year old learners as those who:

1. want to be independent -- yet be child-like,
2. are critical toward society,
3. are ready to refine reasoning skills,
4. begin to understand abstract concepts,

5. develop hero-worships, and
6. can be self-conscious about new tasks (IMSA, 2007, Establish Context, para. 2).

This list serves as an example of types of characteristics that were considered of the learners involved in the learning process. By developing a similar list representative of the target-learning group, a clearer definition of the direction the problem was formed and followed to make it authentic to learner needs and interests.

For this learning module, student interests were defined and established in the initial meeting with the teachers in the district, as described earlier. Establishing such a list helped further clarify the function the learners would serve through the learning process. While each teacher contributed a list of several student needs and interests, the topic focused on the animal shelter was decided as one that would not provoke any possible problems, as predicted with other suggestions. For example, one suggestion involved the students developing an end-of-year graduation event in which the school was having difficulty planning; however, one teacher reminded the others that graduation for this group of 8th graders would not take place due to budgetary restraints. As a result, students were upset and the teachers felt this problem approach would provoke an undesired level of anger and frustration among students. Thus, the animal shelter was viewed as a neutral topic in which all students could, in some way, relate or take interest.

In addition to student needs and interests, the PBLN also provides a sample list of conceptual and skills-based outcomes, which took priority, as they should, in the design of the problem and its context. The sample outcomes offered by the PBLN include involving students in activities such as designing and conducting experiments, interpreting data, communicating effectively with a given audience and using graphs to illustrate probability (IMSA, 2007). While

such a list will be different in every design attempt, consideration of the characteristics of the learners and outlining a list of desired outcomes serves to help the instructor provide information to the designer to more strictly guide the design and development of a problem scenario. Again, the desired outcomes were outlined in the initial meeting with the group of teachers but were later clarified and refined by the instructor, as described later in the document.

After the problem scenario was created and a problem statement was developed, the instructor served as a liaison between the designer and students. The first task was to present the problem to the students which occurred on the first day of implementation on February 6, 2008. After the students considered the problem statement, outlined learning goals, and considered resources needed to address the problem, the instructor provided them with the learning materials and resources developed through the design of the module. As previously mentioned, these learning materials included graphic organizers, an Internet search guide, and evaluation sheets that were presented to learners at several stages throughout implementation. As in the case of the *Buffalo Commons* problem however, some of the artifacts and materials, such as the letter from the President, can be presented as part of the problem statement (Sage, 2000). In the case of the module developed for this research study, the learners were presented with the flyer from the animal shelter as their introduction to the context. Through these materials, learners gathered information about the context and their role within the problem.

Once learners were actively engaged in learning activities and collaboration with peers, the instructor continued to serve as a facilitator (not a deliverer) of information. This is the point where she provided supportive learning materials developed for the module to help students work through the problem. This also included modeling certain metacognitive strategies by asking students relevant, yet open-ended questions through which they consider their process and

progress toward reaching their goals. To help the instructor model such strategies, she was provided with prompts and sample questions throughout the module lesson plans. An example was given in the first day of the module lesson plans. This prompts reads:

The teacher should begin the brainstorm by modeling some questions. For example:

If I were to enter this campaign, I would begin by asking myself a few questions such as:

- What kinds of things might limit the number of animals the shelter can accommodate?
- What are some things the shelter might need to accommodate more animals?

Another example was written into the second day of the module lesson plans. This was a sample scenario provided to the instructor to help model the planning and problem-solving process. The prompt reads:

The teacher will begin the group planning session by modeling some problem-solving questions. For example:

When I am trying to solve a problem or planning to do something, I make sure I understand what needs to be done, where I'm going to get my information, how I'm going to present my information and how much time I have to complete everything. For example, in planning to teach a class, I might decide I need to create something to hand out to all of the students. I then have to decide what I will need to create that handout, how much time I should spend on it and what should be included. So, I might determine the handout needs to contain information on doing Internet searches and that I will need to type directions, so I will use a word-processing program like Word and I can't spend any more than 20

minutes. With this kind of plan, I know exactly what I need to do, how I'm going to do and how much time it will take me. As you develop plans for your campaign entry, think about these things – what will you do, what will you need, how will get it, how much time do you have?

The final responsibility of the instructor was to implement the evaluation instruments designed to assess the PBL module design, student engagement, and learning. These instruments included a rubric to evaluate the module, group-, peer- and self-evaluation forms as well as a rubric for the final project/presentation. All of these items are included in the module lesson plans in Appendix C.

The role of the student(s).

The student role came into play after the context, domain knowledge and problem statement had been developed, reviewed and refined. As the instructor presented the problem statement, students worked in groups to identify the problem. Through this process, student groups interpreted the problem from several different perspectives and worked to agree upon and define an understanding of the problem. After the group agreed on a view of the problem, students in the group worked to outline individual learning goals and set a schedule to refer to as the group members proceeded in the problem-solving process. The interpretation of learning goals differed among groups and the instructor served to facilitate the understanding of the problem (being careful not to instill any sense of right or wrong, or direction).

When the learning goals and problem were identified, learners sought to identify the types of resources required to devise a solution. This occurred in several ways: the learners separated and located resources individually then regrouped and shared; the instructor provided suggested resources as a starting point through which learners could find additional resources;

and the groups worked together to identify, locate and employ agreed-upon resources to devise a solution. As learners engaged in the learning activities, they were advised (by the instructor through the module materials) to focus on the metacognitive strategies used throughout the problem-solving process. Finally, learners compiled resources and created a presentation of the solution while providing supportive evidence to back up claims and suggestions. At this point, they were evaluated through the method developed by the research.

While this discussion served to outline and describe the roles and responsibilities of parties involved in the PBL environment, it was also helpful to consider how the elements of PBL informed the design process. To remain cognizant of this, the key elements of a PBL environment were outlined, as based on suggestions by Barrows (1998), along with implications for what should have occurred as the design process was carried out. This can be found in Appendix D.

Addressing Concerns and Issues: The Use of Scaffolds

As mentioned earlier, several researchers have outlined concerns and issues within the design, development and implementation of a PBL approach to instruction (Barrows, 2002; Brinkerhoff & Glazewski, 2002; Ertmer & Simons, 2006; Hannafin et al., 1999; Jonassen, 1997; Kumar & Natarajan, 2007; Sage & Torp, 1997). A few of the main concerns with incorporating a PBL approach to teaching and learning are (a) the time involved in preparing both students and teachers to engage successfully with the learning environment and the lack of experience in such environments (Barrows, 2002; Brinkerhoff & Glazewski, 2002; Ertmer & Simons, 2006; Hannafin et al., 1999; Jonassen, 1997; Kumar & Natarajan, 2007; Sage & Torp, 1997); (b) teachers shifting their role from provider to facilitator (Ertmer & Simons, 2006; Jonassen, 1997; Sage & Torp, 1997), and (c) measuring student thinking (Sage & Torp, 1997). In general,

didactic instruction, to which students and teachers are most accustomed, does not involve many of the skills necessary to be successful in a PBL environment, such as critical thinking, metacognitive thinking, seeking resources and framing questions. One suggested approach to addressing and compensating for several of these concerns involves the use of scaffolding throughout the instructional events.

Hannafin, Land and Oliver (1999) suggest the use of scaffolds in *open learning environments* (as opposed to *directed learning environments*) to provide support for learners and teachers through four different classifications, *conceptual, metacognitive, procedural, and strategic* (Hannafin et al., 1999, p. 131). For this research study, scaffolds were included in the design of the module and the development of instructional materials in order to provide immediate support for both students and the teacher as they engaged in the PBL environment. In addition, as the module plans evolved, scaffolds were added for teacher and student support. Table 5 is used to illustrate some of the scaffolds used in the PBL module plans developed for this research study.

Table 4

Scaffolding Classifications as used in this Research Study

Scaffold Type	Methods used in module for:	
	Teacher	Student
Conceptual	Provided with questioning prompts to guide learners as they understand the problem (day 1)	Offered access to open Web sites (ongoing)
	Provided with a sample scenario to present to students and model problem-solving (day 2)	Shown how programs like Word and Excel could be used to address needs (ongoing) Provided with graphic organizers to outline goals (day 1 and 2)
Metacognitive	Provided with sample scenarios to present to students to model thinking and reflection (ongoing)	Provided with graphic organizers to develop timeline, recognize needs (day 1 and 2)
	Journal template prompted to monitor personal role and thinking (ongoing)	Provided with checklist to monitor progress (day 6) Evaluation prompted reflection (ongoing)
Procedural	Provided with prompts on how to encourage students to consider use of multiple programs (ongoing)	Teacher showed sample plan/campaign using several different programs (day 5)
		Teacher provided a guide on how to properly search the Internet and find credible sources (day 3)
Strategic	Provided with prompts to generate deeper thought about problem (ongoing)	Teacher provided sample problem-solving guide (day 2)
		Teacher provided a sample plan (day 5)

Study Setting and Rationale

The educational administrators for the state of New Jersey have realized the need to evaluate the technology programs within their schools and implement programs to better prepare students with technology skills. Technology literacy requirements have been implemented and used as guidelines through which every school district must align their curriculum content standards. These standards, found at http://education.state.nj.us/cccs/?_standard_matrix;c=8, are being used as criteria through which literacy and proficiency is measured. To help schools across the state find ways to appropriately assess their students, the New Jersey Technology Assessment Program (NJTAP) was developed and implemented in pilot form in several schools throughout the state. In the school year 2006-2007, the pilot program was employed to begin the process of evaluating the course design and methods of assessment being used to measure student proficiency and technological literacy. The purpose of the pilot was to identify and/or develop resources to assist school districts in measuring student proficiency levels and outline a statewide standard method of assessment. While no instructional or assessment formula was provided, the state collected data from participating schools on what they were doing and how they were assessing students. Several school districts throughout the state were involved and contributed a variety of resources and recommendations for the state to consider.

In one particular school district, a school participated in the pilot in collaboration with the researcher. A description of the school district, the participating school, teacher and the technology courses are provided below. It is important to note that all identifying components of these entities were assigned a pseudonym for the purpose of this research study.

The Pilot Program in Harborside Township

In Harborside Township, a school district in the southern portion of the state, the pilot program reached 225 7th graders and 225 8th graders at a single middle school in the township, Woodburn Middle School (WMS). The program spanned four courses, Computers I, Computers II, Work Skills I, and Work Skills II. Last year, one teacher actively participated in the pilot and served as the instructor for the courses. The courses consisted of a technology curriculum delivered to groups of students as part of their required elective courses (other courses include Physical Education, Art, Music, etc.). Through the elective rotation, students attended the computer course twice a week for one marking period, approximately six weeks. After completing all four technology courses, the students received a total of 90 class periods, approximately 42 minutes each, of technology instruction. The curriculum was developed to meet specific goals in order to prepare the students to meet their 8th grade technology benchmark standards and move on to high school level training.

Evaluation and outcomes.

A brief evaluation of the pilot program was conducted during the spring of the 2006-2007 school year in the one participating school, Woodburn Middle School (WMS). Through this evaluation, several recommendations were made regarding the future of the program and implications for course design and assessment approaches. These recommendations included:

1. incorporate interactive components within assessment of skills and standards,
2. include skills and performance assessment items with rubrics and evaluation items,
3. locate and execute an evaluation measure that includes student interaction with programs and activities; evaluation tools should be more *life-like* as opposed to multiple-choice questions,

4. evaluate students at the end of each of the four courses to determine skill and proficiency level; design alternative activities for students exhibiting either *Advance Proficiency* or *No Proficiency* in identified skill areas (proficiency levels determined by course instructor and evaluator), and
5. continue to align course materials with core subject area assignments and topics to promote relevance with students.

Through these recommendations, the teacher and the technology coordinator for the school district determined the need to alter the design of their Work Skills courses. To follow in line with the advice of the evaluator (also the researcher for this study) and recommendations from the evaluation, they proposed using a problem-based learning approach to teach the courses in order to provide students with more realistic and relevant topics and problems and the opportunity to engage in performance assessments.

For the current school year, Harborside Township has expanded its technology program to include three additional teachers and one additional building. This year, the program is reaching approximately 400 students and is focused on integrating the results and recommendations made at the conclusion of the pilot program last year. Through the outcomes of the program evaluation and the relationship developed between the researcher and Harborside Township School District, a proposal was developed to design a PBL module for one of the technology courses to address several of the recommendations. In order to continue work within Woodburn Middle School and with the Work Skills course, however, it was necessary to follow proper procedure as outlined by the Harborside Township School District and Virginia Tech's Institutional Review Board (IRB) for conducting research in a school setting. Thus, permission from the school board and superintendent was sought in early October 2007. The researcher

composed a letter describing the prior relationship and a description of the proposed research study (see Appendix E). This letter was received, reviewed and approved by the school board and superintendent on October 23, 2007 (see Appendix F). At this point, the researcher had permission to work with the teachers in the school and was able to begin the process of selecting a study participant and target classroom.

A Background on Work Skills I at Woodburn Middle School.

To address the results and recommendations from the evaluation, this research study focused on one section of the Work Skills I courses taught at Woodburn Middle School. Through the general design of this course, students are led through several subunits of instruction, each covering a portion of the technology standards. The students in this course work through instructional activities to help gain proficiency and become prepared to move forward in the program, to Work Skills II and on to high school.

The instructional units, as determined by the teachers of the Work Skills courses and the district technology coordinator, are interdisciplinary units of study covering both core curriculum content and technology content (as outlined by the previously mentioned state technology standards). The Work Skills teachers collaborate with core curriculum teachers and design the technology lessons within the context of content being covered in core classes (i.e. social studies, science, language arts and mathematics). Table 6 shows an outline of the projects and core curriculum content covered in the Work Skills I courses during the 2006-2007 school year.

Table 5

Outline of Work Skills I Projects

Software	Project	Core Subject
Inspiration	Self Assessment	
PowerPoint	Historical Figure; American Revolution	Social Studies
	Element from Periodic Table	Science
Word	MLA Research Paper	Language Arts
Inspiration	Timeline-American Revolution	Social Studies
Access	Periodic Table of Elements	Science

Study Participants

The three participants for this study served two distinct roles. The first two participants served as expert reviewers of the PBL module and the third participant as the course instructor to implement the newly developed PBL module. Prior to identifying participants and the onset of data collection, approval was sought through Virginia Tech's Institutional Review Board (IRB) application. The application for this research study was submitted to the IRB on December 4, 2007 and approval was received on December 6, 2007 (see Appendix G for confirmation letter). With IRB approval granted, the research participants could be identified and thus provided with a description of the study including goals, responsibilities, rights, and potential risks and benefits.

Immediately following the receipt of IRB approval, three individuals were contacted, via e-mail, to request permission to include them as expert reviewers and thus participants in this research study (see Appendix H). All three of these individuals were identified through their expertise and contributions to research in the field of problem-based learning as well as the field of instructional design and technology. Two of these individuals returned the request by agreeing

to participate. Once permission was received, an additional e-mail was sent that contained the timeline and proposed deadlines along with a more descriptive list of responsibilities. A paper copy of the informed consent process and a consent form was also mailed to each participant in early January, 2008. This mailing contained a memo reminding the individuals of their agreement to participate (see Appendix I) and the consent form (see Appendix J). These signed forms were returned via postal mail shortly thereafter. Once participant consent was received, the expert review phase of the research study continued as described later in this document.

The third study participant, Marcy, as she will be referred, was a course instructor for one of the Work Skills I courses, the target setting for the PBL module. The technology coordinator for the school district identified Marcy as a possible participant based on her qualifications and willingness to participate. One key element was that she was also the teacher who participated in the pilot program and evaluation of the courses in the 2006-2007 school year and thus had an existing relationship with the researcher. To secure her participation, a paper copy of the informed consent process along with a consent form (see Appendix K) was mailed in early January, 2008 and collected, in person, at the first interview on February 5, 2008.

The participation of all three study participants was entirely voluntary with the understanding that they would not be compensated for their work.

Procedures

This research study focused on the design, development, implementation and evaluation of a single, 8-day PBL module. The procedures through which this occurred are described below. It is important to note, up front, that the initial proposal for this research study involved the study of both teaching and learning in a PBL environment, which would include monitoring both the teacher and the students. In the original proposal, plans were made to collect data from both

students and the teacher through a preliminary and post survey, observations specifically focused on student engagement and activity, reflective journals from both, project evaluations and a skills-based assessment. To modify the study and remain within the timeline of the researcher, the focus was narrowed to include the teacher as the only data source, thus modifying the purpose to monitor the teaching aspect of a PBL environment and exclude the learning aspect.

The procedures in this research study occurred in several separate stages and involved the execution of several roles. This section includes an outline of those roles followed by a description of the activities required to complete the research study. A timeline is included to outline the course of events and dates of completion, as shown in Table 7.

Table 6

Timeline of Research Events

Event	Proposed Date of Completion	Actual Date of Completion
Present research prospectus to committee	November 16, 2007	November 16, 2007
Meeting with teachers in Harborside Township to discuss module and problem context.	November 19, 2007	November 20, 2007
Submit IRB materials to Virginia Tech IRB	December 3, 2007	December 4, 2007
Identify study participant and expert reviewers; attain verbal consent	December 3, 2007	December 19, 2007
Design and development of PBL module	January 14, 2008	January 11, 2008
Receive written consent from expert reviewers	January 11, 2008	January 14, 2008
Distribute draft of PBL module and materials to expert reviewers and Marcy	January 14, 2008	January 14, 2008
Present completed module and materials to Marcy for final review	January 28, 2008	January 25, 2008
Conduct first interview and distribute preliminary survey to Marcy	February 5, 2008	February 5, 2008
Begin implementation	February 7, 2008	February 6, 2008
Observations of and member check with Marcy	Ongoing	February 28, 2008
Collect reflective journals from Marcy	Ongoing	March 1, 2008
Data analysis of researcher memos and field notes	Ongoing	March 14, 2008
Conduct second interview	February 14, 2008	February 19, 2008
Conduct third interview	February 29, 2008	February 28, 2008
Collect post survey from Marcy	February 29, 2008	March 1, 2008
Collect all data and analyze	March 1, 2008	March 3, 2008
Final write-up of analysis and findings	March 14, 2008	March 14, 2008
Final defense of research	March 21, 2008	March 21, 2008

Components of the Research Study

As mentioned several times throughout this document, participation in a developmental research study and designing and developing a PBL module involves several types activity from several individuals. The roles and responsibilities of the designer, instructor and student(s) have already been described in regards to the design of the PBL module and environment. This section serves to outline additional components of the research study and the individuals involved as well as a description of how each component was executed.

Collaboration.

Developmental research should involve “intense collaboration among researchers and practitioners” (Reeves, 2000, p. 25) and, in this case, the research involved extensive collaboration with the study participant, a teacher of the Work Skills I course. For this research study, collaboration involved a sharing of ideas, perspectives and opinions regarding the design of the PBL module materials and activities. During the initial meeting in November 2007, opinions were sought from the teachers and, once the study participant was identified, additional information was sought from that individual. Through this collaboration, the research-based design ideas were contributed (as they relate to PBL) along with the design model developed for the purpose of this research. To remain in line with the recommendations of Richey et. al., (1996), Marcy acted as a subject matter expert providing content and context-related information.

In addition, while the researcher assumed primary responsibility for the design, development and evaluation of the PBL module, it was necessary to collaborate with the Marcy in seeking information regarding classroom demographics. This information included items such as:

1. A breakdown of student ability levels and/or classifications
2. Class meeting days and times
3. Class sizes and rosters
4. Building/class locations
5. A calendar of school breaks and holidays

The collaboration between the teachers in Harborside Township and, more specifically Marcy, who was a teacher at Woodburn Middle School, occurred through several methods. The initial meeting with the teachers, in late November 2007, was conducted through an on-site, face-to-face visit with each of the 8th grade technology teachers. Following the meeting, additional collaboration occurred through e-mail threads and phone conversations with Marcy. In the development phase of the learning module, in late December 2007 and early January 2008, the Marcy's advice was sought through numerous e-mail messages and two phone conversations. Once the implementation phase began in February 2008, collaboration with the Marcy continued, regarding ideas and revisions of the module, through daily and informal, face-to-face conversations (before and after each day of implementation), three formal face-to-face interviews as well as numerous discussions via e-mail. Both Marcy and the researcher equally initiated the daily discussions and e-mails. The information collected through these collaborations was applied to the overall design of the PBL module to ensure context and learner sensitivity, and considered as useful data throughout the evaluation and analysis.

Communication.

Russ-Eft and Preskill (2001) recommend using communication throughout an evaluation/research project as means to maintain the flow of processes and procedures. Thus, communication was maintained between Marcy and the researcher through several methods

including telephone, e-mail and on-site visits. Table 8 outlines a portion of the communication log; however, for the purpose of space, not all occurrences are listed, as there were in excess of 100 throughout the duration of the research study. Some of these include e-mail threads regarding subjects such as revisions to the learning module, clarifying schedules and meeting times, questions about implementation procedures, and others. In addition, informal face-to-face discussions were conducted before and after each day of implementation for the purpose of member checking, clarifying lesson plans and revising materials. Marcy also provided reflective journal responses through an online survey tool following each day of implementation.

Table 7

Communication With Marcy

Date of Communication	Method	Purpose
November 20, 2007	Face-to-face	To establish purpose and context of the problem; initial meeting with teachers
December 6, 2007	E-mail	Outline components of the research study and seek verbal consent to participate
December 19, 2007	E-mail	Received verbal consent from Marcy
January 7, 2008	E-mail	Clarify schedule and secure calendar of events
January 14, 2008	E-mail	Testing a Web site designed to house resources for the PBL module
January 14, 2008	Postal mail	Deliver module lesson plans for expert review
January 18, 2008	Phone	Discuss the module lesson plans and outline ideas for revision; answer questions and concerns regarding the start of implementation
February 1, 2008	E-mail	Deliver revised module and preliminary survey
February 5, 2008	E-mail	Providing link to online survey tool to complete teacher journal; also include a link to online content for students
February 5, 2008	Face-to-face	First interview to answer questions about the module and prepare for implementation
February 6, 2008	E-mail	Recap of the first day of implementation along with a list of strategies and suggestions for the second day
February 19, 2008	Face-to-face	Second interview to discuss components of the learning module and reflections on the implementation process
February 28, 2008	Face-to-face	Final interview to finalize all details of the research study and discuss reflections of the implementation process
March 3, 2008	Postal mail	A thank-you card expressing appreciation to Marcy for her cooperation

As described earlier in the document, to ensure compliance with the ethical aspects of any research, it was also necessary to communicate with authorities within the school district.

Thus, the written permission from both the building principal and the superintendent of the district was required. To obtain this permission, a letter was written and mailed to the Harborside Township School Board to inform all parties about the proposed research study in early October 2007 (see Appendix E). This letter included an explanation of the purpose of the study, procedures involved, assurance of anonymity and other related messages. In addition, this same letter was mailed to the principal of Woodburn Middle School to inform the building principal and assistant principal of the proposed plan. In return, a letter of approval was received from the school board containing written permission from both the school board and the superintendent of schools in late October 2007 (see Appendix F). Also, during the on-site visit with the teachers in late November 2007, the researcher met briefly with the principal and assistant principal of Woodburn Middle School. This meeting served two purposes: the first to become familiar with the building and the building authorities and second, to gain permission and approval to move forward with the research study. Both the principal and assistant principal provided their verbal consent to conduct the research study within their building.

Support and guidance.

As the implementation phase of the research study ensued, interviews were conducted as a method to not only collect data to inform study purposes but to also continue to familiarize the study participant to the collaboratively developed product, in this case the PBL module. Early on, it was important to ensure that Marcy was properly informed and acclimated to the PBL module activities, materials and procedures. Thus, the first interview was conducted just prior to implementation and this time was used to address any questions or concerns (see the section on evaluation) as well as gather some initial feedback regarding the position of the study participant as she became situated within the PBL environment and familiar with the module. Once the

implementation began, two additional interview sessions were conducted. During these sessions, the study participant was given the opportunity to address additional concerns and ask questions regarding implementation and classroom practices. The protocol for these two interviews can be found in Appendix L and Appendix M.

In addition to interviews, Marcy was also given ample opportunity to discuss procedures and ask questions through the duration of the research study. As such, discussions were held prior to and after each day of the implementation process. Some of these discussions were short addressing one or two simple questions while others were much lengthier and focused on deeper issues such as how to handle student behavior, additional guidance she could offer students, plans for upcoming days and other topics related to implementing the module. The researcher kept notes of these meetings and wrote memos to record the questions and concerns Marcy expressed. The data collected during these opportunities to offer support and guidance were used in the final analysis.

Observation.

Throughout implementation, researchers recommend one important contribution to the research as being the observation of both students and teachers as they are engaged in learning activities (Barrows, 2002; Brinkerhoff & Glazewski, 2000; Kumar & Natarajan, 2007; McLellan, 1993; Sage & Torp, 1997). The observations help to understand the interactions of students and teachers within the context of the PBL module, the activities and materials, also while providing information on the effects of the program (Russ-Eft & Preskill, 2001). The researcher in this study served as a “participant observer” for each of the class sessions (Creswell, 2003). While there was no participation in any of the classroom activities or discussions, or interaction with students, the researcher did serve as a source of support and guidance for the study participant, as

described throughout this document. Thus, the researcher role involved observation and interaction with the study participant. In total, eight observations were conducted, one for each day of implementation. The observations were conducted to identify actions and conversations specific to PBL. As the researcher circulated around the room, a record of such instances, as well as other observations relevant to the research study, were recorded through field notes. In addition, a video recording was taken of each of the eight days and was reserved for clarification and member checks. Following each day of implementation, researcher memos were written to record reflections and more specific reactions to what was observed. Portions of these memos were shared with Marcy for clarification and member checking and were also considered through data analysis (Creswell, 2003; Merriam, 1998).

Marcy was also involved in observation of classroom activities and contributed highlights and perspectives of classroom procedures and the overall process. She served also as a “participant observer” and, through the use of reflective journals (Creswell, 2003; Park et al., 2004; Sage & Torp, 1997), provided information that may have been missed through general observations (Creswell, 2003). This came through the process of “listening, conversation, questioning and interviewing” as part of classroom activities (Payne & Payne, 2004). To help guide her observations and reflections, Marcy was provided with a journal template (see Appendix N). She was also encouraged to record any additional reflections beyond what was prompted on the journal. These reflections were considered through data analysis.

Evaluation.

The evaluation within this research study can be classified as program evaluation. While the general interest of the research is the theoretical aspect of the study, interest also lies in the

people and organization involved. Posavac and Carey (2003) describe the difference between research and program evaluation as:

Basic research concerns questions of theoretical interest, without regard to the information needs of people or organizations. In contrast, program evaluators gather information to help people improve their effectiveness, to assist administrators to make program-level decisions, and to enable interested parties to examine program effectiveness. (p. 10)

Russ-Eft and Preskill (2001) also distinguish between research and evaluation by illuminating the difference being that evaluation is “grounded in the everyday realities of organizations” (p. 6). Tyler, Gagne and Scriven (1967) have also made a distinction between research and, in their perspective, curriculum evaluation, and state the purpose of evaluation is to “acquaint the audience with the workings of certain educators and their learners” (p. 5). In the case of this research study, one of the primary purposes for conducting the research is to modify and evaluate a portion of a course within a school district and help school district leaders make informed decisions about the future design and implementation of that course. Thus, the interest is on the school district, its teachers, students, and programs, and the evaluation can serve to “illustrate the effects of a program, process,....learning,....” (Russ-Eft & Preskill, 2001, p. 15).

Theory is not without its place in program evaluation, however. Posavac and Carey (2003) state, “understanding theories helps in planning programs and selecting variables to observe. However, contributing to the development of theories can only be a delightful side benefit of a program evaluation” (p. 10). Through the evaluation process in this research study, the researcher has worked to develop contributions to theories on instructional design for ill-structured problem scenarios. In order to gain a comprehensive perspective, the evaluation of the

PBL module was conducted through two phases. The first phase of evaluation was in regards to the general design of the PBL module, identified as the expert review. The second phase was designed to measure the impact on teaching, and was conducted through the implementation of the PBL module. These phases, expert review and implementation, are described in detail later in the document.

Summary of the Components of the Research Study

To summarize, this section served to highlight the components of this research study, classified as a developmental study involving the design, development and evaluation of a PBL module. Each component involved activity by several individuals who participated in the execution of the research study. In addition, methods and instruments through which the activities were carried out were recorded and used as part of the data collection and analysis for this research study. Each of the components, the individuals involved and the instruments used to support activity and collect data is shown in Table 9. Following this table is a discussion of each phase of research including a.) design and development (of the module) and b.) evaluation (expert review and implementation).

Table 8

Components of the Research Study

Component	Key individuals	Instruments
Collaboration	Teachers, study participant, researcher	On-site visits, e-mail, telephone
Communication	Study participant, school district administrators, researcher	On-site visits, e-mail, telephone, reflective journals, postal mail
Support and Guidance	Study participant, researcher	Interviews, informal discussions
Observation	Study participant, researcher	Field notes, researcher memos, video recordings, reflective journals
Evaluation	Expert reviewers, study participant, researcher	Expert review, Implementation (to be described further)

Phases of Research

Module design and development.

Through this research study, a single module was developed to cover a portion of the content currently taught within the Work Skills I course. As previously described, the researcher met face-to-face with the teachers of one of the courses technology courses in late November 2007 to define content. During this time, the elements of designing and implementing a PBL module were outlined and the researcher provided each teacher with a summary of PBL and its essential components (similar to what was outlined at the conclusion of chapter 2). Following this meeting, the study participant was officially identified and, through an e-mail discussion, she outlined her personal proposed goals for the project and discussed some of the general interests and performance levels of her students. In addition, the researcher revisited notes taken during the on-site visit in regards to the input and ideas expressed by the study participant. Together, the researcher and study participant agreed on a subunit of content through which to focus the PBL

module that was used in the subsequent development of the learning module for this research study.

In general, the study participant preferred to cover several specific software programs such as Microsoft Word and Excel but remained flexible in how and for what purpose they would be used. In regards to the topic, it was decided that the learning module would be developed around a general theme of interest of most middle school students – animals. In addition, it was also agreed that the PBL module would focus on a problem situated within a local animal shelter having difficulty getting pets adopted and facing the problems of an overcrowded facility.

The design and development of the PBL module occurred in mid-December, 2007 through mid-January, 2008. In recalling the roles and responsibilities in designing a PBL module (see Table 4), each stage of the process was executed and the study participant was consulted when needed. Table 10 outlines the design-related objectives for the designer/researcher and how they were completed. All materials were completed by mid-January, 2008, in preparation for the next phase: expert review.

Table 9

Designer Responsibilities and the Design Process

Responsibility	Process
Establish the context	The researcher met with teachers in late November, 2007 to establish the context and outline content to be covered. The context was situated within a local animal shelter as a campaign to help solve their issue with overcrowding.
Create a problem statement	The researcher developed a problem statement based on the previously outlined context.
Outline possible solutions	The researcher brainstormed ideas on solving the problem and predicted solutions students would propose.
Create archives, materials and resources	The researcher generated a flyer for the local animal shelter to announce the need for help (see Appendix C). The flyer outlined particular items the shelter needed from students participating in their campaign.
Create supportive learning materials	The researcher developed daily lesson plans to guide the implementation of the module (see Appendix C). The lesson plan included questions the study participant could use to facilitate student participation and learning, methods of modeling the thinking and problem-solving process. Also, the researcher located some online resources for students to use should they encounter difficulty with online security issues.

Expert review: phase one of evaluation.

This first phase of the evaluation process occurred in mid-January, 2008. Once the module plans and materials were developed, an expert review packet was submitted to each of the expert reviewers as well as the main study participant. The packet contained 1.) a letter explaining the process (Appendix O), 2.) a copy of the lesson plans, all of the supportive learning materials for the teacher and students (Appendix C), and 3.) an evaluation rubric (Appendix P). The reviewers were given two weeks to complete a review of the module and offer written

feedback on how closely the lessons and materials aligned with the elements of PBL and the degree to which the module reflected a PBL approach to instruction. The study participant also judged the overall coverage of appropriate content in regards to defined objectives.

Upon receipt of feedback, the proposed changes were carefully considered and all necessary alterations to the activities and resources were made. An additional week was used to make revisions to the module and prepare for the next phase of the research study: implementation. A summary of these recommendations and changes can be found in chapter 4.

Implementation: phase two of evaluation.

In late January 2008, all lesson plans and materials for the module were revised and completed. The PBL module was submitted a second time to the study participant for a final review on January 31, 2008. Once all plans and materials were finalized and agreed upon, the study participant prepared for implementation, which began in early February 2008.

Throughout the month of February 2008, the study participant used eight class periods of the same section of students to complete the implementation of the eight-day module. The class met every other day, as they were on a school-wide, two-day rotation. Thus, to complete the eight days needed, the implementation phase spanned the course of four weeks. During this time, the study participant executed the plans and used the resources provided in the module. As is typical of PBL, the module evolved as students became more involved and the study participant realized the need for changes or adaptations. She consulted the researcher regularly about these changes, each of which was approved, as a way to support both student and teacher needs. Some of the additions and changes made to the module included:

1. Creating a visual representation of the planning process to project on the screen and discuss with students,

2. An outline containing a sample step-by-step plan for students to use a guide for developing their own plans,
3. Developing a sample *campaign* to model a completed idea and presentation,
4. Providing students with an outline for their final presentations in which they identified responsibilities.

As previously described, the researcher became a *participant observer* throughout the entire implementation process and recorded field notes of observations (Creswell, 2003). In addition, the study participant was also a *participant observer* and used reflective journals and interview opportunities to share what occurred, from her perspective, during classroom activities (Creswell, 2003; Park et al., 2004; Sage & Torp, 1997). Three interviews were conducted during this phase, one prior to the start, one following day four and the other following day eight of implementation. The first interview was designed to be informal and guided primarily by the needs of the study participant. This initial meeting provided an opportunity to ask questions about the module, clarify schedules and become familiar with the procedures used during implementation. Once implementation began and the study participant became more comfortable with the procedures and the presence of the researcher, the final two interviews were scheduled. As these were more formal than the first, an interview protocol was developed for the second and third interview, which basically contained a list of questions to ask of the study participant as well as some reflective material to consider. These protocols can be found in Appendix L and Appendix M.

Evaluation through implementation.

Delisle (1997) makes some recommendations for how evaluation in a PBL environment should occur and states, “With problem-based learning, evaluation is integrated throughout the

process as the teacher observes students' abilities during each step of solving problems...In addition, teachers should evaluate the PBL problem itself and their own success in using it" (p. 37). For the second phase of overall evaluation, the study participant was consulted regarding implementation of the PBL module. The reflective journals, observations and interviews were designed to gain information regarding how the module was impacting her personal perspective on teaching and the overall effectiveness with her students.

For teacher evaluation, Delisle (1997) recommends teachers not only reflect on student performance, but their own involvement in the PBL environment as well. He states, "the teacher also should analyze his own skill with guiding students rather than directly instructing them" (p. 39). To perform this step of evaluation, researchers have used reflective journals to highlight what students are learning, their thinking involved, the role teachers play in implementing the PBL module and the overall process (Barrows, 2002; Kumar & Natarajan, 2007; McLellan, 1993; Park et al, 2004; Sage & Torp, 1997). Marcy engaged in active class observations and reflective journals, which highlighted specific components of the impact the PBL module made on her teaching. In addition, she completed a preliminary survey (Appendix Q) and a post survey (Appendix R), also encouraging reflection on her own implementation of the PBL module. By engaging in these activities, Marcy was able to monitor implementation strategies, questioning methods and movement in the overall process of interacting in a PBL environment (Brinkerhoff & Glazewski, 2000; Brush, 1997; Hmelo-Silver & Barrows, 2006; Park et al., 2004).

The combination of multiple data sources, such as surveys, researcher observations, interviews and teacher reflective journals were analyzed and used to evaluate and outline the implications of using a PBL approach to teaching digital technology skills. The outcome of this analysis is further discussed later in this document.

This section was designed to highlight the procedures used throughout the research study. In summary, Table 11 is included to highlight these procedures along with the corresponding types of data collected throughout the evaluation process. The section that follows is a more thorough description of procedures used to analyze these data.

Table 10

Summary of Procedures and Data Collection

Procedure	Instrument	Data Source
Module design	N/A	Researcher, study participant
Expert review	PBL module rubric	Expert reviewers, study participant
Implementation	Observations	Researcher, study participant
	Researcher memos	Researcher
	Reflective journals	Study participant
Evaluation	Preliminary survey	Study participant
	Reflective journals	Study participant
	Interviews	Researcher, study participant
	Post survey	Study participant

Data Analysis

Maxwell (2005) states, “the experienced qualitative researcher begins data analysis immediately after finishing the first interview or observation, and continues to analyze the data as long as he or she is working on the research” (p.95). Thus, for this developmental research study, data analysis began at the onset of data collection (from the initial contact with the study participant) and continued through the duration of the expert review and implementation phases. It is important to note that, as Merriam (1998) states, “qualitative research is not a linear, step-

by-step process...collection and analysis is a *simultaneous* activity (p. 151). Thus, as data sources were completed and collected, the analysis process was also underway. For this research study, a constant comparative method of data analysis was used to monitor and analyze data (Glaser & Strauss, 1967; Merriam, 1998; Rossman & Rallis, 2003). This served to “facilitate the search for patterns and themes” as they emerged through the data sources (Patton, 1980, p. 302). Merriam (1998) describes this process of data analysis occurring as “the researcher begins with a particular incident from an interview, field notes, or document and compares it with another incident in the same set of data or in another set” (p. 159).

As themes and patterns emerged, a method of categorizing strategies was employed, which Maxwell (2005) also calls “coding” (p. 96; Rossman & Rallis, 2003). Merriam (1998) suggests coding as a means for organizing and managing data through the use of symbols, notations, key terms or other identifying characteristics that will help with comparing, analyzing and referencing data throughout and beyond the scope of the research study. One challenge however, as mentioned by Patton (1980), is knowing “how to *flesh out* the categories” (p. 312). He recommends several methods through which this process of categorizing can occur, which include (a) the “process of extension (building on items of information already known)”, (b) “bridging (making connections among different items)”, and (c) “surfacing (proposing new information that ought to fit and then verifying its existence)” (p. 312). These methods were considered and codes were applied as they emerged through the data collected. The codes were then used to “facilitate comparison between things in the same category and that aid in the development of theoretical concepts (Maxwell, 2005, p. 96).

More specific to the research study, several types of data were collected and analyzed through this constant comparative method. Merriam (1998) lists three data collection techniques,

to include “conducting interviews, observing, and analyzing documents” (p. 134). For this research study, each of these techniques was used to collect data.

Interviews with Marcy, the study participant, occurred at three points throughout the study; one just prior to the start of implementation, one after the fourth day of implementation and one immediately following the final day of implementation. Each interview was recorded and then transcribed verbatim and used throughout analysis. Observational data came through the observation of eight classes, one for each day of implementation. For each observation, field notes were recorded and a video recording was taken in order to provide a method of validation for field notes. Following each day of implementation, the field notes were word-processed and both the handwritten and typed versions were kept on hand for data analysis.

In addition to the interviews and observations, several documents were analyzed. The documents used for this research study are considered “researcher-generated documents” as they were “documents prepared by the researcher...to learn more about the situation, person, or event being investigated” (Merriam, 1998, p. 119). These documents came in the form of reflective journal entries Marcy completed after each day of implementation (see Appendix N). In addition, Marcy also completed a pre- and post-survey of questions related to the research study (see Appendix Q and Appendix R).

Another strategy for data analysis is the writing of memos (Maxwell, 2005). Memos were used to record researcher perspectives of the design, development and implementation phases. Similar to the reflective journals used in the study participant, memos were used by the researcher to keep track of procedures, thoughts and ideas as they emerged throughout the study. Maxwell (2005) recommends writing memos “regularly...while you are doing data analysis; memos not only capture your analytic thinking about your data, but also facilitate such thinking,

stimulating analytic insights” (p. 96). For this research study, a total of 11 memos were written at several points throughout the study. These memos were important in the ongoing analysis of data in that they helped the researcher record personal reflections or reactions to incidents that occurred. In addition, memos were used to outline thought processes and the convergence of ideas as themes and patterns emerged. Memos were considered in the data analysis and coded along with each additional piece of data.

To reiterate, a constant comparative method of data analysis was used in this study and data was coded to identify themes and patterns that emerged from the data. From the initial piece of data collected, which came through a researcher memo following several e-mail discussions and a phone call with the study participant, the analysis process began. As each piece of data was received, the following steps were used in the coding and analysis:

1. Upon completing and receiving each piece of data, whether it was an interview transcript, a journal entry, a researcher memo, etc., the piece was thoroughly reviewed several times. Following a careful read-through or listen, notes were taken to record perceptions about what was occurring. Through the notes, patterns were noted and recorded on a separate sheet of paper.
2. As a larger volume of data pieces came in, the analysis notes from the previous pieces were reviewed along with the patterns. These additional pieces were thoroughly read and, as themes began to emerge through the identification and classification of patterns, researcher memos were written to record thoughts about trends noted throughout the data in regards to the purpose of the study. Also, as “qualitative design is emergent” (Merriam, 1998, p. 155), the data collected was used to guide the development of each interview protocol. The questions were developed to address

- issues found within the data and as well as gain additional insight into the perspective of the study participant.
3. Toward the end of the study, a list of patterns had been written and additional data pieces were reviewed in a similar fashion to that described above. As the themes became stronger and more apparent across the multiple sources of data, a method of highlighting and color-coding was used to track these themes throughout all pieces of data. Each theme was assigned a color and highlighters and colored tabs were used to make the occurrence of each theme easy to follow and reference. Also, in the interest of a visual person, excerpts from data sources were printed, cut apart and shuffled to identify the place of best fit within the themes.
 4. With the purpose of the study in mind, a list of all the themes was made and evaluated for the possibility of collapsing or combining themes. Several of the generated themes could be considered subcomponents of larger themes thus allowing those to be collapsed and condensed. Once again, excerpts from data sources were printed, cut apart and shuffled to determine where each piece would most appropriately fit. At this point, some data appeared irrelevant to the purpose of the research study and was discarded.
 5. Once themes appeared to be collapsed, the write-up of the findings began. In writing the findings, there still appeared to be some overlap of ideas and thus an additional collapsing of themes occurred prior to the final write-up.

Quality

To heighten the quality of this research, several strategies were employed. The first involved the collection of multiple methods of data and analyzing that data through a constant

comparative method. To summarize, the data analyzed for this research study came from several sources, including:

1. Transcripts from three face-to-face interview sessions,
2. Field notes from eight classroom observations,
3. Video recordings from the eight classes of implementing the PBL module,
4. Teacher journals following each of the eight days of implementation, and
5. Researcher memos from various events throughout the research study.

With the collection of multiple methods of data, the researcher was able to ensure quality through triangulation. Through this, by not relying on one data source, but rather comparing multiple data sources, the risk of biased conclusions is reduced (Maxwell, 2005; Yin, 2003b) and the opportunity for increased validity and reliability is taken (Russ-Eft & Preskill, 2001; Yin, 2003b). As previously described, through the constant comparative method of data analysis, each piece of data was reviewed several times. As themes emerged they were checked against each source of data to validate their occurrence. For example, if the study participant mentioned something of particular interest to the purpose of the research study, other occurrences of similar responses or indications of similar ideas were sought through a review of other forms of data. If a theme only appeared through one method of data, it could not be validated and thus, that piece of data could either be recoded or discarded.

The second strategy used to heighten quality was the use of member checks with the study participant. These member checks were performed to ensure accuracy of observational data and interpretation (Creswell, 2003; Merriam, 1998). After each piece of data was reviewed, a list of interesting or peculiar questions were recorded and presented to the study participant. In addition, through the interview process, the study participant was presented with clips from her

reflective journals, observation notes and past interviews to check for meaning and intention in her statements. The member checks occurred several times throughout the research study; at each interview and through discussions as mentioned previously in the study procedures. The result of each member check was noted and recorded as part of researcher memos or interview transcripts.

Another level of quality came through IRB approval and permission from the school board in order to protect the rights of human subjects. Confidentiality was ensured by securing research data on a locked portable hard drive and locking paper files and other materials in a private location known only to the researcher. Throughout all steps of the research study, including write-up and publication, the identities of all study participants remained, and will remain, confidential. The researcher remains responsible for the security of all data items beyond the scope of the research study.

One additional level of quality came in the identification of researcher bias. To achieve this, the researcher identified personal perspectives and bias. (Creswell, 2003; Merriam, 1998; Stake, 1995). As Merriam (1998) states, “data collection is guided by questions, educated hunches, and emerging findings”. Thus, to form these questions and generate the hunches, a degree of personal perspective and interest comes into play. Through this research study, the researcher bias was primarily noted and monitored through field notes and researcher memos. After each day of implementation, a review of the field notes was conducted. If strong opinions or bias were noted in regards to the activity that occurred or questions that were asked, the videotapes were consulted for a reminder of what actually occurred in the class. If something remained unclear or one-sided, the occurrence was presented to the study participant through a member check, as previously described. In addition to observations, researcher bias was also noted through interviews and discussions. In conducting these events, the researcher remained

cognizant of the rising of personal opinions or perspectives and was careful to refrain from expressing these to the study participant. Primarily, the study participant expressed her thoughts and perspectives, and questions were asked to simply clarify thoughts that appeared unclear or irrelevant.

Summary

In this chapter, the general design and methodology for the research study was outlined. As described, a developmental research design was followed to address the problem statement as outlined in chapter two. The research was conducted in a middle school technology course and the main study participant was the teacher of the course. Data were collected through surveys, reflective journals and interviews of the study participant. Classroom observations were also conducted and field notes were used to gather additional data. The data were analyzed using a constant comparative method and involved the generation of codes and general categories. The following two chapters will outline study results and provide a discussion of study findings and implications.

Chapter 4: Findings

Summary of Data Collected

Through the execution of both phases of this research, the following data were collected and analyzed:

1. feedback from two expert reviewers and the study participant,
2. a pre- and post-survey from the study participant,
3. transcripts from three face-to-face interview sessions with the study participant,
4. field notes from classroom observations,
5. video recordings of the eight classes of implementing the PBL module,
6. researcher memos from observations and discussions with the study participant, and
7. teacher journals from each of the eight days of implementation.

As previously stated, analysis of the data began at the onset of data collection, which began immediately upon identifying the study participant and expert reviewers with receipt of the signed consent forms. This chapter contains a detailed discussion of the outcomes and findings of the research study.

Outcomes and Findings

Expert review.

The expert review phase of this research study yielded valuable information that was applied to the design of the PBL module used during the implementation phase. The expert reviewers (to include the study participant) returned feedback promptly within the two-week review period. Feedback was provided in the form of handwritten or typed comments found throughout the packet as well as comments written on the provided rubric. Through a careful

review and comparison of all comments and feedback, significant changes were made to the learning module prior to implementation. It is important to note that although the expert reviewers provided strongly supported and well-researched feedback, not all suggestions could be implemented. In discussing the proposed changes with Marcy, not all changes were feasible in the amount of time allotted and with the resources available for this research study. Thus, decisions on which changes to make were based on a combination of the comments deemed most vital to developing a true PBL module and those most feasible given the capacities of the teacher, classroom, students, and resources involved. To help illustrate the degree to which comments were made, a list of comments made by each expert reviewer is included in Appendix S. While not all comments are included, those deemed most vital to the module revisions are listed.

With these comments in mind, a revision to the module was made to more accurately reflect the elements of problem-based learning. The substantive PBL changes are summarized in Appendix T.

Benefits of the expert review.

The expert review phase of this research study was particularly important to the overall assurance that the learning materials were a reflection of problem-based learning and were of an instructional quality deemed worthy of implementation. Savery (2006) reports the application of PBL across disciplines has produced some errors in application. To reduce the risk of such confusion in this research study, the expert reviewers helped offer research-based advice in regards the alignment with PBL. The feedback received and changes made as a result of this process contributed to the opportunity to implement the module with little difficulty and with a stronger assurance of problem-based learning. Both the researcher and study participant felt that

the changes made contributed to the development of a much stronger unit of study with clearer goals and objectives.

Upon receipt of the initial module plans, Marcy expressed concern that the plans lacked structure and that she, herself, could not grasp the “big picture” of things. The following is an excerpt from a researcher memo resulting from a phone conversation with her prior to making revisions:

Researcher Memo, January 18, 2008: As a general concern, Marcy is very uncomfortable and feels very uneasy about the lack of structure and not clearly understanding the big picture. This teacher is often well-planned with clear goals and visions for student projects and work. The openness of the structure is unsettling and she is having a hard time wrapping her head around the whole thing.

Shortly following that conversation, the feedback from the expert reviewers was received and reviewed. The changes to the module were made and sent to Marcy for review and approval. Upon receipt of the modified module, she expressed relief and said she was much more comfortable with the new version.

During the initial meeting, just one day prior to the first day of implementation, Marcy again expressed her increased comfort level. The foundation of the conversation was in recognizing the shift from the initial module (which was more project-based and measuring discrete skills and products) to the modified module (which was more problem-based and flexible in the outcome for each group of students) and how that affected the big picture of the goals and objectives. She expressed her understanding of the changes and stated:

I'm a lot more comfortable with it. I think it, uh – you see 'cause I was trying to get what your finished product should look like - that I was guiding them to. So now there really is

no finished product, so I don't have to guide them – I just have to make sure they're on task with what *they're* [italics added] doing...No major [concerns or questions] – I'm fine. Yeah, I like this a lot better.

This increased comfort level was also noted in the researcher memo upon reflection on that same interview. The excerpt from the memo reads:

Researcher Memo, February 5, 2008: At this point, Marcy feels much more comfortable with the design of the module. Her initial concern was realizing there were specific goals for the students but not quite understanding how they were going to get all of the information. With the changes and modifications, she sees that although they were given more freedom to work on their own, with the lack of structure it would actually be easier to get to the end product, especially since there wasn't one specified.

An additional benefit of conducting the expert review process was receiving an outsider perspective on the module plans. The first version of the plans was designed entirely through consideration of a teaching perspective and what would be needed to complete the task. For example, a teacher is concerned with her goals, objectives and the curriculum standards that must be met during the allotted time period. More often than not, these are written as discrete items with a distinct outcome and not much room for flexibility or interpretation. Potential bias toward this teacher perspective was counterbalanced by two independent expert reviews focused on the manifestation of PBL in the module.

In designing the plans, each of these items (as outlined by the study participant) was heavily considered and represented in some form throughout the learning activities; however, it became obvious through the comments from the expert reviewers that the perspective may have shifted away from problem-based learning entirely and more toward project-based or direct

instruction. As mentioned earlier, the expert reviewers were identified through their expertise and contributions to research in the field of problem-based learning as well as the field of instructional design and technology, thus making them “experts”. By combining the perspectives of an experienced teacher (from the study participant) and researchers (from the expert reviewers), the changes to the module were made to reflect both views, thus yielding a stronger instructional module representative of problem-based learning and feasible within the specific context.

Challenges to the expert review.

In light of all the benefits, the expert review phase was not without its challenges. First, even as the review was incredibly beneficial to the overall design and outcome of the research study, the time involved was quite extreme compared to the remainder of the study. As previously mentioned, the identification of the expert reviewers and contact with those individuals began in early December 2007. Once all the materials were developed, they were package and mailed to each individual reviewer in mid January 2008. The review process took an additional two-weeks and revisions consumed an additional week.

An additional challenge met in this research study was the need to remain sensitive to and focus the timetable of the review process around the needs of the expert reviewers. In this case, both of the expert reviewers are employees of universities and, at the time of the planned review process, each had prior engagements through the semester break such as professional conferences, family and holiday plans, and preparation for the start of a new semester. To compensate for this, the researcher provided more than a month of advanced noticed and sent a detailed schedule of when the module materials could be expected and should be returned, allowing each individual to plan as such. In addition, the plans for the module were sent several

days prior to the target date, allowing the expert reviewers a few additional days to modify their schedules.

One final challenge to the expert review, particular to this research study, was the method of communication with each reviewer. Communication with each expert reviewer was conducted at a distance. The request for consent was sent via e-mail along with a description of responsibilities. In addition to an e-mail message, the Virginia Tech IRB consent form was mailed through postal service and returned in the same form from each reviewer. Upon completion of the module, one copy was sent to one reviewer and the study participant via postal mail while the third copy was sent electronically; each reviewer had an individual preference for receiving information and materials. The module plans were returned through the same methods. Thus, contact and communication with each reviewer required careful planning, preparation and management of the delivery of materials and information. In line with this challenge, there was no face-to-face or verbal contact with either of the reviewers during the review process, rather communication was limited to e-mail and postal messages. While this challenge did not carry with it any detrimental effects, perhaps the feedback and comments would have been more substantive and clarified with a more direct line of communication.

Summary of the expert review.

Regardless of the challenges, the expert review process proved to be a method through which to add quality to the design, development and overall outcome of this research study. The following are some of the main outcomes of this phase of evaluation:

1. Expert reviewers offered research-based feedback on the PBL module design,
2. Feedback was used to modify the module to generate a stronger representation of PBL methods to add a degree of quality to the final product, and

3. By incorporating the feedback from the expert reviewers, the teacher became more comfortable with the instructional module.

Implementation and Evaluation

Once the module was revised and completed, the implementation phase of the research study began. The majority of the data collection occurred during this phase of the research and these data were used in the overall evaluation of the module in regards to its impact on the teaching of digital technology skills to 8th grade students (the stated purpose of this study). Through the use of a constant comparative method of data analysis, as described in the data analysis section of chapter three, three main themes emerged. These themes are:

1. Shifting from knowing to applying,
2. Switching roles: from provider to facilitator,
3. Getting other teachers trained and on board.

In this discussion, these themes are defined and supported with data collected from the multiple sources such as interviews, survey, field notes from observations, and researcher memos.

Shifting from knowing to applying.

The mention of 21st century skills is evident throughout this document. Earlier, the case was made for needing to prepare students to be active, successful members of the globally competitive, 21st century workforce (USDOE & OET, 2006). With the intense emergence of technology and technological applications, the way in which students and teachers are using technology warrants a change (ISTE, 2003c; ITEA, 1995; Volk, 2003). This theme addresses how both the students and teacher made such a shift through this research study and the proposed PBL approach to teaching technology skills. The data presented through this theme emerged

quite rapidly as the study participant began, and remained, concerned about how the students were not only reacting to the new method of teaching, but what they were learning as a result.

The discussion about the type and degree of student learning began prior to the first day of implementation. In a phone conversation with Marcy, it was apparent she had definite reservations about the upcoming implementation phase. To reiterate, the origin of the relationship with Marcy came through the pilot study program in the 2006-2007 school year. Through this pilot program, schools in New Jersey were asked to report on best practices in regards to assessment of student proficiency of technology use. As such, the problem-based learning approach was suggested as a possible new approach to teaching the technology courses, through recommendations from that pilot program. This research study served to be an avenue through which the PBL approach could be investigated in a classroom setting. Regardless of the underlying purpose of this research study, Marcy still remained responsible for teaching the students and making sure they were proficient at the end of the semester. After a review of the initial module, she became very concerned that the experience would be detrimental to student success and thus be a poor reflection on her and her teaching. Following this phone conversation, a researcher memo was written to record this reaction. An excerpt from this memo reads:

Researcher Memo, January 18, 2008: As a general concern, the teacher is very uncomfortable and feels uneasy about the lack of structure [of the module] and not clearly understanding the “big picture”. This teacher is often well-planned with clear goals and visions for student projects and work. The openness of the structure is unsettling and she is having a hard time wrapping her head around the whole thing. Also, she is worried about the project failing, students not working hard and looking for the

easy way out and it reflecting poorly on her...She also expressed concerns about the students taking the easy way out on their work.

While this is a natural reaction from a teachers' perspective (Sage & Torp, 1997), Marcy was encouraged by the fact that the building principal and superintendent would not hold her responsible and she would not receive any repercussion should the project fail to meet the intended needs. With that said, she could comfortably move forward to the implementation phase.

As the implementation of the module progressed over the course of the eight days, Marcy began to exhibit a shift in her own thinking about how technology can and should be taught. Several of the needs expressed throughout the literature began to surface in journal entries, responses to interview questions and observations. To recall, the CEO Forum (2001a) reported that 21st century employers are looking for higher-order thinking skills such as inventive thinking, effective communication, and high productivity. Not only that, deKlerk Wolters (1989) argued that students should also be developing relationships between the technology and real-life. From the start, Marcy paralleled this statement in a response in her preliminary survey in regards to how she felt the Work Skills course should be taught. She stated:

I believe the 8th grade Work Skills should allow students to apply skills they are taught in 7th grade Work Skills...Eighth grade should be working on real-life scenarios when applying technological skills.

Within the first couple days of implementation, it was easy to see how accurately the students were reflecting several perspectives found in the research. Again, de Klerk Wolters (1989) reported that students needed to begin developing a "broad concept of technology" (p.7) and move beyond the discrete acquisition of skills. Through the first couple days, field notes

from observations and researcher memos reflect students' noticeable attitude toward technology and the Work Skills class, and it was interesting to see the reaction to the change in activities.

At the start of class on day one of implementation, students entered the room and immediately logged on to their computers. Several of them began Internet searches while others looked aimlessly through the files stored on the machine. Once Marcy began class and introduced the problem through distributing the flyers, the reaction of the students was strong. Several expressed confusion about what was happening; one student thought he was in the wrong room as he asked, with his eighth grade attitude, "So, this is basically language arts class, they just call it computers?" Through further observation of this same class, the reactions and activity of the students reflected the difficulty they were having in the shift of thinking. Again, the student expectations, to use the computer through the entirety of the class, spoke to the perception of computers and how they are viewed and used within the school. In a researcher memo following this same day of implementation, the difficulty students faced was noted as such:

Researcher Memo, February 6, 2008: My response to student reaction to the problem is three-fold. My ideas are that 1.) these are 8th graders [enough said], 2.) they came in expecting to type and do computer lessons, and 3.) this is different – one student even said he was made to use his brain – whether he did or not is another story...this session went as well as I expected and I will continue to monitor student engagement and participation. I think this will come as they move forward with the project.

Into day two of implementation, some frustration began to surface. While exceeding expectations for carrying out the module plans, Marcy was still struggling to keep students engaged in the problem and keep them off of the computers as several of them were doing

pointless activity. For example, students were doing Internet searches with no clear direction or purpose and one group was already beginning to create a flyer but had not yet determined a plan. Marcy was trying to keep each group on track, but students were struggling to keep themselves on track. An element of frustration was noted in the researcher memo that was written following review of the field notes and videotape. This reads:

Researcher Memo, February 8, 2008: I stuck around for a while to speak with Marcy a little more and reassured her that her questioning is going well and I think the students are giving her exactly what I expected. I am a little disturbed because, while I see how this [PBL] *could* work, I think the students are still so trained with books, worksheets, assignments, etc. that it is difficult to get them thinking on their own and giving them freedom to work things out for themselves. They are still expecting the *cookie-cutter* lessons with typing drills and assignments to complete by the end of the class period. Perhaps this shift in thinking and learning will not happen or perhaps they just need some additional time to get acclimated to the new environment.

Regardless of resistance, students continued to pursue their goals and Marcy forged ahead with great strength and determination to get through the module. By the fourth day, students were becoming more engaged in the process of solving the problem and exhibiting results of their attempts to use the technology to help. Thus, in the second interview, following the fourth day of implementation, Marcy was expressing how she felt the change in classroom structure was affecting student learning and attitudes. While she was careful to state that “I don’t think there’s a lot of technology being learned”, she did note how, as the plans were evolving, students were beginning to work better as a team and think differently. In line with the literature, collaboration, communication and thinking skills are all noted as important skills in the 21st

century (ISTE, 2003c; CEO Forum, 2001b; NCREL & Metiri Group, 2003; “Partnership”, 2007). Several comments made throughout the second interview reflect Marcy’s perspective on student gains in how they were interacting with the technology class and beginning to gain such skills. She stated:

They enjoy it [PBL module] and they’re learning. They are really learning, and even to work as a group. Uhm, but as far as technology, they’re not all learning at the pace that I would be teaching it...but I think it [PBL] definitely has advantages. I think they’re learning how to think. You know, they’re really learning how to think and that their opinion counts and how they could apply technology to whatever it is they’re producing. Uhm, from starting from scratch – no directions – at all. Uhm, so I think it really works.

With this perspective and some evidence that students were beginning to think differently, Marcy still remained concerned about meeting standards. As previously noted, the standards are often a driving force for instruction (Sage, 2000; Savery, 2006) and, with some state standards still maintaining a perspective of skills-based needs with discrete measures of proficiency, instruction reflects as much, as is the case in Woodburn Middle School (see Appendix A for information on state technology plans). As such, even though Marcy was beginning to shift in her own thinking about how this technology course could be taught, she was still maintaining a hold on standards, pacing guides and measures of student proficiency. At the point of the second interview, she was not entirely convinced that shifting to a PBL approach would completely address her needs for the Work Skills course and felt responsible for helping students develop a defined set of skills with several different programs. Along the lines with the literature (Kumar & Natarajan, 2007), she was concerned about the time it would take for

students to develop all the necessary skills through the PBL approach and she illustrated this by stating:

Because, I think it would be tough to get all of this [technology skills] – it would be too time consuming...for them [students]. ‘Cause I would want to know – make sure every person knows how to apply whatever it is – how to use every software. They know how to do it – [motioning as if to point to students] she knows how to do Inspiration!, she knows how to Inspiration!, she knows how to do Excel, Access - so I think it would be tough to do the whole thing based on this [problem-based learning].

While several of these programs mentioned (Inspiration!, Excel) were intertwined with the PBL module, Marcy was not completely comfortable with the fact that not every student got experience using each of the programs. Even though students worked as teams and shared the responsibility of solving the problem, there was little rotation between skills and products (i.e. one student worked on the letter, another worked on the flyer, etc.). This again, is a point made in the literature regarding the alignment of PBL with the state-mandated standards (Savery, 2006). Thus, Marcy remained adamant that she would prefer to include a problem that involved the students working on a project through which they produced specific items. From her perspective, she was still exhibiting the need to teach discrete skills and had not completely transitioned to the alternative method of teaching that is PBL, in which students receive less directed instruction and work collaboratively to come to understand what they have learned and how to apply it (Barrows, 1998). Several comments made through surveys, discussions and observations illustrate this perspective. First, to reiterate her response in the preliminary survey, she stated:

I believe the 8th grade Work Skills should allow students to apply the skills they are taught in 7th grade Work Skills. Teach the applications should be moved down to 7th grade. 8th grade should be working on real life scenarios when applying technological skills.

By the point of the second interview, Marcy had not shown a whole lot of shift, still reflecting the need to develop an initial skill set followed by a strengthening of those skills through application opportunities. When asked, during the second interview, about her perspective in regards to how skills should be taught, she responded:

but I do believe...it [PBL] could be incorporated with real life skills for 8th grade technology. But I'd like them to have the skills first." She continued by stating, "that makes it easier...and then they know where to begin, they know how to set it up...so they're applying something they already know. Which is a lot simpler than what we're doing – we're starting from scratch.

Toward the end of implementation, Marcy's response on the post-survey illustrated this same perspective. She stated, "I believe that computer skills should be taught in seventh grade and then students would apply their skills using their knowledge from core curriculum content subjects in the eighth grade." When compared with her response from the preliminary survey, and comments through the interviews, her perspective had not changed a whole lot in regards to covering content; she maintained the need to teach skills first (in seventh grade) and follow up with more application and problem-solving (in eighth grade).

Even though Marcy's personal perspective had not evolved a whole lot, she was beginning to see how PBL was encouraging students to evolve in their thinking and perspective

of how technology can be used. When asked again, in the second interview, about changes she would like to see made to the eighth grade Work Skills course, she responded:

To 8th grade – right – I think it [PBL] would work... I think it definitely has advantages. I think that they're learning how to think. You know, they're really learning how to think and that their opinion counts and how they could apply technology to whatever it is they're producing. Uhm, from starting from scratch – no directions – at all. Uhm, so I think it really works.

To follow up on this comment, she was asked in the final interview if she still agreed with this perspective – were the students learning how to think and did she see a difference between the class participating in the PBL approach and her other classes that were not involved? She confidently responded by stating:

Yeah, I would say I'm seeing a different level of thinking because – in mine [other class], they need to create a document that's given to them and they need to reproduce it, you know, formatting, margins... whatever the software is. They learn how to use technology. Here, they're applying what they learn into the technology. And in my class [traditional] they're learning how to use the technology, so it's a totally different kind of learning. Here they learn to work as a group, in my class I don't work as groups – they work individually on a computer. Everybody learns the same skills - in my room - that's how to use the software that they have. But here they're learning about whatever the topic is and then applying it in whatever way they knew. I didn't teach them how to apply whatever knowledge they had. So, it's two totally different kinds of learning. One is learning real life and one is learning how to use, you know, it's a skills – I'm teaching a skill.

As previously mentioned, the study participant was aware of the benefits of both approaches to learning. In one way, students were gaining discrete skills and, in another way, they gained knowledge about participating in cooperative learning and applied what they know to solve real-life problems. Both of these seemed important to her and she never made it clear if one method was better than another. From several conversations and reflections, it appears she is comfortable using both approaches to teaching and thinks both are important for students to develop the skills needed to attain proficiency, both with discrete computer skills and 21st century skills.

Switching roles: from provider to facilitator.

As previously mentioned in this document, PBL lends itself to several concerns in regards to teaching. One of those concerns was getting teachers to shift their role from provider to facilitator (Ertmer & Simons, 2006; Jonassen, 1997; Sage & Torp, 1997). For this PBL module, scaffolds were provided to help make this a smooth transition, as recommended by Hannafin et al., (1991). Some of these scaffolds included prompts to guide questioning of students, sample scenarios to help model the thinking process, and graphic organizers to help students in the process of planning and developing goals. This section outlines how Marcy made the shift from provider to facilitator, some of the struggles she encountered along the way, and how she weaned herself from the researcher-provided scaffolds to being self-reliant on her own attempts at implementing the module.

To begin, Marcy entered the research study as a participant with little experience or knowledge of PBL. On the preliminary survey, she indicated having “some knowledge” of, with “no experience” teaching through a PBL approach. Thus, she was a self-declared “novice” for this type of teaching and exhibited a general concern for how the module would evolve. Because

this was a new environment for Marcy, the module contained numerous prompts and levels of guidance for her to consider as she went through each day of activities, previously referenced as scaffolds (Hannafin et al., 1991).

During the first few days of implementation, Marcy remained reserved and hesitant in her teaching and followed the lessons almost exactly as they were written. It was obvious she remained cognizant of her role and worked hard to avoid asking “leading” questions and directly instructing the students toward a desired answer. In a review of the field notes from observation on the first day of implementation, a researcher memo was written reflecting her hesitance to look beyond the written plans and follow the plans as they were written. A brief excerpt from the memo reads:

Researcher Memo, February 6, 2008: Marcy seems rushed and flustered through the whole class. While she did a nice job of facilitating student work, it was obvious she was still uncomfortable with the learning environment as students were working on several different things at several different levels. I noticed her reading several of the prompts directly from the written plans and, while those were given just as guidance and ideas, she could divert from them with what came naturally to her, but was not doing so. As the students were working in groups, she tried to complete all of the tasks, including the debriefing, with the whole class. I noticed that several students were not listening as she tried to do this, as they remained engaged in their own work with the groups. Perhaps the questioning, modeling, etc. can occur in the smaller groups instead of trying to get the attention of all the students at once. Or, for example, when she does a debriefing, it might help for all students to turn computer monitors off and be more attentive.

To help ease her hesitation and increase her comfort, it was deemed necessary to reiterate some of the points of PBL. After reviewing the field notes from observations and videotape from that day, an e-mail was sent to Marcy later that afternoon, in which she was reminded of several factors of PBL, such as the learners being cold to the approach and the problem (Savery & Duffy, 1995), the goal at this point being still seemingly unknown to students and will remain iterative throughout, thus requiring some patience (Kumar & Natarajan, 2007; Savery, 2006), and the importance of maintaining the role of facilitator, though this does not necessarily have to occur as a whole-class approach (Savery, 2006). In the interest of maintaining the scaffolds as a support to Marcy (Hannafin et al., 1991), the e-mail contained several suggestions for how best to proceed and continue strengthening the role of facilitator. These suggestions included the following ideas (with direct quotes from the e-mail message in italics):

1. At several points, Marcy appeared to be reading the instructions as they were scripted. In response to this, the following comment was made:

Don't stress too much about strictly following the plan. Give yourself a little freedom to react naturally to things as they evolve - that's a big part of PBL. If you miss a piece or forget to say something I have scripted, it's no big deal. Just keep in mind you are more interested in getting information about their thinking and processes and less about right and wrong.

2. When students came up with a thought or idea, they were stopping at the obvious answers and not moving forward. The following suggestion was made:

As they [students] offer answers, you did a nice job of reinforcing them and encouraging them to continue moving forward. I would suggest more of "That's a

great answer, but don't stop there - keep going,” or as you offer your suggestions say “Those are my ideas, let's work on some of your own.”

3. In trying to model the thinking process, Marcy often tried to gain the attention of the entire class as they were engaged in group work. This became difficult as the students remained engaged and the following suggestion was made:

Keep modeling your thinking such as “If I were to do this, I would...”, “Some questions I might ask myself are...”, etc. You did this today as you followed the plans. I wonder if it wouldn't work better to do this as you float around the groups instead of trying to capture the attention of the entire class?

In her role as facilitator, Marcy also expressed additional struggles beyond the need to relax, get comfortable and let the plans evolve. These struggles align more closely with shifting from provider to facilitator, which correspond with one main struggle expressed through the research of Sage and Torp (1997); their findings indicate, “becoming a coach rather than an information-giver challenges many teachers” (p. 33). Further, “some found it difficult to let go of the sense of control and predictability typical in more traditional instruction” (p. 33). Marcy fell directly in line with this finding as of the first day.

To reiterate, it was obvious Marcy remained cognizant of her new role and worked hard to avoid asking leading question. In fact, she reflected this in her journal entry after day one of implementation in which she stated, “it is very difficult not to lead them toward an answer or an idea.” After day two, she still expressed the desire to lead students in her journal by stating, “I’d like to know if I can lead group 3 back to their original idea.” At this point, she recognized some students were struggling and not reaching the goal she had set for them. Again, she was reminded that through PBL, students set their own goals and should be led only in such a manner

that helps them manage their own activity as they seek these goals (Barrows, 1998). With this in mind, implementation continued and Marcy allowed the plans to evolve and students set individual goals.

Over the course of the next few class periods, the plans evolved and students became more independent in their own work. As a result, Marcy was beginning to see their plans unfold and became more comfortable in her role as facilitator and began generating her own questions, prompts, and modeling thinking processes without guidance from the module plans. For example, on the second day of implementation she felt it would be helpful to provide students with a graphic organizer and to model the problem-solving process. The researcher memo from this day states, “Marcy added the element of showing her own problem-solving process. This was not initially part of the plan but I felt it added a strong component to her role as a facilitator and model.”

On the third day of implementation Marcy decided students needed help in their planning in order to meet goals within the allotted time. Thus, she labeled the third day as “planning day” and provided students with a brief timeline and a reminder of what was expected of them. She continued through this class and the next providing similar supportive materials, as students needed them. At the point of the second interview, following the fourth day of implementation, Marcy was beginning to show signs that she was shifting comfortably from provider to facilitator. To measure this evolution, several questions were asked throughout the interview. At first she was asked to describe expectations she had of herself and, through her response, it was evident she recognized the shift to facilitator would be difficult. She responded:

My expectation was that I was gonna learn how to do this. And...I know the whole thing as facilitator, so it's harder for me to – I knew it was gonna be difficult for me to step

back and not tell them what to do. Because that's how I teach – you know – wherever they get caught, I tell them how to do it and we move to the next step.

Further in the same conversation, Marcy was also asked about her perspective on the questions she asked of the students and how she made decisions on what questions would be asked. Once again, the conversation led to a discussion on her attempts to maintain the role of facilitator and not give the students, or lead them to, specific answers and ideas. It was obvious she remained cognizant of her new role and was trying hard to participate as such in the learning and classroom activities. While she was still “leading” the students, she felt her attempts were to lead them toward an understanding of the process and help in their progress rather than toward specific knowledge or information. The following statements made in the second interview offer evidence of her perception in this regard:

I'm trying to get them to understand...I'm trying to lead them, really. You know, in my questions, I'm trying to lead them to something that doesn't – so they have a better understanding of it – [motioning as if asking a question to students] “Well, why wouldn't you do this?,” I'm trying not to give them answers too...I'm just trying to – I'm trying to have them look at the big picture – or find a better angle to take their idea...I'm trying to lead them without leading them. Really, that's really what I'm doing. Yeah. I'm really trying to get them in where I think they veered off and it just doesn't make sense so, that's the best I could do.

Further in the interview, Marcy was asked to clarify several of the comments made in the reflective journals. These comments showed some personal progression from being concerned that the students would not be capable of making progress on their own to eventually seeing gains in their progress in the absence of directed instruction. Again, it was obvious she was

struggling with being able to maintain the role of facilitator and avoid telling the students what to do to ensure they would progress and reach the final goal. Some of the comments from her reflective journal include:

1. After day one: "It's difficult not to lead them toward an answer or idea,"
2. After day two: "It's much easier to teach a structured class...where you know what the final product would be," and
3. After day three: "I was pleased with the progress some of the groups made. I'd like to know if I can lead Group 3 back to their original idea."

When asked to clarify these statements and talk about her own progression in thoughts and actions, she responded by expressing how she could see it being easier to lead the students because some of the groups were not doing anything at the start of the project; they were failing to produce anything, including goals. Thus, she was unable to see how the project could end in successful learning without her taking a more direct approach to teaching. She was patient, however, and was able to subside her concerns and forge ahead with the plans. Eventually she expressed how the process got easier for her as she began to see progress in each of the student groups. To illustrate this, she stated:

I think because they, themselves, found their own campaign it was easier for me to lead them in that direction. So, I mean, not to an answer, but lead them to understanding. A better understanding of where they should go...it's kind of the whole way this whole thing has taken on - I really didn't see it happening - you know - and now I do see it happening...for all of them...at the beginning, like, I wanted to give them something so it would happen. And then a little bit more...now it's just like one or two things I'd like to tweak, and I did...because that's the unstructured thing. But yeah, I think the whole -

leading them, leading them, leading them - it got easier because they were leading themselves really in a direction that I liked. So, uhm, but I think that's what this whole project - you know - it really got easier for me, cause I could see we were getting somewhere.

One of the important aspects of being a facilitator of knowledge is modeling the metacognitive, or thinking aspects, of learning (Ertmer & Simons, 2006; Savery, 2006). As Marcy became more comfortable in her role, she found new opportunities to model this process to students, both as a group and individually. One example of this occurred on the sixth day of implementation. Following a disastrous attempt at getting students to begin finalizing some plans, Marcy felt her efforts were not well-received by one group in particular. Thus, at the beginning of class on day six, she revisited a conversation she had with this group about what they would or could do to raise funds as part of their plan. Her purpose and suggestions were to help them clarify the fundraising ideas within their group, as this group appeared utterly disconnected. Because she only spoke to one student at a time, and group members were not communicating, the group became confused. As a result of this conversation on day five, she felt responsible for the confusion and lack of progress. Marcy began this conversation by offering an apology and explaining herself to the students, thus modeling the reflective thinking process she was trying to instill as part of the learning module. As noted through field notes and later transcribed through the videotape of this observation, her conversation began as such:

Ok, listen, I wanna talk to you. I think I did you an injustice the other day, alright? I talked to Geoff and I talked Matt about trying to get people to see your new grooming facility, right? Unbeknownst to the two of them [motioning to two other group members]

– they didn't know what I was doing. This [to help develop a plan to see the new facility] was my intention – and I wanted you [the group] to hear the great big picture.

She continued to explain the purpose for her previous comments and what she was trying to accomplish with the discussion. Following this conversation, the group was able to move forward with a clearer understanding of their purpose and goals and continue to work as a team.

The researcher memo written following a review of field notes and observations also reflects how Marcy used this opportunity wisely to take advantage of her role as a thinker and facilitator.

The researcher memo reads:

Resesarcher Memo, February 22, 2008: At the beginning of class, she [Marcy] revisited a conversation she had with group 3 on the previous day about what they would do to raise funds. She felt responsible for their confusion and lack of progress and so apologized. I felt this was a great way for her to model and facilitate thinking about the actions and accepting the consequences of those actions. The students were able to see her imperfections but also see the results of her reflective nature. Even though the students were somewhat unresponsive to her request, she was able to get them more clearly focused on their purpose and plan.

Thus, through this example, the study participant recognized the confusion of the group and how that was hindering their progress. In realizing the group needed some guidance and clarity, her response was to model her own thought process to help them through a group discussion.

As part of this same conversation, Marcy also modeled taking responsibility for seeking resources and searching for information, also one of the important components of PBL (Deslisle, 1997). The same researcher memo continues this thought and states:

She [Marcy] also told them how she talked with a groomer about how much they make and can make by grooming a dog. The students seemed surprised that she actually contacted someone to get this information. Again, it was a great way to model the use of her resources and extending her thinking beyond the classroom.

To conclude this theme, Marcy took this experience as a challenge to her teaching and personal growth. While uncomfortable at first, she responded to her new role as facilitator very positively and eventually relaxed and began to show fruitful efforts of this position. Thus, while her transition from provider to facilitator began roughly, she concluded the process with a well-developed perspective of her role and expressed willingness to try again. In the final journal entry after day eight, she stated:

I believe I set a comfortable and risk-free environment. I think I would be a better model for thinking and action now that I have gone through the process. The lesson was not developed by me, so it took me a little while to grasp how I needed to get the students thinking.

The responses in this journal continued to summarize the role she assumed throughout the entire process. She makes mention of several occasions when she had to back away from her intuitive drive to lead students and, a response such as the one below, shows definite growth in her shifting of roles. She reflected:

I continually checked for understanding and provided support when they [students] needed it. I tried hard not to lead students. I even backed off one group that I believe should have gone my way. I tried to ask probing questions that would lead them to understanding.

Getting other teachers trained and on board.

As this research study is concerned with the implications problem-based learning carries for teaching, it was important to determine how the study participant viewed the potential of implementing such an approach with other teachers. This particular theme did not begin emerging until later in the implementation phase that is, it did not emerge at the onset of data collection, as did the other themes. This section outlines Marcy's perspective of what PBL meant for her teaching and recommendations she had for getting other teachers involved in using the approach.

By the time of the second interview, following day four of implementation, Marcy was showing her shift in roles, as previously described. In observing her reaction and interaction with the module, gaining her perspective on how other teachers may react to teaching with PBL was one goal of the interview. In seeking advice to give other teachers beginning a PBL lesson, Marcy's reaction, at this point, was simply to "have a lot of patience".

In the days following the second interview, there were informal discussions with Marcy about how teachers in her district could become familiar with the PBL approach to teaching, in addition to how professional development opportunities could be structured to inform teachers and encourage them to attempt such an approach in their own classrooms. These discussions stemmed from a few areas. First, in revisiting the literature, it was noted that researchers such as Sage and Torp (1997) actually used a PBL approach to train and encourage teachers to incorporate PBL in their own classrooms. Through this approach they found that while teachers still struggled with some areas of implementation, they had developed a support system to help in the process. Another issue noted in the literature is that teachers are hesitant to shift away from traditional teaching approaches for fear of under preparing students to attain a proficient skill

level, as defined by the state standards (Savery, 2006). Finally, researchers such as Hung et al. (2006) and Sage and Torp (1997) presented cases where teachers failed at their attempts from the beginning as they experienced difficulty generating the problem context and statement. In reviewing this literature, the interest was in determining Marcy's perspective on how to prepare teachers and avoid some of these hurdles.

From her perspective, Marcy was experiencing a true attempt at teaching with PBL by getting her hands dirty and immersing herself in the experience. After one of these conversations, a reflection was made in a researcher memo in regards to how Marcy was gaining first-hand experience with the approach and having embedded chances to reflect on it and what other opportunities like this could mean for the professional development of other teachers. An excerpt from this memo reads:

Researcher Memo, February 22, 2008: In talking with Marcy, I realized one of the main outcomes of this research could be the simple fact that, prior to implementing whole programs to teach students in a manner such as PBL, the teachers should be trained. While many schools offer training through professional development opportunities, I am beginning to see it may be helpful to "see it in action" and work with a hands-on experience. I wonder if professional development opportunities could include a module implementation period, similar to this. I believe Marcy has shifted some in her own perspective on this type of learning and that it is a direct result of "getting her hands dirty" and working directly with the concepts.

As this was an important discussion, the researcher memo continued with additional reactions and thoughts regarding the future training of teachers. Further, in the same memo, additional reflections were made about training teachers to use PBL. The memo continues:

In talking with Marcy, one of the main things I have realized is the importance of doing things like this with more teachers. So often we have professional development opportunities where all teachers sit in the same room and listen to a lecture about teaching styles, methods and approaches. When we return to the classroom, we continue with what we were doing before the professional development...Through this experience, I believe Marcy was intensely immersed in this process and she realized what it takes to be a reflective thinker, to facilitate student learning, to see things from other perspectives. In her interview, she said she would be willing to try such an approach, which is such a gain from where we started – her not wanting to participate, but just being cooperative to get it over with...if we make other teachers participate in professional development through immersion, what kind of gains can we make? This could prove to be a very powerful way to train teachers – immerse them in the approaches.

From Marcy's perspective, she too felt it was necessary to immerse other teachers in a similar experience. She expressed that personally had she not participated in this research study the chances she would consider changing her teaching methods, even slightly, were slim. As of the final interview, she was considering another attempt at PBL, though on a smaller scale, with a similar group of students. She expressed that without this experience, "I don't believe I ever would have done it [PBL]". When asked to clarify and offer a reason why she had not considered such an approach to teaching, she responded, "'cause it's very different from how I normally teach, it's very unstructured and it's totally different than what I've done in the past."

To get to the root of reasons why she would have remained almost stagnant in her teaching, the interview continued with questions regarding her previous training and education. Through this conversation it was concluded that she had little experience, mere introductions,

with alternative methods of teaching, such as PBL. In her teaching courses, she recalled “touching upon PBL” but never actually investigating the approach or experiencing it being done. As such, she was pleased with the opportunity to explore a new method and gain a fresh perspective on teaching.

Further in the final interview, the topic of teacher preparation and training was revisited. Marcy was asked to offer recommendations as to the best way to prepare other teachers to teach with the PBL approach. In response, she provided a description of how she might run a professional development opportunity designed to inform teachers of the approach. Her idea was to essentially place the teachers in the role of the student where they would be responsible for participating in a model lesson using PBL. Also, the leader of the professional development session would serve as the teacher or facilitator, and act as such as the participants worked through their problem, thus modeling the role they would eventually assume. In the interview, she explained:

I think the idea would be to actually do it on an hour scale - whatever the professional development was - where you're presented with a problem, you break into groups and you're given just minimal direction – whatever the problem was – and you're gonna go solve it, and you're immersed in a few seconds and then you're asked to create whatever it is you need to create – as a group – and see how the teams work, and see how you – your group – created it, and then the person explain that you've just gone through problem-based learning. You've solved the problem, you worked as a team, you've been given very little direction and this is your final outcome. So, I think if they could, uhm, participate in a shortened...So I think I would just throw that on them.

The potential here is that Marcy could use her experience as act as a facilitator as other teachers

participated. An opportunity like this would address the need for “tutors in teacher education programs to model interactive approaches (Pearson, 2006, p. 57). In addition to expressing her advice on professional development, she was also asked again to offer advice to other teachers as they began incorporating a PBL approach in their classrooms. Her advice was simple – patience. She stated, “I don’t know – have a lot of patience! Really – at the beginning – ‘cause it takes a while to get - to evolve - it really does.”

Summary

This chapter began by describing the process and outcomes of the expert review. This section provided a description of the feedback received and insight into how the review process guided the design and development of PBL module used in this research study. The section continued with an identification of the themes that emerged from data analysis in light of the purpose of the research study; essentially, what is the impact of using problem-based learning to teach digital technology skills to eighth grade students? These themes included:

1. Shifting from knowing to applying,
2. Switching roles: From provider to facilitator, and
3. Getting other teachers trained and on board.

The themes presented are a result of a constant comparative analysis of the data collected through interviews, surveys, field notes from observations, researcher memos and reflective journals from the study participant, as described in chapter three. The final chapter in this document contains a discussion about how this research can be used to inform future attempts at designing, developing and implementing instruction to teach technology skills through a PBL approach.

Chapter 5: Conclusions and Recommendations

The purpose of this study was to outline implications for using a problem-based learning approach to teaching digital technology skills to eighth grade students. In the previous chapter, the findings from the research were discussed through several themes that emerged from the data analysis. These themes included:

1. Shifting from knowing to applying,
2. Switching roles: From provider to facilitator, and
3. Getting other teachers trained and on board.

This chapter contains a discussion of the results from this study. In addition, recommendations are made to inform future attempts to implement a PBL approach. These recommendations were developed, in light of the contents of the literature review, through a careful analysis of the data. In addition, in consideration of the outcome of the expert review and the implementation phase of the research study, several recommendations are made for instructional designers seeking to develop a design model for ill-structured learning environments. The chapter concludes with a section summarizing how this research study has impacted the study participant, Marcy, and the shift that occurred in her own teaching.

A Shift

In reviewing, considering and reflecting on the themes that emerged through this research study, it was apparent that perhaps another, more comprehensive theme could serve to include each of those described in chapter four, an umbrella if you will. That umbrella appeared to be the need for a “shift”. As noted in the literature, a shift in education is coming, or has come already, with the intense influx of technology (ISTE, 2003c; ITEA, 1995; Volk, 2003). As technology

enters the schools however, the shift does not end there. Eisenberg (2003) states, “technology is changing at a breath-taking pace and will continue to do so for the foreseeable future” (p. 13). Thus, as schools begin to recognize the needs surrounding technology and methods of best practice therein, the evolution of technology will continue to call for modification of such practices. In thinking about this, an interesting message comes to mind: As technology changes, will what students are being taught today still be relevant tomorrow? As stated by Marzano et al. (1988):

Content-area teachers should view their domain as fluid and ever-changing. Therefore, they should not be too rigid in demanding that students understand the content in one particular way. Instead, teachers should realize that the ultimate goal of content-area instruction is for students to integrate the knowledge into their existing store of ideas. This implies that students should process new knowledge in ways that are meaningful and useful to them as individuals (p. 129).

Thus, students learning “content” as it stands today will be facing different content in the years to come. Perhaps, then, students should be taught through methods to encourage the processing of such content in meaningful and productive ways. Again, Eisenberg (2003) questions:

Will learning isolated specific skills such as keyboarding, word processing, or even World Wide Web searching suffice? Clearly not. Will learning to use whatever technologies come along to boost our skills within the overall information problem-solving process? Absolutely (p. 13).

This statement falls in line with the call for students to develop the 21st century skills of higher-order thinking, collaboration, communication and problem-solving (Savery, 2006).

To do this, a shift will need to occur; a shift in what students are taught and the way they are taught. As a result, a shift with teachers will need to occur as well; a shift in how they teach, the role they play in student learning and how they are trained. Problem-based learning has been used as a way to encourage this shift by introducing new roles and perspectives on education to both teachers and students (Ertmer & Simons, 2006; Sage & Torp, 1997; Savery, 2006). The following sections describe the conclusions and recommendations gathered from this research study to address these shifts.

A Shift: From Knowing to Applying

The bar has been raised as the 21st century gathers momentum and more than ever, higher-order thinking skills, self-regulated learning habits, and problem-solving skills are necessary for all students. Providing students with opportunities to develop and refine these skills will take efforts of many individuals... (Savery, 2006, p. 18).

One of the main foci of the literature found throughout this document is on how students are being prepared to participate in 21st century learning and working. As such, a shift was noted in both the definition of technology itself (Volk, 2003) as well as in state and national K-12 technology standards (ISTE, 2003c) to reflect this need. With the way technology is changing, Eisenberg (2003) describes how the shift should involve a movement from preparing students in knowing about technology to being “able to use technology for a purpose, flexibly and creatively” (p. 6). He continues by describing how “helping students learn to apply technology in these ways requires a major change in the way computing and technology are often taught in school” (p. 6). What, then, does this mean for what students are taught and the way in which they are taught? This section of the discussion includes some conclusions, followed by a

recommendation, regarding how to address the shift in determining what students should learn and how it should be taught.

As previously described, there is an ongoing debate about the best method or approach to teaching digital technology skills to students. Roblyer (2000) explicates two viewpoints: the first being that of learning to use technology in the context of a problem or application, and the second being that of teaching technology skills through a more direct approach. The variety of approaches presented in chapter two reflects how states are developing individual perspectives regarding how technology skills should be taught. Several state approaches, such as those of Arizona, Nevada and Virginia, reflect a mixture of perspectives on when and how to teach technology skills. These states use both skills-based and application/production-based approaches in their attempts to prepare students with the required skills (see Appendix for individual state technology plans).

With this debate in mind, Marcy addressed her perspective on best practices for teaching digital technology skills. As presented in chapter four, she shared her position as needing a mix of standardization and customization, a perspective consistent with that of Reigeluth (1999). While she agreed students were learning how to think and apply the use of technology through a PBL approach, she also felt strongly that instruction should not be entirely void of some form of direct instruction to ensure that students were learning identified skills. Thus, her plan was to teach skills in the seventh grade and use “real-life scenarios” in the eighth grade curriculum.

As was noted by Roblyer (2000), teachers feel approaches such as PBL take time away from teaching schedules and covering core curriculum content. In addition, as “most state-funded [schools] are constrained by state-mandated curriculum and an expectation that they will produce a uniform product” (Savery, 2006, p. 18), Marcy continued to hold onto her perspective that

perhaps PBL was not the complete solution to teaching technology skills. She felt that while her students were showing signs of growth in thinking and ability to apply the technology to solve the problem, she was falling behind in her teaching schedule. She also noted the students were not exhibiting growth in identical skills and not producing similar products. This falls in line with a statement by Kumar and Natarajan (2007) who state, “the lack of depth in coverage of prerequisite, foundational disciplinary knowledge by some facilitators has been raised as a point of concern with PBL” (p. 98). This issue with coverage was a cause for concern and thus, Marcy continued to reflect a strong position that discrete skills are needed and should be taught as such. However, she also communicated the need to provide the opportunity to apply those skills through a problem situation, such as that found in PBL. Thus, as is evidenced through this teachers’ perspective, one method or approach may not be sufficient and perhaps multiple methods should be considered for future teaching. The recommendation here comes from several points made by Kumar and Natarajan (2007). They state:

1. Directly jumping into problem-solving...may not be very effective in covering unknown, basic facts for subjects such as...computing in comparison to traditional lecture-based modes of study (p. 98).
2. Problem-based learning also represents an educational environment that encourages students to probe and question deeply, an ability that would eventually become the foundation for future professional and intellectual growth (p. 100).

So, while an approach like PBL may not be completely suitable for learning all the skills necessary to function using a computer or other technology, it is a way to address the call for a shift in what and how students are being taught (Ertmer & Simons, 2006; Kumar & Natarajan,

2007; Sage & Torp, 1997; Savery, 2006). Thus, the recommendation is to incorporate PBL while maintaining the opportunity for more formal instruction on some basic facts and skills.

A Shift: From Provider to Facilitator

An essential component in PBL is having the teacher step away from a directive role and become a facilitator and coach for student learning and thinking (Barrows, 1998; Savery & Duffy, 1995). One of the common issues related to the adoption of problem-based learning is the hesitance of the teacher to make a shift in the role from the provider of knowledge to the facilitator of knowledge (Ertmer & Simons, 2006; Jonassen, 1997; Sage & Torp, 2007). Sage and Torp (1997) report that teachers experience “a paralyzing fear of letting go” (p. 35) as they are required to surrender, or shift, the control of learning to the students. This section of the discussion addresses an important component of PBL found to aid the shift in role from provider to facilitator.

To help with transition in the implementation of a PBL module, Hannafin et al. (1999) recommend the use of scaffolds to support both teachers and students. Recall that in this research study these scaffolds took the form of questions and prompts to engage student thinking, sample scenarios to model the thinking process, and prompts for reflection. It was interesting to monitor Marcy’s progress from the start of implementation through the end. She began on day one by still feeling the need to “lead them toward an answer or idea.” On day two, she still expressed that “it was much easier to teach a structured class” as she continued to develop a sense of how students were reacting to the environment and what they needed from her in return. During this time of struggle, Marcy received support from the researcher, who essentially acted as *just-in-time* support for her needs. With this component of collaboration in place, and her willingness to remain cooperative as a study participant, Marcy continued in her attempts to shift her role from

provider to facilitator. Thus, with the module lesson plans in hand, and guidance from the researcher, she forged ahead.

By the third day, Marcy was showing evidence that she was beginning to see student plans and was now able to guide them more succinctly as they proceeded; recall she stated, “I think because they...found their own campaign it was easier for me to lead them in that direction.” Through the remainder of the implementation phase, Marcy became increasingly comfortable with her new role, as she even began creating support scaffolds for the students and sought opportunities to model her own thinking, planning and problem-solving skills.

From this teachers’ perspective, the scaffolds included in the module were particularly beneficial in that they provided her with the support she needed to evolve in her method of teaching. Through the provision of scaffolds such as guiding questions, sample scenarios to help model thinking, and opportunities to reflect on her own thinking in combination with behind-the-scenes support from the researcher, Marcy was able to make the transition from provider to facilitator. This finding is similar to that found by Brinkerhoff and Glazewski (2000) where the scaffolds became a vital component of the PBL experience more for the teacher than the students. The conclusion here is that while this teacher typically relies on well-planned, directed instruction in which she provides information to students, the inclusion of a support system was able to help ease her transition from provider to facilitator. Thus, the recommendation for teachers preparing to adjust to a PBL environment is to ensure a plan for support is in place, such as the inclusion of well-developed scaffolds.

A Shift: Professional Development for Teachers

The unheralded importance of activity and enculturation to learning suggests that much common educational practice is the victim of an inadequate epistemology. A new

epistemology might hold the key to a dramatic improvement in learning and a completely new perspective on education (Brown, et al., 1989, p. 41).

To recap, one of the closing points in the review of literature found in chapter two regarded how PBL can be applied to teach technology skills and what that entails for the teachers of those courses. Thomas and Knezek (2002), and other researchers (Albion, 2003; Brinkerhoff & Glazewski, 2000; Sage & Torp, 1997), assert that using a PBL approach to train teachers could be just as effective as teaching students in a similar way. The argument here is if students are being made to shift in learning and thinking, why then should teachers not shift as well? If teachers need to shift their teaching to encourage the shift in student learning, why then is there not a shift in the way teachers are trained to reflect as such? With the call for a new level of skills and performance for students (Eisenberg, 2003; ISTE, 2003c; Savery, 2006), teachers should also be prepared with such skills to serve as models. The declaration here is that perhaps training teachers through a PBL approach would increase the chances of using PBL in their own classrooms. What then, will this look like for professional development? This section of the discussion provides insight, along with a recommendation, for how to approach a shift in the professional development of teachers for incorporating PBL in their own classrooms.

PBL is a problem. It is difficult to design and deliver instruction using a PBL approach without prior experience or support, as documented by Ertmer and Simons (2006). As was evidenced through the expert review phase of this research study, the researcher experienced problems with the initial design and had to rely on the support and collaboration of more experienced others to establish instruction better suited for a problem-based learning environment. It has been shown that one of the most difficult stages of developing a PBL lesson is formulating the problem and determining an appropriate problem context (Hung et al., 2006;

Sage & Torp, 1997). In following the design models mentioned throughout this document (Hmelo-Silver & Barrows, 2006; IMSA, 2007; Jonassen, 1997) and reviewing research on previous attempts at implementing PBL (Brinkerhoff & Glazewski, 2000; Ertmer & Simons, 2006, Hannafin et al., 1999, Sage & Torp, 1997) the problem is often the first step in design. Thus, if a teacher begins the process of designing and developing a PBL module, only to reach a stumbling block in the first stage, this will severely affect their motivation to proceed. Self-efficacy and motivation play an important role here as Schunk (1981) attributes this affect on motivation to the link between self-efficacy, motivation, and an individuals' willingness to proceed in a task. The stumbling block of developing the problem will deter the forward movement, even before any application in the classroom. Thus, if teachers cannot move beyond the development of a problem statement, the dissemination of an approach like PBL will be difficult to achieve.

As part of this research study, Marcy was charged with the task of implementing a PBL module to teach technology skills to her eighth grade students. While Marcy was not entirely responsible for the design and development of the model, she was considered an integral component in determining the problem and problem context. Throughout implementation, she was able to collaborate with the researcher and was provided with scaffolding supports to guide her teaching and help in the adjustment of her role as a facilitator. With this support system, Marcy received several influences to help increase her self-efficacy and complete the implementation of the module. She admitted, in the final interview, that without the opportunity to participate in this research study, she most likely would not have tried this instructional approach in her own classroom.

Marcy experienced a form of cognitive apprenticeship, which is said to “enculturate learners into authentic practices through activity and social interaction (Brown, et al., 1989, p. 37). In this case, Marcy was the learner, and the implementation of the module served as the authentic practice. She received support from the researcher, who acted as a coach to “promote learning, first by making explicit their tacit knowledge or by modeling their strategies for students in authentic activity” (p. 39). In this case, Marcy was provided with research-based support and behind-the-scenes coaching as she implemented the module. To reiterate, she stated that without the opportunity to work with the researcher, “I don’t believe I ever would have done it [PBL]... ’cause it’s very different from how I normally teach.”

Marcy realized the importance of using an approach like PBL in getting her students to think beyond the skills she was trying to teach. As previously described, she recognized the method as a way to encourage a different level of thinking and see the variety of ways students can develop a product or solution using the technology she provides. With this as a goal for many schools across the nation, how then can teachers be prepared to teach in this manner?

As stated through a researcher memo as a reflection on conversation with Marcy following day six of implementation, perhaps an immersion opportunity, such as this, would encourage other teachers to make a shift in their own teaching methods. As it stands now, Marcy is able to share her experience with other teachers in the district, thus providing an experience through which other teachers can receive support. Marcy had even described her own picture of what this professional development experience would look like. She described having teachers work as interdisciplinary teams to experience working through a problem together. A coach, such as Marcy, would be present to offer support and coaching. Essentially, she would immerse

the teachers into the student experience with the hope of developing some interest and motivation to attempt the PBL approach in their own classrooms.

This experience offers an excellent opportunity to reconsider the way teachers are being prepared to address the shift in needs of students. Perhaps considering an alternative such as cognitive apprenticeship would help provide teachers with “an authentic, situated, and theoretically grounded alternative to traditional...pull-out professional development programs” (Glazer, Hannafin & Song, 2005, p. 65) and thus increase the “conceptual understanding through social interaction and collaboration in the culture of the domain, not of the school” (Brown et al., 1989, p. 40). The recommendation here is to immerse teachers in the whole PBL experience similar to the methods used by Sage & Torp (1997), where teachers became students, designers and coaches, thus receiving experience running the gamut of PBL.

What This Means for Instructional Designers

This developmental research study involved the development of a problem-based learning module designed to teach technology to eighth grade students. Researchers have expressed concern that there is not enough research done in the field of instructional design with a call for the examination of instructional design models (Briggs, 1982; Driscoll & Dick, 1999). Further, within the field of instructional design exist concerns regarding how instructional designers should approach the learning issue of problem-solving (Jonassen, 2000). To reiterate, Jonassen (2000) states, “instructional-design research and theory has devoted too little attention to the study of problem-solving processes” (p. 63). By combining a developmental research approach with the examination of an instructional design process for problem-solving, these concerns can be addressed. This section was developed to offer advice to instructional designers and researchers who seek to pursue problem-solving processes. As a result of the design and

development phase, the expert review of the module, and implementation, two main recommendations surfaced.

The first recommendation for instructional designers seeking to design a problem-solving environment is to collaborate. One goal of developmental research is to link theory, research and practice (Richey et al., 1996). Through this research study, a link was maintained between:

1. Theory, through an exhaustive review of literature and theory related to instructional design and problem-based learning;
2. Research, through collaboration with researchers in the field of instructional design and problem-based learning; and
3. Practice, through collaboration with teachers in order to develop and implement the problem-based learning module.

One of the elemental findings here came through the expert review process. The first section of chapter four was used to describe the process and outline the impact on the module. Through a review of some of the feedback and comments received from each reviewer, an excessive, yet welcomed, amount of advice and guidance was provided to help improve the instructional module before the implementation phase. Without this process it appears the module would not have strongly represented the targeted PBL approach, thus offering insufficient or inaccurate findings. In this case, the expert reviewers were researchers in both fields of instructional design and PBL. The advice provided was research-based and helped more accurately ground the module design in research-based design ideas. In addition, in also seeking advice from the study participant, a teacher for the target audience, reminders were provided about standards, student needs and classroom limitations. Each of these was elemental in the overall design and development of the module and the advice received led to a sounder product.

Thus, the message here is that just as the teacher needed support in implementing the PBL module, so did the designer. With such an array of resources, instructional designers do not, and should not, have to be alone in their attempts to design and develop sound instruction.

The second recommendation resulting from the outcome of this developmental research study is to encourage instructional designers to seek existing models to guide their design and use a combination of such approaches best suited for the needs of the audience and the environment. Recall that the design model for this instructional module was an adaptation of several existing models for designing and developing PBL modules (IMSA, 2007; Jonassen, 1997; Hmelo-Silver & Barrows, 2006). As such, a combination of researcher perspectives was used to develop guidelines for creating the instructional module. Through this process, the following was determined as a general formula for developing additional modules:

1. Begin with a problem
2. Hypothesize how students/audience might react, outline possible solutions
3. Determine resources that will be needed
4. Identify collaboration opportunities
5. Include reflection and debriefing opportunities
6. Develop support scaffolds for the students and the teacher

Even with the identification and delineation of the steps for designing a PBL environment, not all components will fit or are feasible for every situation. Thus, while it is important to consider multiple perspectives, it is also important to remain flexible in order to allow for room to best meet the needs of the target audience. For example, one of the steps listed above is the inclusion of reflection and debriefing opportunities. Through the implementation process, the study participant and researcher realized this step was not always feasible (though it

was included several times throughout); however, it was realized that this was an elemental component of PBL and could not be removed completely from the design. As such, the evolution of the module allowed for some flexibility in this aspect and alternatives were provided to the schedules for reflection and debriefing. In this case, the design of the module remained flexible, as did the designer, and room was provided for adapting to the learning situation, environment and audience.

The message through this recommendation is that allowing multiple perspectives of design models to permeate will help keep an element of flexibility in the overall design process. Thus, it is not necessary to remain married to one idea, model or even a component of a model; but, it is important to remain in line with the general requirements of the target learning approach. Also, when developing a new model or adapting to an existing model, keep in mind the perspective of other researchers and designers in addition to the needs of the audience.

Summary of Conclusions and Recommendations

In this developmental research study, a problem-based learning module was designed to teach a portion of an eighth grade technology class to investigate the effects on the teaching of technology skills. Through an analysis of the data and review of the literature, a shift in approaches to teaching technology skills was noted as an overarching theme; a shift in how and what students are taught, a shift in the role teachers play in student learning, and a shift in the way teachers are prepared to implement methods of teaching such as PBL. The following is a summary of the conclusions and recommendations identified and discussed regarding the implications of using problem-based learning to address this shift. In addition, a summary is provided of recommendations made to help instructional designers as they develop learning materials and programs with a PBL approach. The conclusions and recommendations are:

1. PBL helps teachers encourage essential 21st century skills by helping students experience how technology can be applied to problem situations, carrying the recommendation that teachers should pursue PBL as an alternative method to teaching technology skills.
2. PBL partially addresses the issue of when and how to teach digital technology skills by providing students with the opportunity to practice and apply what they learned in previous direct teaching situations. Thus, the recommendation is that teachers can incorporate PBL in combination with other methods of instruction to encourage both skill-building and application of, and productivity with those skills.
3. While teachers may have reservations, a smoother transition among teaching styles can occur through the incorporation and reliance on scaffolds, thus offering some level of support; therefore, the recommendation is that teachers wanting to engage in a PBL environment should secure a support system through scaffolds and/or collaboration with other practitioners.
4. Preparing teachers to use a PBL approach might be as simple as teachers being taught in the same manner as they will be teaching, thus the recommendation is to immerse teachers in a PBL environment for professional development to gain exposure to the process and get them accustomed to the environment.

The conclusions and recommendations also offered advice to instructional designers interested in designing and developing instruction using a PBL approach. The two recommendations are:

1. Instructional designers pursuing developmental goals should seek to collaborate with other researchers and practitioners. This will allow for a broader perspective and

- greater understanding of theories, research and practice regarding the target instructional module.
2. Instructional designers should seek guidance from existing design models and allow for some flexibility as the instruction evolves. The target content and audience will drive the needs and goals of the instruction and the design model should remain flexible to adapt as such.

Final Thoughts

For the study participant, teaching with a PBL approach in her technology class was a learning experience. As a teacher who thrives on structure and strictly defined activities, the execution of this module was a fresh perspective on teaching. While she concluded the experience with some reservations, she expressed seeing the benefit of such an approach and articulated her willingness to make alterations to her technology class based on what was learned. However, as she is not completely sold on the approach for her own teaching, her willingness to be flexible in the future is a reflection of forward progress for her and her school district. By sharing her experience, she can encourage and motivate other teachers to take risks and pursue new teaching methods. Perhaps, she can serve as a model to others as new attempts are made. In her own reflections, Marcy seemed surprised at her own reaction and stated, “I didn’t think I would enjoy it as much as I do...now I’m getting to know it [PBL].” Finally, when asked if she was glad she participated she replied, “You know, I think I am. Yeah.”

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Appendix A

Overview of State Technology Plans

State	Definition or Mission of Technology	Type of Standards	Use of NETS
Arizona	Technology is the application of tools to solve problems that extend human potential for the benefit of society http://www.ade.state.az.us/standards/technology/	Mix of skills-based, application	STU-A TCH-A ADM-A
Indiana	Develop, produce, use, and assess the impacts of products and services that extend the human potential to improve and control the natural and human-made environment http://www.doe.state.in.us/standards/docs-Technology/2006-08-15-TechEd-Stds.pdf	Primarily application, production	TCH-R ADM-R
Massachusetts	<i>None defined: Reference to ISTE/NETS as a rationale</i> http://www.doe.mass.edu/edtech/standards.html	Skills-based	STU-A TCH-A
Michigan	Technology literacy is the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century. http://techplan.org	Skills-based	STU-A TCH-A ADM-A
Nevada	Technology is the application of resources and knowledge to solve problems and meet human needs. Technology includes, but is not limited to, the use of computers http://www.nde.state.nv.us/standards/standcomp/compotech-standards.html	Mix of skills-based, application, production	TCH-A
New Hampshire	Educational technology is one component of a larger system for improved student outcomes. Technology should be integrated into the curriculum in such a manner that it cannot be separated from the learning process. http://nheon.org/oet/stateplan/nhttp2002.htm#II3a	Mix of skills-based and application	STU-R TCH-A ADM-A

State	Definition or Mission of Technology	Type of Standards	Use of NETS
New Jersey	Any modification of the natural world designed by human beings to solve human problems, enhance human life, or extend human capability http://education.state.nj.us/cccs/?standard_matrix;c=8	Skills-based	STU-A TCH-A ADM-A
North Carolina	No specified definition; high concentration on 21st century literacy and skills http://tps.dpi.state.nc.us/TechPlan0509/	Production, application, strong 21st century	TCH-R ADM-R
Virginia	A technology literate student possesses technology skills that support learning, personal productivity, decision making and daily life. http://www.pen.k12.va.us/VDOE/Technology/plan2003-09.pdf	Mix of skills-based, application and production	STU-A TCH-R ADM-R
Washington	Technology literacy is the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge and skills in the 21st century http://www.k12.wa.us/EdTech/TechfoundationStudents.aspx	Mix of skills-based, application, production	STU-A TCH-A ADM-A

Use of NETS key
(ISTE, 2003d)

STU: students

TCH: teachers

ADM: administrators

A: adopted, adapted, aligned with current NETS

R: referenced some of the standards in their plans

Appendix B

Correlation of Problem-Based Learning and Learning Theories

Learning Theory	Sample Strategies for Teaching and Learning	Potential Role in PBL
Behavioral Learning Theory	Reinforcement	As learners monitor their goals and peers provide feedback they determine their own level of achievement and learning.
	Practice	Practice comes through developing a process; once developed, the process can be transfer to other problem situations.
Social Learning Theory	Modeling	Teacher models metacognitive strategies through questioning and think-alouds; learners serve as peer tutors and models.
	Collaboration	Learners work in groups of several students and collaborate on determining goals and developing products or solutions.
	Situated learning	Learners participate in contextual learning as they are situated within a problem situation.
Cognitive Learning Theory	Self-regulation/metacognition	Learners set personal goals and monitor those goals to determine success; teachers model thinking strategies. Teachers and learners are asked to reflect on their thinking and actions and make revisions as needed.
	Discovery learning	Learners outline goals and determine what information is necessary to solve the problem, recognizing what information is already known and applying that to develop new knowledge or procedures. Learners have the liberty to set their own agenda.
	Cue schema - (activate prior knowledge)	Upon recognizing the goals and what knowledge is needed, learners outline that which is already known and modify existing knowledge to devise a plan or solution.

Learning Theory	Sample Strategies for Teaching and Learning	Role in PBL
Constructivist Learning Theory	Scaffolding	As the learners are situated within the problem context they are given some level of support, such as a list of possible resources or graphic organizers to guide thinking. As they become engaged in the problem and develop individual needs, the type and level of support decreases and reliance on individual and group efforts increases. The teacher and students are also provided with metacognitive scaffolds to guide reflection and goal-setting. These are also decreased as familiarity with the process increases and can be done independently.
	Guided inquiry	The teacher guides learners through the process of solving a problem by posing questions, modeling thinking, providing examples; teacher facilitates student learning through questions, discussions and reflective activity.
	Reciprocal teaching	The teacher initiates and presents the problem context through discussion and questioning. As learners become engaged, they participate in more discussion among peers to construct meaning, discussion with the teacher eventually becomes minimal.

Appendix C

PBL Module Lesson Plans as Presented to the Study Participant

Helping the Animal Shelter Beat Those Holiday Blues

Grade Level

This lesson has been developed for 8th grade students but can be adapted for most other grade levels.

Time Allotment

This lesson is estimated to span over the length of eight 45-minute class periods

Overview

This lesson is designed to teach students how to use technology to help them solve problems. Specifically, the students will gain skills in using programs such as Microsoft Word and Microsoft Excel. In addition, they will use the Internet to gather information to help them address the determined problem. As this lesson is designed to be used in a computer course, students will be using technology to develop their documents throughout the lesson activities and their final products. It is intended that students will gain basic skills on computer programs, improve Internet search skills, practice typing skills and develop critical and creative thinking skills through problem-solving.

Subject Matter

This lesson is designed to teach primarily digital technology and computer skills; however, the lesson is interdisciplinary in nature and can be adapted to meet standards in multiple subject areas such as math, language arts, science and history.

Learning Objectives

Students will be able to:

- use digital technologies to solve a problem
- gather information and resources from the Internet
- create documents using multiple computer programs (specifically Word and Excel for this course)
- make decisions about appropriate computer programs as they relate to the topic and problem
- generate products in a presentable format using digital technologies (specifically Word and Excel for this course)

Standards

This lesson addresses the following New Jersey Core Curriculum Content Standards for Technological Literacy, which can be found at:

http://education.state.nj.us/cccs/?_standard_matrix;c=8

- 8.1.A.2: Use common features of an operating system (e.g., creating and organizing files and folder).
- 8.1.A.3: Demonstrate effective input of text and data, using touch keyboarding with proper technique.
- 8.1.A.4: Input and access data and text efficiently and accurately through proficient use of other input devices, such as the mouse.
- 8.1.A.5: Create documents with advanced text-formatting and graphics using word processing.
- 8.1.A.7: Construct a simple spreadsheet, enter data, and interpret the information.
- 8.1.A.10: Use network resources for storing and retrieving data.
- 8.1.B.6: Choose appropriate tools and information resources to support research and solve real world problems, including but not limited to:
 - On-line resources and databases
 - Search engines and subject directories
- 8.1.B.8: Use computer applications to modify information independently and/or collaboratively to solve problems
- 8.1.B.10: Determine when technology tools are appropriate to solve a problem and make a decision.

This lesson also addresses the following National Educational Technology Standards for Students (NETS*S) for grades 6-8, which can be found at:

http://www.iste.org/inhouse/nets/cnets/students/pdf/NETS-S_Student_Profiles.pdf

NETS*S 1: Creativity and Innovation

- Indicator activity 9: Integrate a variety of file types to create and illustrate a document or presentation.

NETS*S 3: Research and Information Fluency

- Indicator activity 7: Select and use the appropriate tools and digital resources to accomplish a variety of tasks and to solve problems.

NETS*S 4: Critical Thinking, Problem-solving, and Decision Making

- Indicator activity 7: Select and use the appropriate tools and digital resources to accomplish a variety of tasks and to solve problems.

NETS*S 6: Technology Operations and Concepts

- Indicator activity 7: Select and use the appropriate tools and digital resources to accomplish a variety of tasks and to solve problems.
- Indicator activity 9: Integrate a variety of file types to create and illustrate a document or presentation.

Materials

General:

- Computers with Internet access
- Computer productivity programs such as Word, Excel, Publisher

- [Teacher journal prompts](#)

Day 1:

- [Flyer from the animal shelter](#)
- Paper and pencil
- [KWL chart for group work](#)
- Tools to record group information to display to class (overhead, whiteboard, etc.)
- [Self-evaluation form – day 1](#)

Day 2:

- [Group planning chart](#)
- [Group evaluation form – day 2](#)
- [Self evaluation form – day 2](#)

Day 3-7:

- Group planning chart completed from Day 2
- [Group evaluation form – day 3-7](#)
- [Self evaluation form – day 3-7](#)

Day 8:

- Equipment for student presentations
- [Presentation rubric](#)
- [Peer evaluation form](#)
- [Self evaluation form](#)
- [Teacher evaluation of students](#)
- [Teacher evaluation of self](#)

The Problem Statement

As a trend, the animal shelter experiences an influx of abandoned or surrendered animals within the first few months following the holiday season. The shelter is seeking assistance in making sure all animals are properly housed and cared for until they are adopted. To encourage community input, the shelter is running a campaign to gather some innovative and creative solutions for helping the animals. They are asking schools to participate and encourage students to enter.

Day 1

Introduce the Problem and Brainstorm

Activity	Description	Role	Time
Present problem	<p>The teacher will begin class by presenting a flyer distributed from the local animal shelter to describe the campaign and problem.</p> <p>The teacher will also use this time to present the timeline, requirements and campaign deadlines (see flyer).</p> <p><i>This can be made into a classroom competition. The teacher can present the campaign to students and add the element of students competing against each other to determine the best ideas to send to the animal shelter. A reward or prize can be given for the best idea (the most creative, organized researched, etc.), which the teacher can present on the last day of the project.</i></p>	Teacher	5 min.
Check for understanding	<p>After describing the problem and the campaign, the teacher should check to make sure all students understand the problem and their task.</p> <p>Questions to ask:</p> <ul style="list-style-type: none"> What is your understanding of the issue – what is the shelter asking for? What are the limitations we might encounter as we participate in this campaign? 	Teacher and students	5 min.
Brainstorm	<p>Teacher will begin the brainstorming activity by presenting the graphic organizer students will use to organize their group thoughts and questions. The teacher should begin the brainstorm by modeling some questions. For example:</p> <ul style="list-style-type: none"> If I were to enter this campaign, I would begin by asking myself a few questions such as: <ul style="list-style-type: none"> • “What kinds of things might limit the number of animals the shelter can accommodate?” • “What are some things the shelter might need to accommodate more animals?” <p>Students will be placed in their groups and begin their own brainstorming process. The groups should be at least 4 students. The teacher will distribute the graphic organizer to help guide their group brainstorm.</p> <p><i>During this time, the teacher should circulate to monitor the group work. They can engage with students</i></p>	Students	20 min.

	<p><i>by asking questions to determine point of view such as elaborating on an idea, asking where an idea originated, etc. but should avoid questions that appear to lead them toward an answer or specific idea.</i></p> <p><i>Also, the teacher can guide them in outlining their required resources. For example, if students say they will need to use the internet to find information, the teacher should ask them to clarify by describing what part of the internet (i.e. looking at other animal shelters, getting information on pet care, key search words, etc.). Again, avoid using leading questions.</i></p>		
Debrief	<p>Student groups will summarize their brainstorm with the whole class. The teacher will begin this by asking students to identify some of the issues or limitations they mentioned and how they will go about preparing to develop their ideas. After the groups have shared some (no need to share it all) of their information, the teacher will engage students in a debrief of the class to prepare students to be thinking about their activity, group work and position within the problem. Some questions to ask include:</p> <ul style="list-style-type: none"> • “What can you tell us about your brainstorming? Talk about the things your group said or did.” • “Is there anything you think your group should have or should not have done during this time?” • “Does the situation make sense to you? Are you stuck with anything or did your group have any questions you couldn’t answer?” • “What will your goals be for the next class?” 	Students and teacher	10 min.
Self-evaluation	Students will receive a set of questions and a checklist to complete as a self-evaluation . If class time does not allow them to complete this, they can do it at home.	Students	5 min.

*** In understanding students should take sufficient time to engage in the self-evaluation, it is equally important to have a strong debriefing session at the end of the class. Since this is a new style of learning for most students, they should receive more guidance at this point. Additional stress will be placed on self- and peer-evaluation later in the lesson as they become more comfortable with asking questions of themselves and others.**

Day 2

Group planning and gathering resources

Activity	Description	Role	Time
Revisit the problem	<p>The teacher will begin class by asking students to revisit the problem and campaign. This can occur by asking several students to recall ideas from their brainstorm. In addition, the teacher can present questions students may have presented during the class debrief.</p> <p>A prompt can be: “What is our understanding of the problem and the campaign?”</p>	Teacher and students	5 min.
Group planning	<p>The teacher will begin the group planning session by modeling some problem-solving questions. For example:</p> <p style="padding-left: 40px;">“When I am trying to solve a problem or planning to do something, I make sure I understand what needs to be done, where I’m going to get my information, how I’m going to present my information and how much time I have to complete everything. For example, in planning to teach a class, I might decide I need to create something to hand out to all of the students. I then have to decide what I will need to create that handout, how much time I should spend on it and what should be included. So, I might determine the handout needs to contain information on doing internet searches and that I will need to type directions, so I will use a word-processing program like Word and I can’t spend any more than 20 minutes. With this kind of plan, I know exactly what I need to do, how I’m going to do and how much time it will take me. As you develop plans for your campaign entry, think about these things – what will you do, what will you need, how will get it, how much time do you have?”</p> <p>Students will get together with their group members and begin outlining a plan for their campaign entry. The teacher will provide them with a graphic organizer to help guide them in this process.</p> <p><i>As the students work in groups, the teacher will circulate and monitor student progress. As the teacher recognizes student goals and ideas, help to keep them manageable by asking clarifying questions; again, avoid the leading questions that appear to guide them toward an “answer”. For example, if students are saying they need to type a letter, ask them what program they will use. With their response, the teacher can follow up with questions such as:</i></p> <ul style="list-style-type: none"> • “Do you know how to do that?” • “What will you need to learn how to do that?” • “Where can you get help learning how to do that?” <p><i>Also, during this time, the teacher should review the student self-evaluations from the previous day. In</i></p>	Students	20 min.

	<i>looking at the evaluations, the teacher can help students elaborate on their thoughts and ideas. For example, if the student comments that their group had several questions about a particular issue with the problem, the teacher can elaborate and ask the group how they have handled the questions, what other information or sources have they considered, etc.</i>		
Debrief	<p>This will be similar to the debrief session in the first class. The teacher can ask one student from each group to give a quick summary of what their group decided in regards to their plans and ideas. This can be a time for students to express what they might need from the teacher (such as instructions, resources, etc.). In addition, the teacher should guide students by asking questions such as:</p> <ul style="list-style-type: none"> • “How well did your group manage its time today?” • “What kind of changes do you think you need to make to the group?” • “Do you think the group understands what is happening and what is required to submit your idea?” • “Did your group get stuck on anything today?” 	Students and teacher	10 min.
Group evaluation	Students will conclude the class by evaluating their group work through a checklist . This is just as important as the whole class debrief so time should allow for completion of this activity in class.	Students	10 min.
Self evaluation	Students will receive a set of questions and a checklist to complete as a self-evaluation . If class time does not allow them to complete this, they can do it at home.	Students	5 min.

Day 3

Gathering resources, begin preparing submission proposal

Activity	Description	Role	Time
Restate problem	The teacher should do a quick check to make sure students still understand the problem and what their requirements are. The class can use this time to ask any questions about requirements, deadlines, etc. As students move toward their group work, remind them to look at their plans before they begin working.	Teacher	5 min.
Group work	<p>Students will use most of the remainder of class working on their proposal entries. Through their group planning the day before, they should have outlined goals, assigned roles to group members and developed a timeline.</p> <p><i>As the students are working, the teacher should circulate to monitor group and student progress. As the teacher approaches students or groups, questions should be asked to clarify ideas and plans. Again, it is important to avoid leading questions. Students may also ask for help in learning a new program or where to find information. Encourage them to approach their group members first before helping. Also, use this opportunity to model internal questioning. For example, if a student is in charge of gathering information from internet resources, the teacher can guide them by explaining their approach to a similar task such as:</i></p> <p style="padding-left: 40px;"><i>“When I need to search for something on the internet, I usually think of a few key words of what I am looking for. Once I come up with some pages from my search, I take a quick look at the homepage and look for several things to decide if I should continue spending my time on that site. Look at the paper I gave you on internet search strategies and you can use those questions to help you use your time well.”</i></p> <p><i>Also, students searching for information on the internet can be provided with web surfing strategies and questions to ask as they look at websites. This information can be provided to all students but may only be used by those doing actual research.</i></p>	Students	30 min.
Group evaluation	The teacher will stop group work and engage students in a group evaluation . Students will debrief in their group instead of with the entire class.	Students	10 min.
Self evaluation	Students will receive a set of questions and a checklist to complete as a self-evaluation . If class time does not allow them to complete this, they can do it at home.	Students	5 min.

Day 4-8

Prepare idea proposal and presentation

Students will continue working through the next 4 class periods on preparing their idea proposals and making sure they meet all of their goals and entry requirements. Group activity should continue in a similar fashion where students continually review and modify their goals as needed; the teacher should remind students to visit their [group evaluations](#) before they begin work each day. Each class period should include time for group debriefing and [evaluation](#) and individual students should complete their [self-evaluation](#) after each class. After the first few classes, this time could be reduced to about 5-7 minutes.

As the projects evolve, the teacher will provide students with needed guidance and continue asking questions to highlight and guide their thinking. Each day, the teacher should circulate and review student self-evaluations. Questions should be asked based on the content of their evaluations, such as:

- What might you need to be more motivated?
- Where do you plan to get answers to your questions?
- How can you become more involved in the group plans?
- What disagreements do you have with other group members and why?

On the final day, the students will present their idea proposals and they can judge which would be the best one to submit (it may be possible to bring a member of the animal shelter in to be a judge as well). They will also complete the [peer-](#) and [self-evaluations](#) to conclude the project. The teacher can use the [project rubric](#) to assign a grade to the group for their work and presentation.

Campaign Flyer

Front:



Back:



KWL Chart – Day 1 Brainstorm

What is the issue or limitations?	What do we know? (about shelters or caring for animals)	What do we still need to know?	How or where will we get more information?

Day 1 - Self-evaluation

1. What did I learn today? (This can be about any part of the class.)

2. What questions do I still have about the campaign or the problem the shelter is having?

3. What questions should I ask my group members or teacher tomorrow?

4. What role did I play in my group today (how did I help)?

5. What are my plans for next class?

Rate your contributions to the work you did with your group today.

	Excellent	Good	Fair
I contributed my own ideas and opinions.			
I contributed information and facts.			
I helped determine a plan.			
I worked well in my group.			
I am interested and motivated to continue working with my group.			

Day 2 – Group Planning

What is our campaign idea?	What are the steps we will take to prepare our entry?	What information do we still need to know and how will we get it?	Who will do what part? (assign jobs or roles to each member of your group)	How much time should we spend on each piece?

Day 2 - Group evaluation

1. What were our goals for today?

2. What are our goals for tomorrow?

3. Where should we focus our attention during next class?

4. What questions do we have?

Rate the work your group did today.

	Excellent	Good	Fair
We stayed on task and used our time wisely.			
We met our goals for today.			
We listened to everyone's opinions and ideas.			
We used our resources well and asked good questions.			
We developed a plan of action for the next class.			
Our group is interested and motivated to complete reach our goals.			

Day 2 – Self-evaluation

1. What did I learn today? (This can be about any part of the class.)

2. What questions should I ask my group members or teacher tomorrow?

3. What role did I play in my group today (how did I help)?

4. Is there anything I can do differently to be a better member of my group?

5. What are my plans for next class?

Rate your contributions to the work you did with your group today.

	Excellent	Good	Fair
I contributed my own ideas and opinions.			
I contributed information and facts.			
I used resources to complete my tasks.			
I helped carry out our plan.			
I worked well in my group.			
I am interested and motivated to be part of this group and help reach our goals.			

Day 3-7 – Group evaluation

1. What were our goals for today?

2. What are our goals for tomorrow?

3. Where should we focus our attention during next class?

4. What questions do we have?

5. Do we have enough time to complete our goals?

Rate the work your group did today.

	Excellent	Good	Fair
We stayed on task and used our time wisely.			
We met our goals for today.			
We listened to everyone's opinions and ideas.			
We used our resources well and asked good questions.			
We developed a plan of action for the next class.			
Our group is interested and motivated to complete reach our goals.			

Day 3-7 – Self-evaluation

1. What did I learn today? (This can be about any part of the class.)

2. What questions should I ask my group members or teacher tomorrow?

3. What role did I play in my group today (how did I help)?

4. Is there anything I can do differently to be a better member of my group?

5. What are my plans for next class?

Rate your contributions to the work you did with your group today.

	Excellent	Good	Fair
I contributed my own ideas and opinions.			
I contributed information and facts.			
I used resources to complete my tasks.			
I helped carry out our plan.			
I worked well in my group.			
I am interested and motivated to be part of this group and help reach our goals.			

Grading Rubric - Final Project

Category	4	3	2	1
Organization	Well organized with a logical format, ideas flowed smoothly and project was effective.	Some organization with logical thoughts, ideas flowed well and project was effective.	Some organization, flow of ideas was somewhat distracting and project was reasonably effective.	Ideas and organization were confusing, flow of ideas was distracting and project was not effective.
Research	Went beyond the given research information, solicited additional material and used a variety of resources, used many resources to gather information	Used given materials to their potential, took some initiative to locate information beyond what was given, used several resources to gather information.	Used the given materials appropriately, did not seek information beyond what was given.	Used very little information from the resources and did not seek additional resources.
Tools	Used a variety of tools to prepare the presentation, made appropriate selection of programs and materials in developing products, shows a clear understanding of differences in purpose between several programs and tools.	Used a variety of tools to prepare the presentation, made good selection of programs and materials in developing products, shows basic understanding of differences in purpose between several programs and tools.	Used one or two tools to prepare the presentation, selected programs and materials based on generic recommendations, shows little understanding of differences in purpose between several programs and tools.	Used one or two tools to prepare the presentation based on recommendation from instructor, shows no understanding of differences in purpose between several programs and tools.
Equipment Use	Exhibits extreme comfort in using equipment when developing, demonstrating or presenting information or products, uses advanced features of programs with no help from others.	Exhibits comfort in using equipment when developing, demonstrating or presenting information or products, uses mainly basic features of programs with some help from others.	Exhibits some reservation in using equipment when developing, demonstrating or presenting information or products, uses mainly basic features of programs with help from others.	Exhibits extreme reservation in using equipment when developing, demonstrating or presenting information or products, uses only basic features of programs with help from others.
Creativity	Used a unique approach to solve the problem, develop and deliver the product, exhibits uniqueness in approach to making decisions and developing solutions.	Arrived at a unique approach to solve the problem, develop and deliver the product with some coaching, exhibits ability to be unique in approach to decision-making and developing solutions with some need for coaching.	Used a generic or modified approach to solve the problem, develop and deliver the product, exhibits ordinary approaches to decision-making and developing solutions.	Used a frequently encountered approach to solve the problem, develop and deliver the product, exhibits ordinary approaches to decision-making and developing solutions.
Overall	Exceeds the requirements of the project and works within and beyond the goals of the group, efficient use of time and is extremely resourceful.	Meets the requirements of the project and works within the goals of the group, efficient use of time and is resourceful.	Meets 75% of the project requirements and works toward the goals of the group, ineffective use of time and only slightly resourceful.	Meets few of the project requirements and does not work within the goals of the group, wastes time and is not resourceful.
Total				
_____ /24				

Day 8 - Peer Evaluation

Directions: Write your group members' names in the boxes to the right. Look at each item and assign each group member a number according to how they worked within your group. Read each item carefully and pay close attention to the numbers. When you are finished, add up the numbers in each column and write them at the bottom.

		Name	Name	Name
1. This person participated in group discussions and activities...	4: always active 3: usually active 2: too active, they dominated the group 1: usually was not active 0: did not participate at all			
2. This person cooperated with other group members...	4: very well, they listened and did not argue 3: okay, they listened but argued some 2: okay, they didn't listen well and argued some 1: poorly, they did not listen and argued a lot 0: did not participate at all			
3. This person remained focused and helped us meet our goals...	4: always 3: most of the time 2: sometimes 1: rarely 0: never			
4. This person came prepared and kept all materials organized...	4: always 3: most of the time 2: sometimes 1: rarely 0: never			
5. This person asked good questions and contributed to group decisions...	4: always 3: most of the time 2: sometimes 1: rarely 0: never			
6. This person accepted constructive criticism and worked to make improvements....	4: always 3: most of the time 2: sometimes 1: rarely 0: never			
7. This person carried an equal share of the group responsibilities...	4: always 3: most of the time 2: sometimes 1: rarely 0: never			
8. What amount of the actual work involved for your final project did this person complete?	4: Their share of the work 2: More than their share of the work 1: Less than their share of the work 0: None of their work			
9. How would you rate this persons overall work in the group?	4: Excellent 3: Good 2: Neutral 1: Fair 0: Poor			
Total	Add up all the numbers in each column and write them in the boxes to the right.			

Day 8 - Self Evaluation

Directions: Write your names in the boxes to the right. Look at each item and assign yourself a number according to how you feel you worked within your group. Read each item carefully and pay close attention to the numbers. When you are finished, add up the numbers write the total at the bottom.

Your name

1. I participated in group discussions and activities...	4: always active 3: usually active 2: too active, they dominated the group 1: usually was not active 0: did not participate at all	
2. I cooperated with other group members...	4: very well, they listened and did not argue 3: okay, they listened but argued some 2: okay, they didn't listen well and argued some 1: poorly, they did not listen and argued a lot 0: did not participate at all	
3. I remained focused and helped us meet our goals...	4: always 3: most of the time 2: sometimes 1: rarely 0: never	
4. I came prepared and kept all materials organized...	4: always 3: most of the time 2: sometimes 1: rarely 0: never	
5. I asked good questions and contributed to group decisions...	4: always 3: most of the time 2: sometimes 1: rarely 0: never	
6. I accepted constructive criticism and worked to make improvements....	4: always 3: most of the time 2: sometimes 1: rarely 0: never	
7. I carried an equal share of the group responsibilities...	4: always 3: most of the time 2: sometimes 1: rarely 0: never	
8. What amount of the actual work involved for your final project did I complete?	4: Their share of the work 2: More than their share of the work 1: Less than their share of the work 0: None of the work	
9. How would I rate my overall work in the group?	4: Excellent 3: Good 2: Neutral 1: Fair 0: Poor	
10. I learned new computer skills from my work...	4: Lots of new skills 3: Some new skills 2: Strengthened skills I already had 1: One or two new skills 0: No new skills	
11. I learned new facts from my work...	4: Lots of new facts 3: Some new facts 2: Clarified facts I already had 1: One or two new facts 0: No new facts	
Total	Add up all the numbers and write the total in the box to the right.	

Teacher Daily Journal Template

Please use this form as a guide to help you complete your journal entry at the conclusion of class. Feel free to add or address additional topics, concerns or questions.

What are some of the questions you took or heard from students?

What are some of the questions you asked of students?

How did you model thinking processes?

What role do you feel you played in student learning today?

Describe your perspective on student engagement?

List or describe anything you observed as interesting, peculiar, etc

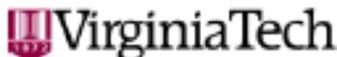
Appendix D

Correlation of PBL Elements and the Design Process

Elements of PBL	Implications for Design
Student-centered	<p data-bbox="824 443 1305 470">Problem scenario focused on students</p> <p data-bbox="824 516 1414 583">Learning activities designed for active student involvement</p> <p data-bbox="824 627 1414 695">Includes guidance or prompts for encouraging student self-questioning and monitoring</p>
Teachers as facilitators, tutors	<p data-bbox="824 772 1317 837">Teacher has minimal role in executing activities</p> <p data-bbox="824 884 1365 951">Design includes opportunity for teacher to model metacognitive strategies</p> <p data-bbox="824 995 1365 1062">Includes sample questions or statements to guide student-teacher interaction</p>
Collaboration	<p data-bbox="824 1140 1390 1207">Activities include opportunity to collaborate with other students</p> <p data-bbox="824 1251 1378 1318">Problem requires multiple perspectives and open for interpretation (ill-structured)</p> <p data-bbox="824 1362 1406 1428">Students are directed to collaborate on setting goals and determining solutions</p>

Elements of PBL	Implications for Design
Interdisciplinary	<p data-bbox="824 323 1393 394">Problem required investigation into multiple disciplines</p> <p data-bbox="824 436 1393 506">Students are provided with or are directed to pull resources from other disciplines</p>
Reflection	<p data-bbox="824 583 1393 655">Activities involve student reflection on involvement with the problem and the group</p> <p data-bbox="824 697 1393 768">Teachers are prompted to monitor student activity and provide reflective insights</p> <p data-bbox="824 840 1393 869">Students are prompted to evaluate their peers</p>
Presented in authentic context	<p data-bbox="824 947 1393 1018">Problem scenario is designed around real-world issues, related to student interest</p> <p data-bbox="824 1060 1393 1131">Activities and materials are designed around authentic needs and realistic settings</p> <p data-bbox="824 1173 1393 1270">The problem is presented to the students through a realistic method; teacher is directed on how to execute</p> <p data-bbox="824 1312 1393 1417">Teacher is prompted to provide continual reminders of the problem being <i>real</i> and encourage students as such</p>

Appendix E

Letter of Proposal to the Harborside Township School Board

Instructional Design and Technology

Liesl M. Combs, Ph.D. candidate
 220 War Memorial Hall, 0313
 Blacksburg, Virginia 24061
 540/239-6776
 lcombs@vt.edu
<http://www.soe.vt.edu/ldt>

3 October, 2007

██████████ Township School Board
 ██████████ Township School District
 ██████████ Drive
 ██████████ Township, NJ ██████████

To the members of the ██████████ Township School Board:

In compliance with the school district policy number ██████████ I am writing to request permission to conduct research within your school district. I am currently pursuing my doctoral degree in Instructional Design and Technology from Virginia Tech located in Blacksburg, Virginia and I hope to use this research toward my final dissertation. To this point, I have been in regular contact with ██████████ the Director of Educational Media Technology, and have previously done work for your school district through this contact. My previous work, completed in May of 2007, involved a program evaluation of the ██████████ courses taught by ██████████ at ██████████ Middle School. The work I am proposing will be a continuation of that evaluation and involve collaboration with both ██████████ and ██████████ along with other teachers of the ██████████ courses.

The purpose of this research is to discover any implications of a problem-based learning approach to teaching digital technology skills within your 8th grade curriculum. One of the recommendations coming out of the evaluation last spring was to include more performance-based assessment items to gain a more accurate measure of student skills and abilities. Through this recommendation, ██████████ and I have considered designing a portion (or portions) of the ██████████ courses through a problem-based learning approach. For more information on this approach and how it applies to your students, see the enclosed document titled *Research Proposal*.

Through this research, I plan to contribute to the future of your technology program for students within your school district. With my findings, I will make recommendations to the technology department regarding instructional design of the course and appropriate assessments therein. My involvement within your schools will include collaboration with some teachers and the director of technology through which I will contribute research-based design elements to be used within course instruction. I will also participate in classroom observations and pose occasional questions to students, within minimal to no interruption to class activities.

Student involvement will be minimal; their participation will include following standard daily routines and participating in instruction and activities designed through the problem-based learning approach. They will not be asked to attend extra classes, stay after school or perform activities beyond the scope of the ██████████ courses. Prior to working within your schools, I will apply for approval from the Institutional Review Board for working with human subjects (for more information, go to <http://www.irb.vt.edu>). In this application, I will present the information I am including with this request. Their approval and my compliance with their guidelines will insure complete anonymity of all students, faculty and staff involved in the research project. As mentioned in the attached document, any information gathered through this research will remain anonymous and student identities will not be revealed. The project and report will not involve the use of student names or physical identities and will focus primarily on the course design and instruction.

The scope of this project will be limited to only a few months time. I will begin design work in mid-December of 2007 and implementation and evaluation in February of 2008. It is estimated I will complete design work, implementation and data collection by early March of 2008. Following this work, I will provide the results and outcomes of this research project, which can be used by your school district to help report necessary items to the New Jersey Board of Education in regards to technology proficiency requirements of students.

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I truly appreciate your timely attention to this request. Please feel free to reference the attached document for additional information about the research project. I am willingly available to answer any outstanding questions you may have. I hope you will allow me to work with your school district and help make valuable contributions not only to your school programs, but general education within the state as well. Thank you, in advance, for your time and consideration.

Sincerely,



Liesl M. Combs

Enclosure

Cc: [REDACTED] Assistant Superintendent
[REDACTED] Director of Educational Media Technology
[REDACTED] Assistant Principal, [REDACTED] Middle School
[REDACTED] teacher, [REDACTED] Middle School

Appendix F

Letter of Approval From the Harborside Township School Board

[REDACTED] **SCHOOL DISTRICT**
Office of the Superintendent
[REDACTED] Drive
[REDACTED] Township, New Jersey [REDACTED]
[REDACTED]

Superintendent [REDACTED]
Assistant Superintendent [REDACTED]
Assistant Superintendent [REDACTED]
Business Administrator [REDACTED]
Board Secretary [REDACTED]

Superintendent's Office
Phone: [REDACTED]
Telefax: [REDACTED]

Business Office
Phone: [REDACTED]
Telefax: [REDACTED]

October 24, 2007

Liesi M. Combs
Virginia Tech
220 War Memorial Hall, 0313
Blacksburg, Virginia 24061

Dear Ms. Combs:

During the regular meeting held on Tuesday, October 23, 2007 the Board of Education approved the request from **Virginia Tech** for the **2007/2008** school year:

Liesi M. Combs Research in pursuit of Doctoral Degree (Instructional Design and Technology) with cooperation of [REDACTED] mid-December 2007 to March 2008.

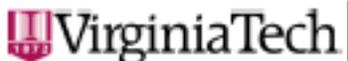
Sincerely,

[REDACTED]

Superintendent

[REDACTED]

Appendix G

IRB Approval

Office of Research Compliance
 Institutional Review Board
 2000 Kraft Drive, Suite 2000 (0497)
 Blacksburg, Virginia 24061
 540/231-4991 Fax 540/231-0959
 e-mail moored@vt.edu
 www.irb.vt.edu

PVA000005721 expires 1/22/2012
 IRB # is IRB00020967

DATE: December 6, 2007

MEMORANDUM

TO: Jennifer Brill
 Liesl Michele Combs

FROM: David M. Moore 

Approval date: 12/6/2007
 Continuing Review Due Date: 11/21/2008
 Expiration Date: 12/5/2008

SUBJECT: **IRB Expedited Approval:** "The Design, Development and Evaluation of a Problem-Based Learning Module for Teaching Digital Technology Skills to Middle School Students", IRB # 07-619

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective December 6, 2007.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.
2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.
3. Report promptly to the IRB of the study's closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher's responsibility to obtain re-approval from the IRB before the study's expiration date.
4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

Important:

If you are conducting federally funded non-exempt research, this approval letter must state that the IRB has compared the OSP grant application and IRB application and found the documents to be consistent. Otherwise, this approval letter is invalid for OSP to release funds. Visit our website at <http://www.irb.vt.edu/pages/newstudy.htm#OSP> for further information.

cc: File

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE UNIVERSITY AND STATE UNIVERSITY

An equal opportunity, affirmative action institution

Appendix H

E-mail to Expert Reviewers Requesting Participation

E-mail Subject Line: Problem-based Learning Module

Good morning! I am a research assistant for _____ and a PhD student in the Instructional Design and Technology department at Virginia Tech. I have recently spoken with _____ regarding my upcoming dissertation work in problem-based learning and asked if she would support my request of a favor from you. She told me that through a conversation with you, you may agree to help with my research. If I may say in advance, I appreciate your time and any help you can offer.

My research involves the design, development and implementation of a problem-based learning module for teaching digital technology skills to middle school students. One of the study procedures for my research involves an "expert review" of the module and related materials. I am trying to identify who those "experts" could be. Through my time reviewing literature, I have come across much of your work in problem-based learning and teaching technology. I have come across your studies in several journals, _____ on problem-based learning. Thus, in recognizing your work in this area and knowing of the relationship you have with _____, I realized how valuable your input could be to my research.

I am foreseeing the design of this module to be complete by mid-January (my timeline says January 15). I have then allotted about a week for the module to undergo expert review giving me about a week to revise the materials before they are scheduled to be implemented in a classroom. The module will consist of lessons designed for about 8 class periods (each about 45 minutes long) for students enrolled in an 8th grade technology course. The lessons will all focus on one central problem (i.e. the students will have 8 days to compile a solution to their problem).

Do you think you would be willing and/or able to serve as one of my *expert reviewers* of this module? Again, from the work you have done, I feel your input would be very beneficial to my project and I would greatly value your opinions and suggestions.

Please consider my request and let me know if this is something you would have time to do. I appreciate the time you have taken to read my request and look forward to your response. I apologize again for the two e-mails, but I guess these things happen from time to time!

Have a great holiday! Take care!

Liesl Combs

* Note: the initial greeting was slightly different for each request; however the body of the request, was the same.

Appendix I

Memo Sent to Expert Reviewers with Consent Form

Liesel M. Combs, Ph.D. candidate
220 War Memorial Hall, 0313
Blacksburg, Virginia 24061
540/239-6776
lcombs@vt.edu
<http://www.soe.vt.edu/ldt>

9 January, 2008

[REDACTED]

Thank you again for agreeing to participate in my research study on problem-based learning and serve as an *expert reviewer* of my learning module. Before the review process begins, I need to receive your written consent to participate in order to remain in compliance with the policy set forth by the Institutional Review Board at Virginia Tech.

Enclosed with this memo is a copy of the informed consent document with a summary of your role as a participant as well as any associated risks and benefits. Please review this document carefully. Once you have reviewed the document, feel free to ask me any questions or seek clarification. If you are comfortable with your responsibilities, please provide your written consent by signing one of the copies and returning it to me by mail; I have enclosed a self-addressed, stamped envelope. I have also included a second copy for you to retain for your records and future reference.

If you have any questions, do not hesitate to contact me. Thank you for your time!

Sincerely,

Liesel M. Combs

Enclosure

Invent the Future

Appendix J

Text for Informed Consent Form for Expert Review Participants

Title of Project: **The Design, Development and Evaluation of a Problem-Based Learning Module for Teaching Digital Technology Skills to Middle School Students**

Researcher: Liesl M. Combs (licombs@vt.edu)

I. Purpose of this Research Project

You are invited to participate in a study in which I will seek to learn more about how a specified instructional design model affects the teaching of digital technology skills to middle school students. This study will extend current research in the areas of using a problem-based learning approach to teaching these skills.

II. Procedures

Data collection involves the following stages:

1. Researcher will submit module design to the participant for approval.
2. Participant will use a rubric provided for evaluation of the module.
3. Participant will provide written feedback and suggestions for revision of the module.

III. Risks

The risks associated with participation in this study are minimal. The researcher will work to ensure all materials collected through this study are stored securely and remain confidential.

IV. Benefits

Participation in this project will provide information that may be used to improve classroom activities for teaching digital technology skills to middle school students. No guarantee of benefits has been made to encourage individual to participate in this study.

V. Extent of Anonymity and Confidentiality

The results of this study will be kept strictly anonymous and confidential. Your written consent is required for the researcher to release any data identified with you as an individual to anyone other than personnel working on the project. The information you provide will have your name removed and only a pseudonym will identify you during analyses and any written reports of the research; you reserve the right to choose this pseudonym. Data will be kept for approximately one year after the conclusion of the study.

VI. Compensation

Your participation is voluntary and unpaid.

VII. Freedom to Withdraw

You may withdraw from the research project at any time and for any reason. You are free not to answer any questions or respond to experimental situations without penalty. To withdraw please inform the researcher listed at the bottom of this form.

VIII. Subject's Responsibilities

I voluntarily agree to participate in this study.

IX. Subject's Permission

I have read the Consent Form and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent:

_____ Date _____
Subject signature

Should I have any pertinent questions about this research or its conduct, and research participants' rights, and whom to contact in the event of a research-related injury, I may contact:

Liesl M. Combs _____ 540-239-6776/licombs@vt.edu
Researcher Telephone/e-mail

Jennifer M. Brill _____ 540-231-8328/jmbrill@vt.edu
Committee Chairperson Telephone/e-mail

David M. Moore _____ 540-231-4991/moored@vt.edu
Chair, Virginia Tech Institutional Telephone/e-mail
Review Board for the Protection of Human Subjects
Office of Research Compliance
1880 Pratt Drive, Suite 2006 (0497),
Blacksburg, VA 24061

Appendix K

Text for Informed Consent Form for Teacher Participant

Title of Project: **The Design, Development and Evaluation of a Problem-Based Learning Module for Teaching Digital Technology Skills to Middle School Students**

Researcher: Liesl M. Combs (licombs@vt.edu)

I. Purpose of this Research Project

You are invited to participate in a study in which I will seek to learn more about how a specified instructional design model affects the teaching of digital technology skills to middle school students. This study will extend current research in the areas of using a problem-based learning approach to teach these skills.

II. Procedures

Data collection involves the following stages:

1. Researcher will submit module design to the participant for approval.
2. Participant will use a rubric provided for evaluation of the module.
3. Participant will meet with the researcher in person to discussion feedback and suggestions for modification of the module.
4. Researcher will observe participant over an 8-session period to observe participation in the teaching of digital technology skills through a problem-based learning approach. These sessions will be video-taped.
5. Participant will be asked to complete a journal including a reflective response at the conclusion of each instructional session (8 total, no more than 15 minutes each).
6. Researcher will conduct three (3), one-on-one interviews with the participant to clarify classroom activities and responses to journal entries. These sessions will be audio-taped and last approximately 30 minutes each.

III. Risks

The risks associated with participation in this study are minimal. However, whenever audio and video recordings are made, there exists the possibility that such recordings might be heard and your voice recognized by someone. The researcher will work to ensure all materials collected through this study are stored securely and remain confidential.

IV. Benefits

Participation in this project will provide information that may be used to improve classroom activities for teaching digital technology skills to middle school students. No guarantee of benefits has been made to encourage individual to participate in this study.

V. Extent of Anonymity and Confidentiality

The results of this study will be kept strictly anonymous and confidential. Your written consent is required for the researchers to release any data identified with you as an individual to anyone other than personnel working on the project. The information you provide will have your name removed and only a pseudonym will identify you during analyses and any written reports of the research; you reserve the right to choose this pseudonym. Recordings will be kept for approximately one year after the conclusion of the study.

VI. Compensation

Your participation is voluntary and unpaid.

VII. Freedom to Withdraw

You may withdraw from the research project at any time and for any reason. You are free not to answer any questions or respond to experimental situations without penalty. To withdraw please inform the researcher listed at the bottom of this form.

VIII. Subject's Responsibilities

I voluntarily agree to participate in this study.

IX. Subject's Permission

I have read the Consent Form and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent:

_____ Date _____
Subject signature

Should I have any pertinent questions about this research or its conduct, and research participants' rights, and whom to contact in the event of a research-related injury, I may contact:

Liesl M. Combs _____ 540-239-6776/licombs@vt.edu
Researcher Telephone/e-mail

Jennifer M. Brill _____ 540-231-8328/jmbrill@vt.edu
Committee Chairperson Telephone/e-mail

David M. Moore _____ 540-231-4991/moored@vt.edu
Chair, Virginia Tech Institutional Telephone/e-mail
Review Board for the Protection of Human Subjects
Office of Research Compliance
1880 Pratt Drive, Suite 2006 (0497),
Blacksburg, VA 24061

Appendix L

Interview Protocol for Interview 2

Questions/Overview of Interview Session

- Turn on recorder.
- Thank you for scheduling this time.
- Reminder all answers will remain anonymous and confidential, to be used for data analysis.
- Purpose of the interview to discuss observations of researcher and teacher, gain teacher perspective, determine progress and outline final days.
- Ask Marcy if she has any questions about the interview process.

Discuss Expectations

- Expectations of students
 - Prior to the four days we have already completed, what expectations did you have of the students?
 - How did you expect them to react or behave?
 - What did you expect them to learn?
 - Did they meet, not meet, or exceed those expectations?
 - With the four days remaining, what are your expectations of them?
- Expectations of yourself
 - What did you expect of yourself in the first four days of implementation?
 - Describe your picture of how things should have progressed.
 - Compare that with how things have progressed and discuss your affirmations or disappointments.
 - What do you expect of yourself in the remaining four days?

Class Procedures

- Structure of lesson plans
 - As you see how the lesson evolve, which is typical of PBL, how comfortable are you with this?
 - Would you prefer more structured or direct lesson planning?
- Questioning
 - How do you make decisions about the questions you ask of the students?
 - How, if at all, is this different from questions you ask of students in other classes or through other lessons?
- Understanding
 - What is your perception of student understanding – both of the lesson and activities, and the use of the computer?
 - What is your perception of student understanding of the evaluations and reflective pieces?

Reflective Statements

Present these comments (one at a time, in order of days) to Marcy. I see a little progression in each of these statements and you seem to be evolving in your own thoughts. Can you say anything about that?

- (Day 1) “it is very difficult not to lead them toward an answer or an idea, particularly groups 2 & 4.”
- (Day 2) “It is much easier to teach a structured class where you know what the final product will be. I have a major concern that Group #2 will not develop a campaign.”
- (Day 3) “I was pleased with the progress some of the groups made. I’d like to know if I can lead Group 3 back to their original idea so that their costs are associated with building a grooming facility, and their campaign can be to raise money with grooming dogs to the public.”

- Peculiarity

- (Day 2) “It is much easier to teach a structured class where you know what the final product will be. I have a major concern that Group #2 will not develop a campaign.”
 - What is your take on this statement?
 - What do you recall was annoying?
 - Describe your annoyance.
 - Would this statement change or remain the same as things have progressed?

Additional Implementation

- What advice would you have for other teachers working to implement problem-based learning in their classroom?
- If you were to continue, what would you keep or change?

Changes to the Course

Present this statement to Marcy, made on the preliminary survey.

“I believe the 8th grade Work Skills should allow students to apply the skills they are taught in 7th grade Work Skills. Teaching the applications should be moved down to 7th grade. Eighth grade should be working on real life scenarios when applying technological skills.”

- With this in mind and the experience you have had thus far, how would you rate problem-based learning as a possible approach to making this change?
- What would need to happen to help problem-based learning address your perspective on the Work Skills course? Consider the factors involved (e.g. time, resources, etc.)

General Questions or Comments

- Do you have any questions about the days to come?
- Anything else?

Closing

- Thank you for your time.
- Can we schedule the third interview?
- Do you need anything for the next day of implementation?

Appendix M

Interview Protocol for Interview 3

Questions/Overview of Interview Session

- Turn on recorder.
- Thank you for scheduling this time.
- Reminder all answers will remain anonymous and confidential, to be used for data analysis.
- Purpose of the interview to discuss observations of researcher and teacher, gain teacher perspective, determine progress and outline final days.
- Ask Marcy if she has any questions about the interview

End of Implementation

Talk about and get perspective on the final projects and outcome of the learning module.

- What did you think about the projects and presentations?
- Talk about their projects and your expectations regarding what they produced, the technology they used, etc.

Students

- Did you get what you expected out of the students?
- Would you consider students to be “proficient” by how you perceive the 8th grade technology standards?
- Do you think you met the progress indicators that you would have under normal circumstances?
- Do you think the students have the correct level of skills to get the job done?
- In the last interview, you talked about the students learning how to “think”. Do you notice this thinking being any different than in some of your classes? How?

Teaching

- What has this experience meant for your teaching?
- Describe the work involved in going through this process. What kind of commitments did you have – planning, prep, etc.?
- With the changing standards (such as the NETS) and the concentration on differentiated instruction in your district, it seems instructions such as PBL will need to be adopted or included in instructional approaches. How could we continue training other teachers – what is your take on best practices there?
- Where do you see this approach fitting into the middle school curriculum?
- We’re at the end and, while this was a pilot version of this type of program and teaching, what conclusions can you make?
 - How has this affected your teaching?
 - Have you noticed any overlap in your other classes or teaching responsibilities?
 - In your collegial talk, have you had any responses from other teachers?

Closing Comments and Questions

- What have you learned from this experience?
- What have you seen as some of the limitations?
- Would you like to add anything else, additional comments?
- Are you glad you did it?

Closing

- Thank you for your time, help and cooperation!
- Reminder of final survey and reflective journal.
- Plans to send report of student evaluations.

Appendix N

Journal Outline for Study Participant

Please use this form as a guide to help you complete your journal entry at the conclusion of class. Feel free to add or address additional topics, concerns or questions and use as much or as little space as needed.

What are some of the questions you took or heard from students?

What are some of the questions you asked of students?

How did you model thinking processes?

What role do you feel you played in student learning today?

Describe your perspective on student engagement.

List or describe anything you observed as interesting, peculiar, etc.

Is there anything else you want to add?

Appendix O

Letter Submitted to Expert Reviewers for Review of Module

Instructional Design and Technology

Liesel M. Combs, Ph.D. candidate
 220 War Memorial Hall, 0313
 Blacksburg, Virginia 24061
 540/239-6776
 lcombs@vt.edu

12 January, 2008

Thank you for participating in my research as an *expert reviewer*. In this packet you will find a learning module designed for 8th grade students enrolled in a course designed to teach digital technology skills. It is intended that the module be taught using a problem-based learning approach to instruction and has been designed as such.

You have been identified as an *expert reviewer*, which signifies you have experience and expertise in the areas of problem-based learning and/or teaching. Using these expertise, please review this module carefully and offer as much feedback as you can. Your feedback will be used to revise this module prior to implementation in a classroom.

In this packet you should find all materials needed to do a full review of the module. The first section contains a rubric for evaluation of the module itself. You will use this to guide your review and to record your comments, questions and suggestions. The second section contains the complete set of lesson plans for the 8-day module. Within this section you will find a lesson overview, the problem statement, eight days of teacher plans, supplemental materials and assessment tools.

The implementation phase begins the week of February 4 so I will need the review completed no later than the first part of the week of January 28, in order to allow time for revisions. If this becomes a problem, please contact me and I will advise you further. When you have completed your review, return the materials to me using the pre-addressed and stamped envelope. You are welcome to make a copy to keep for your records, if desired. If, at any time, you have questions or problems, do not hesitate to contact me. My e-mail address and phone number are listed above and I am available throughout the week, during the day and evening.

Again, I thank you for your help and cooperation. Your time and input are invaluable to my research and will definitely contribute to its success.

Sincerely,

Liesel M. Combs

Invent the Future

Appendix P

*Rubric for Evaluation of the PBL Module Submitted to Expert Reviewers***Rubric for
Evaluation of the Problem-Based Learning Module**

This rubric has been developed through careful research on problem-based learning (see citations below). The elements have been identified as essential components to designing and incorporating a successful problem-based learning environment. For review of this module, please consider each element individually and rate the degree to which the module aligns with the criteria of each (4 being closely aligned and 1 being not at all aligned). A space has been provided below each element to allow for more specific reviewer comments. Should you have comments beyond the space provided, please attach as many additional sheets as needed to the back of this rubric.

Following the rubric of elements you will find a few additional questions giving you the opportunity to explore the module in its entirety and offer some additional feedback. Please provide as much feedback as you are able and feel free to direct any questions to me at any time throughout the review process.

PBL Element	4	3	2	1
1. Problem	The problem is ill-structured and open to multiple interpretations; problem represents a real-world scenario with strong relevance to student interests; age-appropriate	The problem is ill-structured with some focus on specific elements; problem represents a real-world scenario with some relevance to student interests; somewhat age-appropriate	The problem is somewhat structured with several focused and defined elements; problem represents a real-world yet unrealistic problem as related to student dynamics (age, location, etc.); not age-appropriate	The problem is well-defined and leads students toward a solution and/or makes suggestions for how to approach; problem is fictional and unrealistic to the student population; not age-appropriate and irrelevant to this age group
Comments:				
2. Learning Objectives	Objectives are stated as knowledge construction including growth over time; can be accomplished through self-directed and group learning activities; students work to select their own goals and use personal interpretations and experiences in developing meaning; can be assessed through projects using rubrics	Objectives are stated as a combination of mastery of skills and knowledge construction; can be accomplished through discovery and self-directed learning activities; requires personal interpretations and experience; can be assessed through performance tests and peer- and self-evaluation	Objectives are stated as a mastery of specific skills that can be accomplished through a mixture of instructional methods (lecture, direct instruction, student exploration, role-playing); require some personal interpretation and experience; can be assessed through a combination of standardized and performance tests	Objectives are stated as mastery of specific skills and can be accomplished through lecture or direct instruction; require no personal interpretations or experiences; can be assessed through standardized tests
Comments:				

PBL Element	4	3	2	1
3. Role of Student	Students are active participants in developing personal and group learning goals; work to investigate the problem and seek a solution through collaboration with other group members; actively construct their own information through identifying and using resources to help develop and present a solution; evaluate self and peers; monitor learning and ask questions of self and others	Students are active participants in developing learning goals; work to identify a problem and collaborate with other students; actively construct their own information while using resources and information defined and/or delivered by the instructor; monitor learning and uses prompts from the instructor to question learning	Students are semi-active participants in learning activities and primarily receive information from instructor; goals are pre-defined and require some collaboration for seeking solutions; uses resources and information directly delivered by the instructor; remains focused on teacher activity and goals	Students are passive in learning activities and are receivers of information; goals are pre-defined and require individual work for seeking solutions; uses resources and information directly delivered by the instructor
Comments:				
4. Role of Instructor	Instructor maintains a role of facilitator throughout learning activities and is prompted to model questioning to help students in their self-questioning activities; guides students to help them develop learning goals and construct knowledge; collaborates with students and offers assistance when needed; develops a realistic method of presenting the problem	Instructor provides minimal instruction of content and primarily serves as a resource for students; models questioning strategies; guides students in their collaborative attempts; helps students outline learning goals and strategy; directly presents the problem to students	Instructor provides some instruction of content but encourages both independent and collaborative activity; presents the problem and leads students to knowledge through questions and outlines goals and strategies	Instructor provides knowledge to students through direct delivery; sets the learning environments and guides students through practice activities and corrects students as needed; presents small problems and demonstrate problem-solving process; leads students to knowledge through direct questioning on discrete skills
Comments:				

PBL Element	4	3	2	1
5. Activities	Designed for active student involvement and include guidance for encouraging student self-questioning and monitoring; encourage group collaboration and can be uniquely defined by individual students	Designed for some active student involvement with some content being delivered directly; includes group-work and hands-on activities	Designed for a mix of active and passive student involvement with much of the content being delivered directly; primarily includes individual work with some hands-on activities; minimal group-work	Designed for mostly passive student involvement with most of the content being delivered directly; primarily includes individual work with activities that require memorization and/or drill-and-practice
Comments:				
6. Collaboration	Students primarily collaborate with peers; goals are agreed-upon and set by all members of the group; students use class time to work with groups to attain goals; all students participate equally; roles assigned by group members	Students collaborate with peers and work toward goals set as defined by the problem; students use class time to participate in group activities with some time used for individual work; all students participate equally; roles may be assigned by the instructor	Students have some collaboration with peers but primarily engage in individual activities; some class time is used for group discussion together with whole-class discussion and individual tasks	Students primarily work independently on individual, yet standardized tasks
Comments:				
7. Interdisciplinary	Problem requires investigation into and activity within multiple disciplines	Problem references several disciplines but most of the work is done within one discipline	Problem is mostly centered on one discipline but may use reference to others	Problem is strictly focused on one discipline with little to no tie-in with other disciplines
Comments:				

PBL Element	4	3	2	1
8. Reflection	Students are required and guided to participate in reflection on involvement with the problem and within their group; students also reflect on group processes and peer roles; reflection is combined with other forms of evaluation	Students are minimally guided to reflect on their personal learning and participation in activities; reflection on overall group processes and peers is not included; reflection is combined with other forms of evaluation	Students are not required to individually reflect on learning, activities and group processes; teacher can guide reflection through a whole-group discussion	Students are not asked to reflect on their learning and/or participation; no peer evaluation is included
Comments:				
9. Assessment	Use of rubrics for projects, portfolios, presentations; peer and self evaluation; can be different for individual students depending on learning goals and skill level; measures growth over time and achievement of goals	Use of performance-based assessment on group projects and/or product; mixed with skill-based assessment such as a standardized, written tests; accommodations can be made for students of differing ability levels; measures growth with some emphasis on discrete skills	Use of primarily skills-based assessment such as standardized, written tests; can include some performance-based on individual hands-on projects and activities; measures discrete skills; can be modified for students of differing ability levels	Use of skills-based assessment such as those that are norm- or criterion-referenced; standardized for all students; can be modified for students of differing ability levels but measured content remains the same
Comments:				

Appendix Q

Preliminary Survey for Study Participant

Preliminary Survey

Thank you for agreeing to participate in this research study. Your participation and contributions are extremely valuable and your time is very much appreciated. The attached survey will provide some information that will be used in addition to the data gathered during classroom observations and interviews. The responses will be used as part of the final analysis of data and will add dimension to the results of this research study.

The survey is divided into three parts. The first part asks some general information about your position in being part of the Work Skills I course. The second part will ask more specific questions about the instructional design of the course. The third part contains a few demographic items along with a couple open-ended questions giving you the opportunity to share information about your teaching style and position in regards to the Work Skills I course. Please take about 10-15 minutes to complete this survey.

As you answer the questions, please remember your identity will not be attached to any written portion of this research. The researcher will maintain your confidentiality through measures outlined on the consent form you previously received. If, at any time, you feel uncomfortable with answering these questions, please contact the researcher. The researcher will collect your answers at the initial meeting on ***Tuesday, February 5.***

Thank you again for your time!

Part I

For items 1-10, use the scale of 1-4 to decide how strongly you agree with each statement.

1= strongly agree

2= agree

3= disagree

4= strongly disagree

- _____ **1.** I enjoy teaching the Work Skills I.
- _____ **2.** I like the design of the Work Skills I course.
- _____ **3.** I am actively involved in the design of the Work Skills I course.
- _____ **4.** The Work Skills I course should be required for *all* students.
- _____ **5.** The Work Skills I course is necessary for student success in school.
- _____ **6.** Students are interested in the learning in the Work Skills I course.
- _____ **7.** Students are actively engaged in their learning in the Work Skills I course.
- _____ **8.** Students seem to enjoy the Work Skills I course.
- _____ **9.** Students are successful in the Work Skills I course.
- _____ **10.** I think technology skills are necessary for student success in school.

Part II

For items 11-16, use a scale of 1 to 5 to rate your current position on each of the questions.

11. In understanding there are several teachers who teach the same course, how active are you in the design of the activities and materials for the Work Skills I course?

1	2	3	4	5
Inactive		Somewhat active		Very active

12. How comfortable are you in teaching the Work Skills I course as it is currently designed?

1	2	3	4	5
Not comfortable		Somewhat comfortable		Very comfortable

13. In your opinion, how successful is the Work Skills I course, as it is currently designed, in facilitating the learning of digital technology with your students?

1	2	3	4	5
Not successful		Somewhat successful		Very successful

14. What is your current knowledge level of problem-based learning as an approach to classroom teaching?

1	2	3	4	5
No knowledge		Some knowledge		Very knowledgeable

15. What is your current level of experience teaching through using a problem-based learning approach?

1	2	3	4	5
No experience		Some experience		Extensive experience

16. After meeting with the researcher several times to discuss plans for the course, how comfortable are you with using the problem-based learning approach to teach a portion of this course?

1	2	3	4	5
Not comfortable		Somewhat comfortable		Very comfortable

Part III

For items 17-21, answer each question to the best of your knowledge and ability. Please feel free to attach additional sheets if needed.

17. How many hours per week do you spend, on average, preparing for the Work Skills I course? _____

18. For how many years have you been teaching the Work Skills I course? _____

19. For how many years have you been teaching in general (Work Skills or other subjects)?

20. Please provide a short description of your main approaches to teaching and learning activities you incorporate in the Work Skills I course.

21. What, if any, changes do you think should be made to the design of the Work Skills I course?

Appendix R

Post Survey for Study Participant

Post Survey

Thank you for agreeing to participate in this research study. Your participation and contributions have been extremely valuable and your time is very much appreciated. This survey will provide some information that will be used in addition to the data gathered during classroom observations and interviews. The responses will be used as part of the final analysis of data and will add dimension to the results of this research study.

The survey will appear similar to the one you completed prior to the implementation of the learning module; some of your answers may change and some remain the same. The survey is divided into three parts. The first part contains several items asking your position on teaching the Work Skills course should you adopt a problem-based learning approach. The second part contains items more focused on your comfort and experience in teaching through a problem-based learning approach. The third section contains items asking information about some proposed changes to teaching style and learning activities. Please take about 10-15 minutes to complete this survey.

As you answer the questions, please remember your identity will not be attached to any written portion of this research. The researcher will maintain your confidentiality through measures outlined on the consent form you previously received. If, at any time, you feel uncomfortable with answering these questions, please contact the researcher. Please complete this survey no later than Saturday, March 1, 2008.

Thank you again for your time!

* Note: this survey was distributed through an online survey tool rather than in person, so the format is slightly different.

Part I:

For items 1-8, consider your experience in this research study and with the problem-based learning approach to your teaching. If the course were redesigned based on the problem-based learning approach, decide how strongly you would agree with each statement by checking one box.

- 1.) I would enjoy teaching the Work Skills I course.
 Strongly agree
 Agree
 Disagree
 Strongly disagree

- 2.) I would like the design of the Work Skills I course.
 Strongly agree
 Agree
 Disagree
 Strongly disagree

- 3.) I would be actively involved in the design of the Work Skills I course.
 Strongly agree
 Agree
 Disagree
 Strongly disagree

- 4.) Students would be interested in the learning in the Work Skills I course.
 Strongly agree
 Agree
 Disagree
 Strongly disagree

- 5.) Students would be actively engaged in their learning in the Work Skills I course.
 Strongly agree
 Agree
 Disagree
 Strongly disagree

- 6.) Students would enjoy the Work Skills I course.
 Strongly agree
 Agree
 Disagree
 Strongly disagree

- 7.) Students would be successful in the Work Skills I course.
 Strongly agree
 Agree

- Disagree
- Strongly disagree

8.) The technology skills the students would gain are necessary for student success in school.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

Is there anything you would like to add or comment on items 1 through 8?

Part II:

For items 9-13, use the scale of 1 to 5 to rate your position on each of the questions, should the Work Skills I course be redesigned using a problem-based learning approach.

9.) In understanding there are several teachers who teach the same course, how active would you be in the design of activities and materials for the Work Skills I course?

1	2	3	4	5
Inactive		Somewhat active		Very active

10.) How comfortable would you be teaching the Work Skills I course?

1	2	3	4	5
Not comfortable		Somewhat comfortable		Very comfortable

11.) In your opinion, how successful would the Work Skills I course be in facilitating the learning of digital technology skills with your students?

1	2	3	4	5
Not successful		Somewhat successful		Very successful

12.) What is your current knowledge level of problem-based learning as an approach to classroom teaching?

1	2	3	4	5
No knowledge		Some knowledge		Very knowledgeable

13.) How comfortable would you be modeling this approach to teaching to other faculty members?

1	2	3	4	5
Not comfortable		Somewhat comfortable		Very comfortable

Is there anything you would like to add or comment on items 9 through 13?

Part III:

For questions 14 and 15, please provide your reflections following this experience.

14.) Please provide a short description of changes, if any, you plan to make to your main approaches to teaching and learning activities you incorporate in the Work Skills I course.

15.) What, if any, changes do you think should be made to the design of the Work Skills I course?

Appendix S

Comments from Expert Reviewers on Revision of PBL Module

The items listed below are comments taken from the feedback received during the expert review process from the two expert reviewers and the study participant, Marcy. The comments are taken directly from reviewer comments when indicated by quotations, otherwise have been paraphrased.

Comments from Expert Reviewer 1:

1. “My one over-arching comment is that this feels a lot more like project-based learning...”
2. “I think this problem is perhaps too ill-structured...”
3. “With some tweaks, the process used [for the role of the student] within the first few days is a good exemplar. It desperately needs to be repeated for the portions that cover the actual learning goals.”
4. “I don’t think there’s enough [collaboration] built into the scoring and the process to encourage collaboration. Right now they’re told to complete the tasks in groups – but not encouraged to do so.”
5. “The self and peer evaluation is a step in the right direction but this is generally an open process facilitated by the tutor. Keep in mind that this [reflection] is usually done in small groups and constitutes one of several things that may not be tenable for PBL with this age group.”
6. “The teacher role here should also include meta-cognitive elements.”
7. “How big are these groups? Barrows talked about 5-9 per group (1996).”

8. “The goal of PBL is to learn in the context of solving a problem. Some of your primary learning goals are about using Word and Excel – but for those you have the most directed portions of the instruction (at least I assume they are directed...)”
9. “Personally, I think you need to get away from the idea of a deliverable. This does sound far more like project-based learning...have a debrief session in which potential discussions are discussed and critiqued, and you trace back to the information source or sources that informed the solutions.”
10. “Finally, engage them in the same process for the letter and the spreadsheet that they went through for the central problem. Have them look at the very real and very authentic criteria for developing these documents...if this is the content you care about the most – that should be part of your debrief at the end as well.”

Comments from Expert Reviewer 2:

1. “The problem seems a little overly constrained. Lots more control could be given to students.”
2. In regards to learning objectives and items mentioned in the rubric, the reviewer pointed out there is not enough opportunity for students to select their own goals and use personal interpretations and experiences in developing meaning.
3. The role of the instructor is rated a 2, in which the instructor presents the problem and leads students to knowledge through questions and outlines goals and strategies. There is not enough of the instructor taking on the role of the facilitator.
4. The module “should/could be more collaboration potential with stakeholders – without this it removes it from the real-world context.”

5. “Could consider having daily de-briefings...what did you learn today, what will you work on tomorrow, etc.?”
6. Assessments don’t really measure growth rather more emphasis is on discrete skills.
7. “Seems like the problem could be more open-ended. Ideas for what to pursue are mostly directed by the teacher. To get buy-in from the start, I suggest involving the kids in some brainstorming (whole group) about potential issues, solutions, etc. This might generate some interest and enthusiasm. I also suggest bringing in someone from the Animal Shelter – either at beginning or end.”
8. “It has many of the basic elements [of PBL] yet could do more to really utilize these elements. A little too much teacher control, not enough student control. Some aspects seem unrealistic...the most authentic aspect, in my opinion, is the campaign to address the issues. Here’s where the students can get creative and can focus on different solutions. I almost think the campaign should be central to the unit.”
9. “Most of the unit focuses on analyzing the givens (what it costs to board, care for animals)” instead of having students use the technologies to solve a problem.
10. “So the goal is to think of ways to care for the overflow of animals? Not much time is spent on this until the final activity.”
11. “Shouldn’t students be the ones to suggest the use of other websites as a way to gather more info? There may be other ways to gather additional info as well – phone calls, newspapers, etc., guest speakers.”
12. “Should this [peer- and self-evaluation] occur more frequently perhaps – by the end of the project, there is no way to make adjustments or provide useful formative feedback.”

Comments from Marcy:

1. “The problem is structured. It is age appropriate; students know what a shelter is, what it takes to operate and could make suggestions on how to solve the problem at the shelter.”
2. “One objective is to have an artifact (Excel spreadsheet) to present to the director of the shelter showing information regarding the cost of running the shelter. I don’t know where this is developed.”
3. “The project is structured so that students investigate the overcrowding problem and are active participants in developing learning goals and solutions to the problem.”
4. “I believe that there are more activities than is doable in the 8-day period.”
5. “Day 2 requires students to work in pairs to do their research. Groups are reconfigured on Day 5 to groups of four. This would change the group dynamics and roles that were previously assigned to each other.”
6. “The biggest restriction that the school has is the filters to the Internet. This has been addressed and the sites have been opened for this particular project.”
7. “The major problem I see is that the students will solve the problem with the least amount of effort. For example, students might suggest that animals over a certain age be euthanized.”

Appendix T

Module Revisions as Based on an Analysis and Compilation of Reviewer Comments

Reviewer Feedback	Reflection in Revised Module
The module reflects more of a project-based approach. Some of the learning goals are about specific objectives. The problem could be more open-ended with less direction from the teacher.	<ul style="list-style-type: none"> • Several of the <i>deliverables</i> were removed, such as the <i>Word</i> letter and the <i>Excel</i> spreadsheet. • The rubrics for the deliverables were removed.
The module needs to include <i>debriefing</i> opportunities for the student groups and the whole class.	<ul style="list-style-type: none"> • The revised instructions contained prompts for the teacher to stimulate student reflection at the end of several class sessions. • Self- and group-evaluations were added for <i>each</i> day of implementation. • Reflection prompts were added to encourage teacher debriefing.
Student groups should contain 5-9 students each and remain consistent throughout the unit.	<ul style="list-style-type: none"> • Student groups were formed on Day 1 and remained the same for the eight days. • Student groups consisted of 4-5 students; determined as the best approach through conversation with the study participant.
The module does not include enough student collaboration, the students are not encouraged to collaborate and collaboration is not measured.	<ul style="list-style-type: none"> • Student groups were made an elemental part of the module by initiating on Day 1 and continuing through the end of the module. • Group-evaluations were included for each day of implementation. • Peer-evaluation was stressed for the end of the module.

Reviewer Feedback	Reflection in Revised Module
The teacher role should include metacognitive components.	<ul style="list-style-type: none"> • The teacher was prompted to complete a journal after each day of implementation with prompts to encourage reflection on metacognition and the thinking process. • For the final journal, the teacher received an evaluation of self and evaluation of student engagement that included metacognitive components.
Provide prompts and guides to help with brainstorming activities.	<ul style="list-style-type: none"> • On the first day of implementation, a KWL chart was added and provided to each group of students. • On the second day of implementation, a group planning chart was added and given to each group of students.
Students are given too many resources and should seek them on their own (i.e. they should determine what elements of the Internet to use, what websites to consult, etc.).	<ul style="list-style-type: none"> • Access to the portal containing websites was removed. • Prompts to find information were removed and the teacher was prompted to ask questions about what information they would find and how.
The students should have more control.	<ul style="list-style-type: none"> • Students were encouraged from Day 1 to develop their own goals and identify the needed resources. • The discrete assignments (Word and Excel) were removed and control over which programs to use was given to the students.
The module should/could have more collaboration with stakeholders.	<ul style="list-style-type: none"> • At the end of the implementation, a representative from the animal shelter came to view and judge student presentations. While this was added after the fact, it was in consideration from Day 1.
There is not enough of the instructor taking on the role of the facilitator.	<ul style="list-style-type: none"> • Prompts were added and emphasized in the module to encourage questioning of student thinking and reasoning. • The teacher was provided with sample scenarios to help model thinking and the problem-solving process.