2009-03-23

The Design of a Blended Approach for Teaching the TPCK Framework in a Technology Integrated Course

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THE DESIGN OF A BLENDED APPROACH FOR TEACHING THE TPCK FRAMEWORK IN A TECHNOLOGY INTEGRATION COURSE

by

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A development project submitted to the faculty of

Brigham Young University

in partial fulfillment of the requirements for the degree of

Master of Science

Department of Instructional Psychology and Technology

Brigham Young University

April 2009

BRIGHAM YOUNG UNIVERSITY

GRADUATE COMMITTEE APPROVAL

of a thesis submitted by

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As chair of the candidate's graduate committee, I have read the thesis of Andrea Velasquez in its final form and have found that (1) its format, citations, and bibliographical style are consistent and acceptable and fulfill university and department style requirements; (2) its illustrative materials including figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the university library.

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ABSTRACT

This report describes the design, development, implementation, and evaluation of a web-based unit that was designed to enable blended learning in a course for pre-service teachers learning about technology integration. The unit aims to teach students about the TPCK (Technological Pedagogical Content Knowledge) framework and how to incorporate it in their teaching designs to make their instruction more effective. The report describes the process of design and development using the rapid prototyping technique. The evaluation section describes the results of the implementation of the design. Finally, the conclusion provides a critique of the project's strengths and weaknesses.

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CHAPTER I: INTRODUCTION

The Instructional Psychology and Technology department at BYU provides a course, IPT 286/287, for students in the McKay School of Education who are preparing to graduate with a teaching certificate. The course focuses on helping the pre-service teachers learn how to effectively integrate technology into their teaching.

Recently a theoretical framework for understanding technology integration was developed by Mishra and Koehler (AACTE Committee on Innovation, 2008, pp. 12-13). This framework is called Technological Pedagogical Content Knowledge (TPCK). The faculty member in charge of curriculum development for the IPT286/287 course wanted to use this framework for teaching students about technology integration and he requested that some instruction be created that could be used with all of the IPT286/287 courses.

Students who need the training offered by this course, come from over a dozen different teaching majors across campus. Additionally students enter the course with a wide range of technology experiences and skill levels. The current format of the course involves sections that are capped at an enrollment of 50 students and taught in a traditional approach, in other words, a face-to-face style in which the course instructor is responsible to teach the students in a classroom setting.

Challenges

Two of the main challenges that are faced in creating instruction for this class are trying to deal with the challenge of pacing for students who come in with varying skills and abilities, and trying to individualize instruction to a wide range of student content needs (dance, science, elementary education, language arts, performing arts, etc.). Providing proper pacing and individualized learning opportunities to fit each subject

specifically has proven to be a challenge with such a broad spectrum of incoming students.

These two challenges make it difficult to tailor a face-to-face class session that fits everyone's needs. Below is a student evaluation for Winter Semester 2007 of this course that likely came from a more advanced student who felt the pacing was too slow:

> … It seemed like a lot of class time was wasted that we didn't actually have to be there, but I'm not sure of any suggestions on how to fix it.
>
> … students should have a stronger motivation for coming to class because most of the time, I didn't feel like it was very valuable to be in class. I think the pacing needs to be quickened and the class time should be worth the students' time.

While some students, like the one quoted above feel that the pacing of the class is too slow and the content not challenging enough, others feel happy with the course. Another student said,

> The pacing was great and I like that it was an hour a day for the entire semester rather than two hours for half a semester. Keep it how it is. I liked the projects and class materials. They really will be useful and I've actually used them as soon as we learned them. It was a good class.

Yet, other students continue to feel overwhelmed by the pace of the course and the amount of material covered. This student commented by saying,

> Many people in this class have little knowledge of computer navigating skills which were never taught. The ground floor basics were skipped over so I did projects for the class but I have no idea or understanding of the concepts.

This development project will attempt to develop instruction for the most

important unit of the IPT286/287 course, the Technology Integration Unit, in a way that will effectively address the issues of pacing and individualizing instruction to the content-specific needs of the students.

Redesigning the Technology for Pre-service Teachers Course

In defining design problems, Cross (1982) stated that, "…They are therefore not susceptible to exhaustive analysis, and there can never be a guarantee that 'correct' solutions can be found for them" (p. 224). There are many possible solutions to this problem, some of which could involve redesigning the structure of the course or creating additional tools and resources that could be used in conjunction with the instruction already being offered.

Some of the ways this course could be restructured to fix the pacing needs for students is by encouraging the instructors of the course to become facilitators more than authoritative lecturers in the class, subsequently allowing more student interaction and flexibility. Another possible solution could include allowing students to finish their projects at their own pace from beginning to end of the program. Instructors could do this by giving students resources to refer to when trying to learn a technology and by being more readily available to students when they have problems or questions.

Additionally, there are ways that this course could be changed to best meet content needs of each pre-service teacher. The wide range of content needs can be better met by making each section of IPT 287 subject-specific so that the instructors can teach technologies with particular affordances matched to the pedagogies utilized within that subject area. We can also do an analysis of some of the most used pedagogies in each subject area so the instructors are familiar with these pedagogies. Instructors could also

be better informed about the general content taught within each subject area for which they teach technology applications.

In consultation with the faculty of the course, it was decided that providing online instruction that could be supplemented with face-to-face instruction would provide the flexibility that could address the pacing issue. This kind of instruction that combines face-to-face and online instruction is called blended learning (Graham, 2007). Additionally, it was determined that the design of content-specific challenges with supporting examples would be a good way to individualize the instruction to learner needs.

CHAPTER II: LITERATURE REVIEW

The problem posed is a design problem that requires a design solution. In other words, there is no right or wrong solution to this problem. There are many ways that this problem may be solved, but some may be more comprehensive than others. "It is also now widely recognized that design problems are ill-defined, ill-structured, or 'wicked'… (Rittel & Webber, 1973, pp. 160-161) What designers tend to do therefore is to seek, or impose, a 'primary generator' which both defines the limits of the problem and suggests the nature of its possible solution" (Cross, 1982, p. 224). It is the job of the designer in this case to study the problem, understand the limitations and criteria, and propose possible solutions.

Technological Pedagogical Content Knowledge as a Framework for Effective Technology Integration

Teaching requires the teacher to work as an autonomous agent making decisions to fit each unique situation that arises. Adding technology to this domain makes things even more complicated. Technological pedagogical content knowledge (TPCK) is a framework that offers an explanation on how instructors can better approach teaching more effectively using technology. The TPCK framework (see Figure 1) provides theory-based ideas for how to integrate technological tools and pedagogical strategies to specific content domains. It essentially states that content, pedagogy, and technology are interdependent. In other words, the content and design of the technology integration unit will revolve around TPCK with the purpose of teaching our pre-service teachers how to create an equilibrium between content, pedagogy, and technology in their teaching, allowing them to create instruction that best meets the needs of their students.

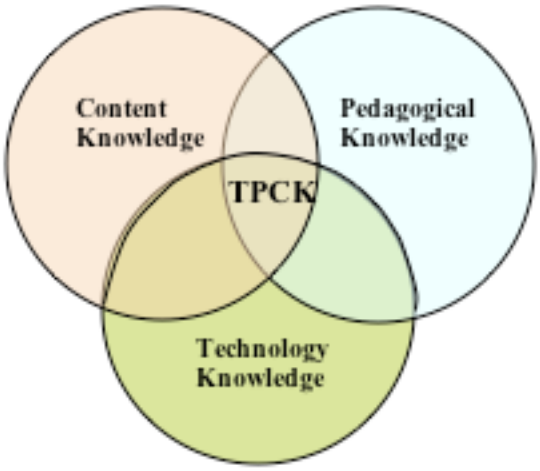

Figure 1. Technological Pedagogical Content Knowledge (TPCK) Framework.

It is important for teachers to understand that each technology has affordances and constraints. For example, a chair has the affordance of allowing someone to sit in it. Some of the constraints are that it might be heavy or large and it takes up space. However, there are a number of different ways we can use a chair. The affordances and constraints do not limit us to "repurposing" or finding creative uses for this object. "Thus creative uses of technology require us to go beyond this 'functional fixedness' so that we can innovatively repurpose exiting tools toward pedagogical ends" (AACTE Committee on Innovation, 2008, p. 6).

Teaching with technology is a "wicked problem." According to Mishra and Koehler (2008), a "wicked" problem is one that has "incomplete, contradictory, and changing requirements" (p. 10), and "has complex interdependencies among a large number of contextually bound variables" (p.11). In addition, the problem evolves and provides new criteria and constraints as solutions are considered and implemented. Solutions to these types of problems need to be custom designed (Koehler & Mishra,

2008). This project focuses on helping students understand this problem and design solutions for teaching with technology pertinent to their instructional needs.

Content Knowledge

Content knowledge refers to knowledge of specific subject matter. According to Shulman (1986), this includes "knowledge of concepts, theories, ideas, organizational frameworks, knowledge of evidence and proof, as well as established practices and approaches towards developing such knowledge" (pp. 4-14). In other words, content knowledge refers to knowledge of ideas but also knowledge of how to inquire and develop those ideas.

IPT 286/287 assumes that students have and are acquiring content knowledge in their subject specific classes. The course teaches students to look at the Core Curriculum Standards to recognize the objectives that define the content taught and develop lessons and activities based around that content knowledge.

Pedagogical Knowledge

Pedagogical knowledge refers to methods and practices of teaching. This is a very large area of knowledge that encompasses the areas of "student learning, classroom management, lesson plan development and implementation, and student evaluation" (Harris, Mishra, & Koehler, 2007, p. 6). For example, such a teacher would be knowledgeable about how to write a good lesson plan, how to best reach each student, how to create a good test, etc. A teacher who knows pedagogy understands "cognitive, social and developmental theories of learning and how they apply to students in the classroom" (Harris et al., 2007).

In IPT 286/287 students are encouraged to think about the pedagogies that are

appropriate for the subject matter they will teach. Some general pedagogies can be used with all subject matters, while other more specific pedagogies are relevant only to a specific subject matter.

Technological Knowledge

In the TPCK framework, the term technology refers to "hard technologies" like devices, hardware, software, etc. "Soft technologies" that refer to processes and methods are encompassed by the "Pedagogy" portion of the TPCK framework. Technology is always in a state of change or as Mishra and Koehler would say, "a state of flux" (AACTE Committee on Innovation, 2008, p. 15). Technology knowledge changes more quickly than pedagogy or content knowledge. Technology knowledge involves computer literacy but it also involves a deeper level of knowledge which enables the individual to process, communicate, and solve problems using technology. According to the Committee of Information Technology Literacy of the National Research Council (1999), this technology knowledge is referred to as FITness, or fluency of information technology. Mishra and Koehler (2008) state, "FITness goes beyond traditional notions of computer literacy to require that persons understand information technology broadly enough to apply it productively at work and in their everyday lives, to recognize when information technology can assist or impede the achievement of a goal, and to continually adapt to changes in information technology" (p. 15).

IPT 286/287 strives to teach students more than simply learning how to use technology, but it also teaches students how to apply technology by helping students critically analyze which technologies fit specific goals and how to adapt to changes in technology. IPT 286/287 focuses mainly on learning digital technologies. It is the course

objective to teach students more than just computer literacy, but to also teach students how to integrate technology successfully into their everyday lives, to recognize when it can assist or impede achievement and how to adapt to changes. It is assumed that students coming into the course have previously attained a level of computer literacy and have passed the requirements to be in the teaching program.

TPCK Equilibrium

Although these three elements of instruction are very different, they do not exist independent of each other. Mishra and Koehler (2006) argue that there is a complex interplay between the knowledge of pedagogy, content, and technology. Furthermore, they agree with other scholars by saying "that knowledge about technology cannot be treated as context-free and that good teaching requires an understanding of how technology relates to the pedagogy and content" (p. 1025-1026). Productive integration of technology in teaching only exists if all three of these issues are taken into consideration (Mishra & Koehler, 2006, pp. 1025-1026).

In addition, every teaching situation is unique and requires a different equilibrium between the three bodies of knowledge. For example, every subject matter is taught using different (sometimes similar) pedagogies, which subsequently require the use of different technologies. Expert teachers know how to maintain this equilibrium needed by using that experience and knowledge to balance all three categories in order to fit the specific needs of their students (Harris et al., 2007, p. 11).

Many who are advocates of TPCK are also advocates of applying the knowledge attained through instruction to real world situations. Some experts call this learning by design, case studies, or authentic problem solving. Lave (1991) called it communities of

practice in which students learn by participating in a meaningful context. There are many examples of technology integration that have been effectively implemented by involving teachers "in authentic problem solving with technology" (Mishra & Koehler, 2006, pp. 1033-1034). Shulman (1992) began the TPCK movement by advocating PCK (Pedagogical Content Knowledge). Besides being a principal advocate for PCK, Shulman is also an advocate for case studies. When asked about case studies he said, "when you use real teaching cases you are always dealing with the particular. The case includes information about the subject matter, the curriculum, the class, the school, and sometimes the community…" (Shulman & Sparks, 1992, p. 14). Mishra and Koehler (2006) call this real world approach "learning by design" and report that "participants find learning by design approaches as being challenging and fun" (p. 148). Learning by design leads to participants learning through dialogue and interaction within their learning community (Mishra & Koehler, 2005, p. 18).

A technological pedagogical content knowledge framework is what we are aiming to teach and achieve through the instruction in this course. This will require that we understand the pedagogy of the various subject specific disciplines and the content that these students are expected to teach in their professional careers. By understanding pedagogies or methods used to teach this content, we can teach the pre-service teachers how to incorporate the technologies that best fit their content and pedagogy. We can do this by presenting them with real world scenarios, case studies, or "learning by design", to allow them to learn through the challenges of the design. For example, the content science teachers will be expected to teach their students, will require that they have knowledge of certain technologies such as science probes like the light sensor probes, or

the sound level meter. They will have to incorporate these probes in their teaching using certain pedagogies (engage in a lab) that fit the technology (science probes) and the content (light or sound).

Blended Learning as an Instructional Strategy

Technological advances have enabled us to blend the lines between traditional face-to-face and computer-mediated instruction. This phenomenon is usually referred to as "blended learning." Although there is some variation in the definition of blended learning, most people will agree that blended learning involves "combining computer mediated instruction and face-to-face instruction" (Graham, 2007, p. 5). According to Graham, Allen, and Ure (2005) there are three main reasons for using a blended learning approach which include a more effective teaching method, an increase in convenience and access, and an increase in cost effectiveness. In this project, the main reason to incorporate a blended learning approach in the redesign of this unit is to increase access and flexibility. Using a blended approach in the course will address the course challenges by allowing for flexible pacing and individualized instruction.

Increasing Access and Flexibility

One of the main conveniences of using a blended learning approach is that it increases access and flexibility. This project will focus on increasing access and flexibility while maintaining a high quality of instruction using the TPCK framework. According to Graham (2007), many learners want the convenience offered by a distributed environment yet do not want to sacrifice the social interaction and human touch they are used to in a face-to-face classroom. This new approach will allow students to retain the benefits of face-to-face instruction with added flexibility of access. Blended

learning allows people to have the "best of both worlds" by allowing some face-to-face interaction while simultaneously allowing for individualized pacing through the use of computer-mediated instruction.

Enabling Blends

A blended instructional approach reduces the level of frustration by allowing more flexibility at many levels. Students will be enabled in their education by being allowed to choose along any point of the continuum (see Figure 2) the amount of face-to-face instruction or online instruction they desire without compromising the quality or methods of instruction.

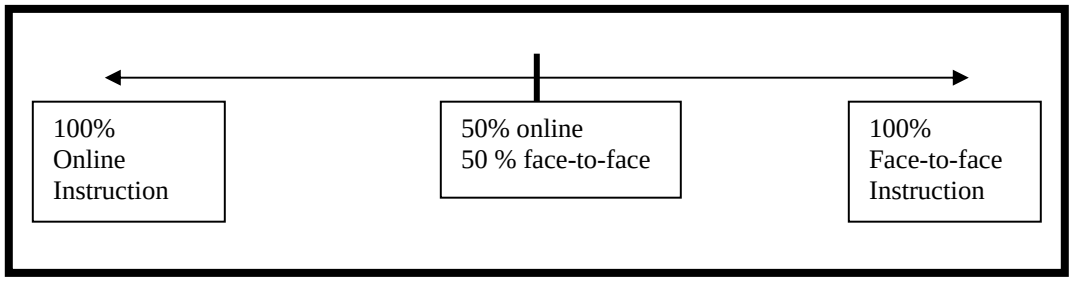

Figure 2. Continuum between online instruction and face-to-face instruction.

This project will consist of designing an enabling blend at a course level. Students will be given the choice of a blend that best fits their needs. The biggest challenge will be helping students choose the right blend.

Desired Outcomes

In other words, the pedagogical strategies used in the class will remain constant and will not be modified, but the flexibility will be increased with the use of an *enabling blend*. In addition, enabling blends address issues of access and convenience providing added flexibility (Graham, 2007). Not only will students have the flexibility of mobility

and time with the online option, in addition, they will be allowed to choose if they would like to learn a part of a unit using only the online materials or attend a face-to-face session in class or both. They will be allowed to select a blend for the course that fits their needs. They have an option of trying the online alternative and then attending a face-to-face session if they decide they need added help.

Students will have flexibility to work at their own pace and adapt the instruction to their own learning needs. Students will learn to think critically about their technology choices as they relate to pedagogy and specific content. Furthermore, this will allow their instruction to be more effective. We anticipate that the enabling blend and the TPCK approach will improve our student ratings and that more students will be able to learn at a distance or in class depending on their preference.

Product Search That Addresses Challenges

A product search is an attempt to find similar products or objects that have been created with the purpose of teaching similar instruction in similar ways. There are many teacher education programs that focus on teaching technology. Many programs have not developed online instruction for their courses. Although some of the instruction can be found online, most of these programs are not designed as a blended learning approach.

Process

Primarily, a general search was conducted which examined various university websites to find their syllabus structure for classes similar to IPT 286/287. In addition, universities and colleges that did have some online instruction were further examined to learn about their website structure, purpose and teaching pedagogy. After examining specific online instruction created for pre-service teachers, specific resources that could

aid students in completing the unit online were also gathered. These came together through website searching, word of mouth and trial and error. Many of the faculty members currently teaching IPT 286/287 helped give ideas as to helpful links and resources that could aid students in integrating technology to teach more effectively.

Findings

The main findings from the product search included resources and tutorials that already exist on the Internet that can be used or accessed from the new site. A summary of the findings can be found in the Table 1, which lists relevant programs and resources. In terms of universities and programs already in existence it was evident that many universities do not have a technology course for pre-service teachers. Many universities teach technology in conjunction with other courses. For those programs which do have such a program, the content found on their sites could be useful but no program had a structure or setup like the one we are aiming to achieve through a blended learning approach incorporating the use of the TPCK framework.

Table 1.

Product Search Finding.

Description	Findings
Universities **without** a technology course for Pre-service teachers	Harvard Stanford
Programs **with** Technology Pre-service Teacher Online Instruction	University of Virginia- http://www.teacherlink.org/content/ University of Wisconsin- http://www.uwstout.edu/soe/profdev/courses.shtml#tech University of Maryland, College Park http://www.wam.umd.edu/~mlhall/teaching.html Georgia Institute of Technology The Family Learning Nook The Busy Teacher's Website
Resources and tutorials found on the Web	UEN.org Apple tutorials and Apple help Google Earth software and help Video Databases- VMDB, Edutopia Audacity Gabcast VoiceThread Inspiration.com Microsoft PhotoStory Blogger Educational Podcasts Media Workshop Stellarium Celestia NASA Google Tools Wikipedia Delicious

CHAPTER III: DESIGN

Context for IPT 286/287 Course

In order to understand the context of the project, it was important to understand the purpose of the course, project criteria, constraints, resources, and the characteristics of the target audience. The following sections provide more detail about these aspects of the project.

Purpose of the Course

The units in the course were designed to help students address the national standards. The goals for this course are related to the International Society for Technology in Education (ISTE) National Educational Technology Standards for Teachers (NETS-T) (http://cnets.iste.org/teachers/t_stands.html). This class helps students become familiar with these standards and begin their journey towards developing the knowledge, skills, and dispositions that these standards require. The technology integration unit focuses on all five of the NETS-T standards, which are:

I. Technology Operations and Concepts

Teachers demonstrate a sound understanding of technology operations and concepts.

II. Planning and Designing Learning Environments and Experiences.

Teachers plan and design effective learning environments and experiences supported by technology.

III. Teaching, Learning and the Curriculum.

Teachers implement curriculum plans. These include methods and strategies for applying technology to maximize student learning.

IV. Assessment and Evaluation.

Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies.

V. Productivity and Professional Practice.

Teachers use technology to enhance their productivity and professional practice.

VI. Social, Ethical, Legal and Human Issues.

Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in PK-12 schools and apply those principles in practice.

Table 2 shows how the current course structure complies to the NETS-T standards which are operations and concepts, planning and designing learning environments, teaching, learning and the curriculum, assessment and evaluation, productivity and professional practice, and social, ethical, legal and human issues.

The existent class syllabus has been used to group each one of the five units to the standard it belongs to. For example, unit 1 (internet safety) and unit 2 (copyright and fair use) both fall under the ethical issues standard. Unit 3 teaches students how to evaluate digital resources and how to find resources that fit their lessons. Therefore, the standard that best fits this unit is productivity. Unit 4 teaches students how to use Excel to assess students' improvements and learning needs. This unit falls under assessment and evaluation. Unit 5 is the Technology Integration unit. This is the unit this project intends to redesign into a blended learning approach. For elementary education students, this unit entails two final projects that the student must plan, design, and use in teaching concepts to their students. This unit comprises three of the NETS-T standards, which are,

operations and concepts, planning and designing learning environments, and teaching. The purpose of this project is to help students acquire and refine these skills through a blended learning approach.

Project Definition

The following sections explain in more detail the criteria, constraints and resources used to design the website. These sections give the project definition and direction. The criteria for the project help the designer understand the project needs in order to achieve its purpose. The constraints allow the designer to see the boundaries of the design challenge. The resource analysis allows the designer to do an inventory of the resources or tools that are available to help complete the project.

Criteria. There were many specific criteria that this project needed to meet in order to be successful in achieving its purpose. The unit module needed to be flexible, interactive, motivational, informative, challenging, effective and simple. In order to meet these criteria the modules were created to be rich in media with less emphasis on text. We hoped to provide most of the content in form of a movie or audio file accompanied by text. This simplified the design as well as informed students adequately and increased motivation and relevancy.

In terms of flexibility, we expected the course to provide students more flexible options. In addition, we wanted the course to be flexible in design in order to be easily modified and improved. A flexible design is one that is structured so as to accommodate change. The design had to be flexible so as to reach the wide range of audiences, subject matters, grade levels and learning styles. A simple design in which the pages remain as constant as possible and the only thing that changes is the content found therein helped us

Table 2.

Categories of the NETS-T Standards and Class Units Belonging to Each

	Unit 1- Internet safety	**Unit 2-** Copyright /Fair use	**Unit 3-** Finding and Evaluating Digital Resources	**Unit 4-** Technology enabled assessment	**Integration Unit 5 -** this will be different for all audiences.
NETS-T 1 Operations and Concepts					X
NETS-T 2 Planning and Designing					X
NETS-T 3 Teaching					X
NETS-T 4 Assessment and Evaluation				X	
NETS-T 5 Productivity			X		
NETS-T 6 Ethical Issues	X	X			

Note. Unit 5 will be project oriented focused on integrating technology into specific content areas and levels. Students in sections of 286 will have one integration project. Students in 287 will have two integration projects, one of which may be a practicum project. Units 1-4 focus on general skills that are needed for all of the learner audiences.

achieve this flexibility. The database of challenges also allows instructors flexibility in regards to which challenges they decide to have their students complete.

The design must motivate students and show students the relevance of the skills they are acquiring through completing the course. The videos or audio files in the module will be useful in showing students the added value of the technology in their lesson.

The design must be logically structured and organized in a manner that is timely and in sync with the face-to-face course equivalent. This design must be equivalent in time consumption and difficulty to the face-to-face version of the course, which means that it needed to be designed in a way that did not provide students an easy way out of the workload and instruction. For this reason, the unit required a pre-assessment and a post-assessment to determine which students needed the instruction and which students mastered the unit. There needed to be a precise balance on flexibility and constraints to help students make the best choices as to a plan of study that will benefit them the most and provide them with the greatest returns.

Constraints. There are a few constraints that affected the design of this project. One of the constraints on this project was that the course needed to accommodate the schedule in which the class is taught over the course of one semester. Also, the course needed to be completed and ready for use for Winter 2008 semester. There was a schedule to adhere to. Another constraint was that the client was very busy which posed constraints on time. Therefore, meeting times need to be carefully planned and executed to efficiently meet their purpose.

In terms of the constraints the design will place on students, the pre-assessment will be useful in determining whether a student should be allowed to take the online version of the course, or whether a student should be exempt from the course all together. If a student performs well on the pre-assessment, he or she will be eligible for exemption of that specific unit. According to the performance on the pre-assessments, some students might qualify to take the unit completely online. Others might be required to take the entire course in the traditional, face-to-face approach.

Another constraint that must be taken into consideration is that the course syllabus is under construction and improvement this semester. This is a course that is not yet completely developed and established. On the contrary, many new methods and activities were implemented this semester in an attempt to expose students currently taking the course to the new methodology of TPCK. Not only is the content of the course a new convention, but the technologies being taught differ from class to class and even from instructor to instructor. In addition, each instructor has their own methods or strategies of teaching it. In general, this course is evolving under rapid change and it currently exists as each instructor interprets it.

In addition to the course content evolving, the TPCK framework is also evolving. Between the beginning of the project and the termination TPCK became TPACK (Technology Pedagogy And Content Knowledge) (Thompson & Mishra, 2007). In addition, the TPCK framework is not clearly defined and each one of the components is subject to change.

One of the reasons we decided to use challenges as the main pedagogy of the unit is because it enables flexibility from instructor to instructor, subject to subject and grade

level to grade level. The online module provides a database of challenges from which each instructor can choose which challenges to assign students. This approach allows instructors the power of assigning challenges that will target their student's needs, grade level and the content in their respective subject matter.

Resources. There are many resources that aided in the development of this project. One of these resources was the syllabus currently in use in each of the sections being taught during Winter semester 2008. This provided structure and current modifications depending on the audience it was created for. The TPCK framework has been taught one semester before the design was implemented which gave us some data and useful feedback on changes that needed to be made before, during and after the design of the unit module.

In addition, all instructors and TA's currently teaching the course were a useful resource by contributing feedback of strategies and technologies that worked in their teaching and those that did not work so well. Faculty and TA's also provided feedback on the design of the modules. Students were also considered a resource by providing feedback on the current course and on beta versions of the modules throughout the semester.

Other resources include websites found online that have useful tutorials and tools for students to use in order to complete their challenges. The online module links to these other websites that have already been created. This minimized the design workload and will provide students with useful information. Other universities were also a resource by providing us with ideas and information that have already been developed and proven effective.

In addition, the Center for Teaching and Learning at Brigham Young University contributed to the project by allowing members of the CTL team to contribute through helping with details and allowing work on the project during regular work hours.

Characteristics of the Target Audience

The target audience for the instruction will eventually be elementary education, early childhood education, secondary education and secondary education pre-service teacher students at Brigham Young University taking IP&T 286/287. However, this project will aim at testing this new approach with the elementary education target audience, or IPT 287 only, with hopes of expanding the blended learning approach to early childhood, secondary education, and special education audiences in the future. These students will be teaching a variety of subjects and grade levels. Most of the students have not had prior experience using multimedia technologies. On the other hand, some students might be very proficient at some of the technologies.

There are four different audiences for this course. Table 3 lists the four groups to whom this class is offered. Early Childhood, Elementary Education, and Special Education are all enrolled in sections of IPT287 while all secondary education majors enroll in sections of IPT286.

While some of the instructional content is general enough to be applicable to all teaching students, much of the content must be targeted to the specific needs of each group according to section and subject matter. In order to teach this range of content to a variety of age groups, the pedagogies utilized also vary. It is important to understand the content, technology, and the differences in pedagogical needs of each group if the intent is for each group to learn real life solutions to their full capacity from this instruction. A

list of pedagogies that match the strategies used in each subject matter and that are specific to each subject matter were compiled and used in the design of these modules. This project focused on the needs of the elementary education target audience, IPT 287.

Table 3.

Description of Target Audience That Enrolls in the Class

Audience	Description
Early Childhood	Early childhood deals with children from kindergarten to grade three. Their needs differ from elementary age students. The main difference is that reading levels are different. Therefore, strategies used to teach this skill need to be different and tailored to the age group.
Elementary Education	This program prepares teachers to improve the education that elementary school children receive. Teachers must focus on all aspects of the curriculum which include math, science, social studies, language arts, and reading.
Special Education	Special education students are often post baccalaureate students taking classes in order to extend their teaching credentials. Students may choose an emphasis in mild/moderate disabilities or severe/profound disabilities. Both of these levels of impairments are very different. Severe profound students deal with very difficult impairments that severely impair cognitive and life functioning abilities. On the other hand, mild moderate students deal with learning disabilities and behavioral problems.
Secondary Education	Secondary education students come to this class from different departments. These students are preparing for a career teaching at the middle school or high school level. Below is a sample of the wide range of the secondary education majors in the McKay School of Education: Biology Composite Teaching Chemistry Education Dance Education English Teaching Family and Consumer Science Education History Teaching Physical Science Composite Teaching School Health Education Social Science Composite Teaching Spanish Teaching Theatre Arts Education The main subjects that take the class are: Science (more subsections), Language Arts, Social Studies, Performing Arts (more subsections), Health/Family Consumer Science and Language Learning.

Instructional Materials

Project Objectives

This project focused on developing online instructional challenges for one unit of the course, the Technology Integration Unit. As before mentioned, the primary goal of the course is to teach students how to incorporate technology into education by giving them the option to complete the instructional units independently as opposed to doing them in class. Along with meeting the national standards criteria, the online unit was created with the purpose of allowing students more flexibility while preserving the content of the instruction and assessment process. The nature of the instruction consists of assignments and assessments that will be the same for face-to-face and online instruction.

Considering the criteria and objectives for the redesign of the instruction, the tasks students will need to complete to receive credit for the unit, were designed as self contained challenges. During the completion of each challenge, students will be allowed to choose whether they do a face-to-face instruction, online instruction or both. The challenges will allow students to do some instruction online and some face-to-face. It will also allow students to vary their mode of learning from challenge to challenge or even from step to step in completing each challenge depending on their learning needs.

The modules will focus on mastery oriented learning, therefore, we included a pre-assessment as part of the course to tell what knowledge level students enter the course with. Before beginning any instruction or any tasks, students will be encouraged to complete a pre-assessment survey that will assess their level of technology knowledge coming into the course. Students will also be required to take a post assessment upon

completing the assignments for the unit. The post assessment will allow the course instructors to measure learning progress. Each unit will follow a sequence similar to the one shown in Figure 3.

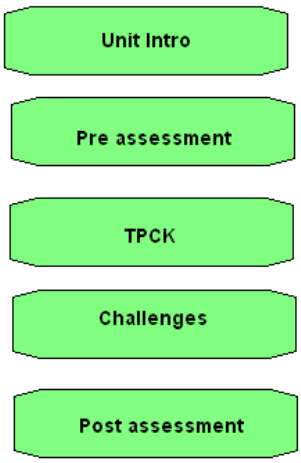

Figure 3. Main parts and sequence for the unit in the redesign of the course.

Challenges

This instructional project consists of breaking down the Technology Integration Unit in the existent syllabus into sections that can be developed into online challenges or scenarios. Instructions and interactive activities to evaluate if students are really learning were also added to these challenges. This facilitated communication and learning in the unit module.

Each challenge was designed to target a specific subject and present a specific TPCK scenario to fit that subject's content needs, technological tools and pedagogical practices. The purpose of the challenges is to allow pre-service teachers to learn by design in a real world context. In order to do this, the pre-service teacher becomes a designer in using educational technologies. The TPCK framework is a tool that the

teacher can use as a guideline to create an effective design. Therefore, it will be important that students understand the concept of TPCK before they begin completing the challenges. By completing each challenge, pre-service teachers will have to think critically and design a lesson based on TPCK. In the process, they will become more cognizant of the technology, content, and pedagogy used for teaching that instruction.

The current project consists of five challenges for Elementary Education Pre-Service teachers. Eventually, as the database of challenges grows to include other sections of IPT, each subject matter will have different challenges, but all challenges will aim at achieving the same purpose, to teach pre-service teachers technology and how to use it effectively in their teaching. For example, science students will be presented with a challenge that will teach science probes and how to integrate them into their teaching using the TPCK framework. On the other hand, social studies and history teaching students will get a challenge that teaches them Google Earth and how they can integrate that technology into their teaching using the TPCK framework. Therefore, although the challenges vary from subject to subject, the objective of teaching technology integration is constant across subject matters and the integration of the TPCK framework will also be constant in the design and completion of the challenges.

Design Process and Summary

In preparation for design, a front end analysis was conducted to clarify the context, tasks and the nature of the target population. The analysis consisted of a current resource training analysis, target population analysis, and task analysis. These analyses allowed us to create a unit model with the basic components of the design that best fit the

constraints, the criteria, the environment and the target population. (See Appendix A for current resource training analysis, target population analysis and task analysis).

After conducting a front end analysis of the design challenge, rapid prototyping design took place. The rapid prototyping stage was done in conjunction with the client, in this case the instructor of the course, to evaluate design decisions as they were made. The initial design became the initial prototype for subsequent iterations of improved designs. Rapid prototyping still makes use of analysis, design, development, implementation and evaluation. However, the steps are done consistently after each prototype to reduce the time needed to create a final product. For example, the design, development and formative evaluation are all done consistently throughout each phase of the prototype development. In addition, the prototype designs began as low fidelity prototype, or a very simple prototype that would evolve into a higher fidelity prototype as the design developed into the final product. According to Jones and Richey (2000), using rapid prototyping "should reduce production time because: (a) using working models of the final product early in a project tends to eliminate time-consuming revisions later on, and (b) design tasks are completed concurrently, rather than sequentially throughout the project" (¶ 2).

Development

Many versions of the design were created throughout this process. Using the rapid prototyping methodology, after each version of the design prototype was completed, an evaluation took place in which necessary changes for the next iteration were defined. In general there were three Phases to this process before arriving at the

final design. Many features in each design phase were modified from one prototype to the next.

Phase one. Phase one consists of the earliest prototypes that were designed for this project. Figure 4 depicts a screen that would allow the students to choose the challenge they would like to work on from a variety of options. A strong visual component was one of the criteria decided upon early in the development of the design phase. The reason for a strong visual quality to the site was to make navigation intuitive and less confusing.

As shown in Figure 5, the challenges were designed to be completed by following a sequence of steps that would guide the student and provide all the resources and instruction necessary to complete the challenge. During the analysis phase of the project, it was apparent that the following steps would be necessary to complete each challenge: Introduction, Examples, Tools, and Conclusion. It would also be necessary to portray the TPCK framework visually to remind students of the importance of designing their instruction based on that framework. Therefore, the challenges all have a similar structure and emphasize the TPCK framework. All challenges are specific to a content domain but general components, such as structure and sequence stay consistent from challenge to challenge.

In order to reinforce the TPCK framework in the design, a description and visual of the framework would be constantly present at the bottom of the screen regardless of the content displayed in the main window. The left hand navigation would also be constantly present throughout the site to provide students with a user-friendly navigation and to reduce confusion or frustration when navigating from challenge to challenge.

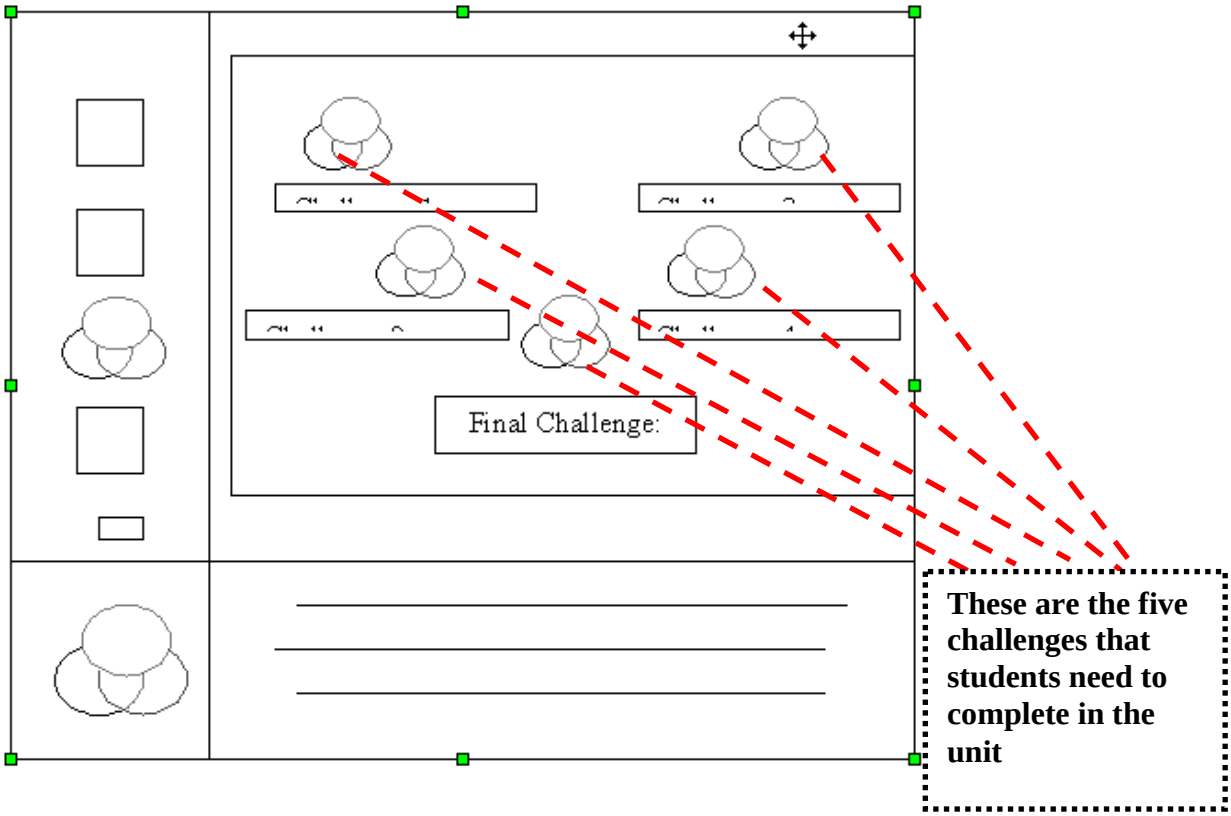

Figure 4. Initial prototype that shows all the challenges from which students can select.

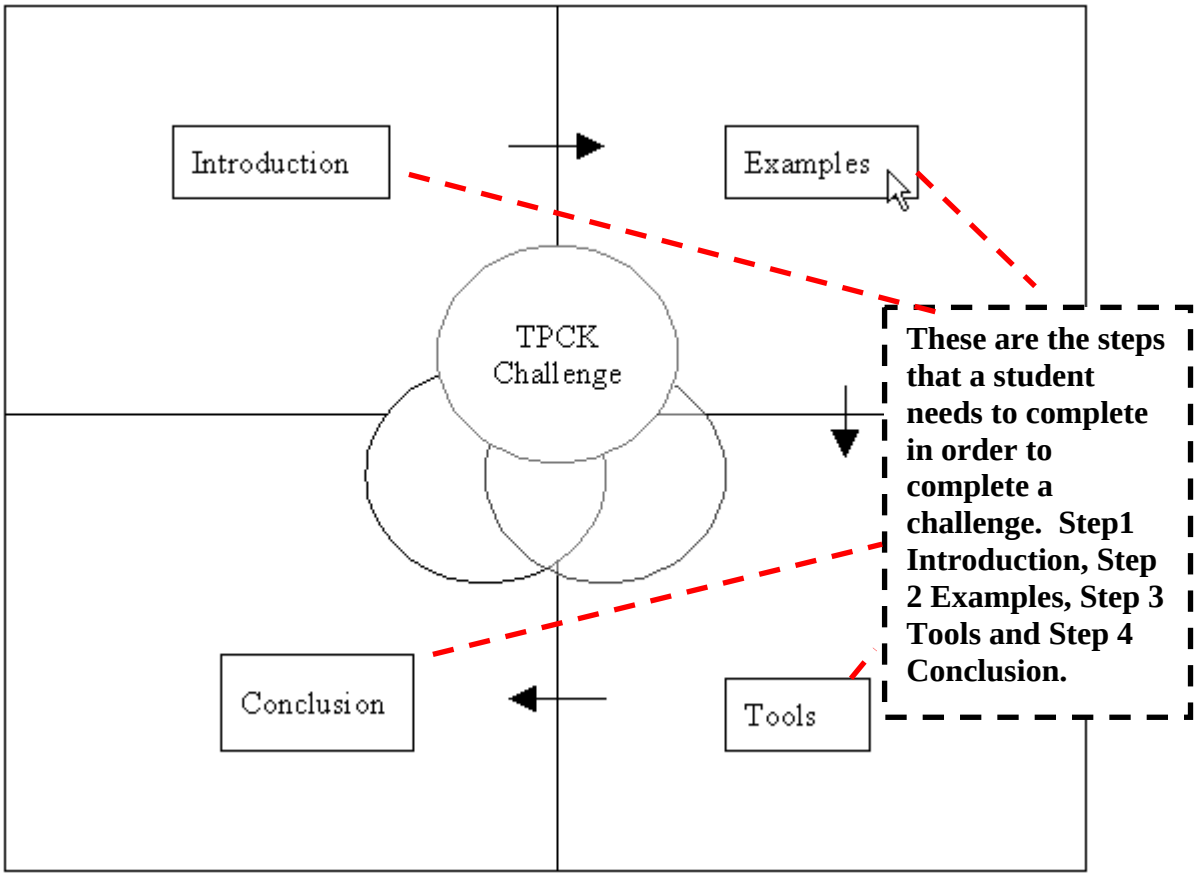

Figure 5. Prototype depicting a possible sequence for one challenge

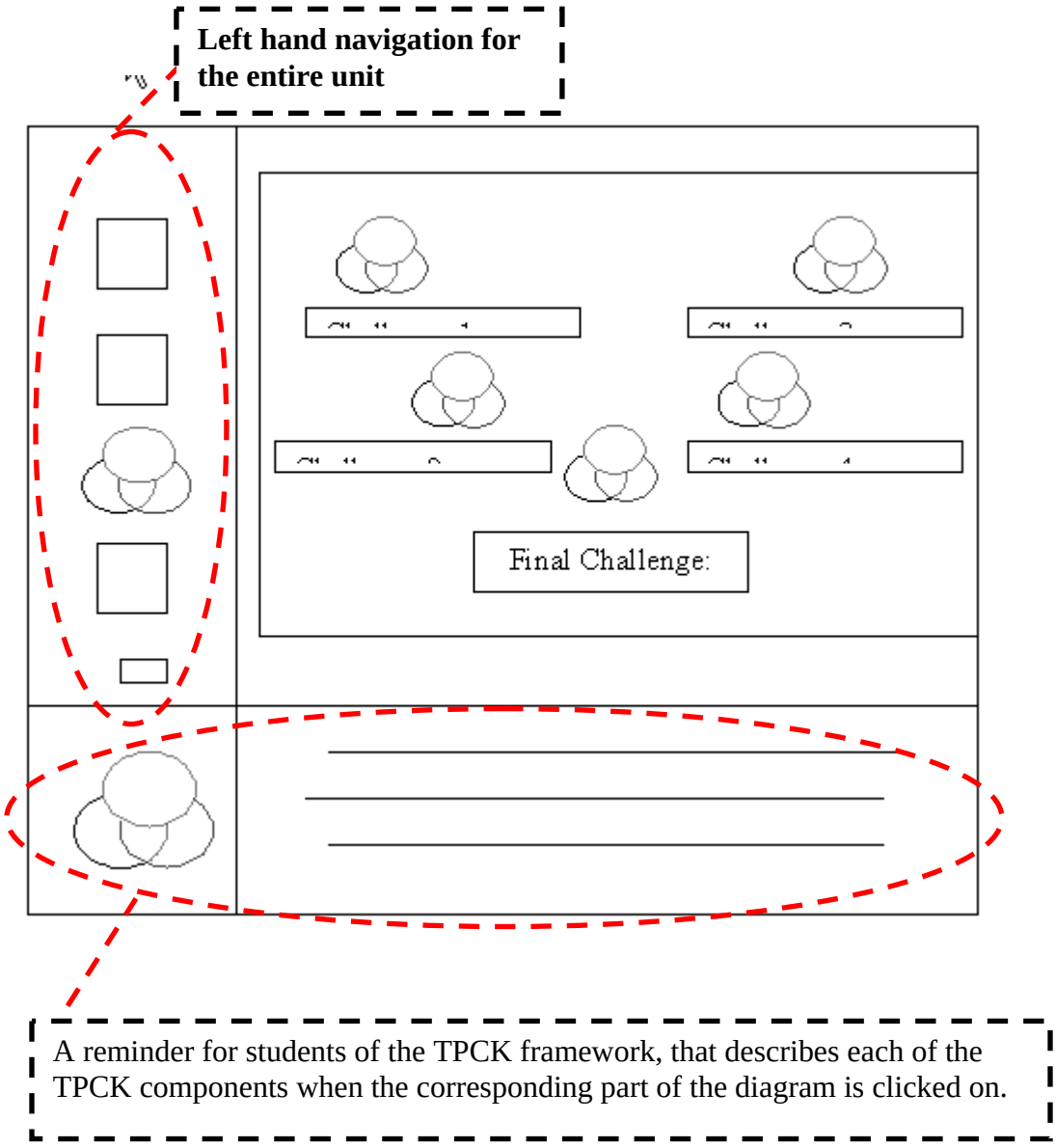

Figure 6. Initial prototype for the earliest prototype created which displays (1) left hand navigation and (2) a reminder of the TPCK framework and a description of the components of the framework.

Phase two. During phase two a higher fidelity design was created. During this phase of rapid prototyping it was apparent that scalability would have to be a criterion to take into consideration in the design. For this reason, it would be necessary to create a way in which challenges could easily be added and accessed. One of the major changes that took place from phase one to phase two was the decision to display all the challenges as a database in the form of a table rather than as discrete objects or icons. A table format would allow for more information to be displayed in a concise and organized fashion making the database a tool to access the best fitting challenge depending on the following descriptions: TPCK Emphasis, Subject, Challenge Title, and Grade Level.

Notice that the TPCK explanation at the bottom of the page is still used in this phase. Icons were also a feature introduced at this phase. Although icons were used in this prototype, they had not been planned or decided on. The icons used in this prototype were more like placeholders. Figure 4 evolved into Figure 7. Instead of showing the challenges as buttons on a page the challenges will be shown as a database in the form of a table. One of the main reasons for this decision was the nature of the target population which would require a large number of challenges to be available and to be easily accessible and easy to find.

After choosing a challenge, Figure 8 shows the screen that would appear to students as they prepare to complete a challenge. The challenge is still composed of an Introduction, Examples, Tools and Conclusion. In the center, the student could click on the TPCK diagram that says “Your Design” to begin completing the challenge. Once again, the TPCK diagram would be visible in the bottom left hand corner of the screen to

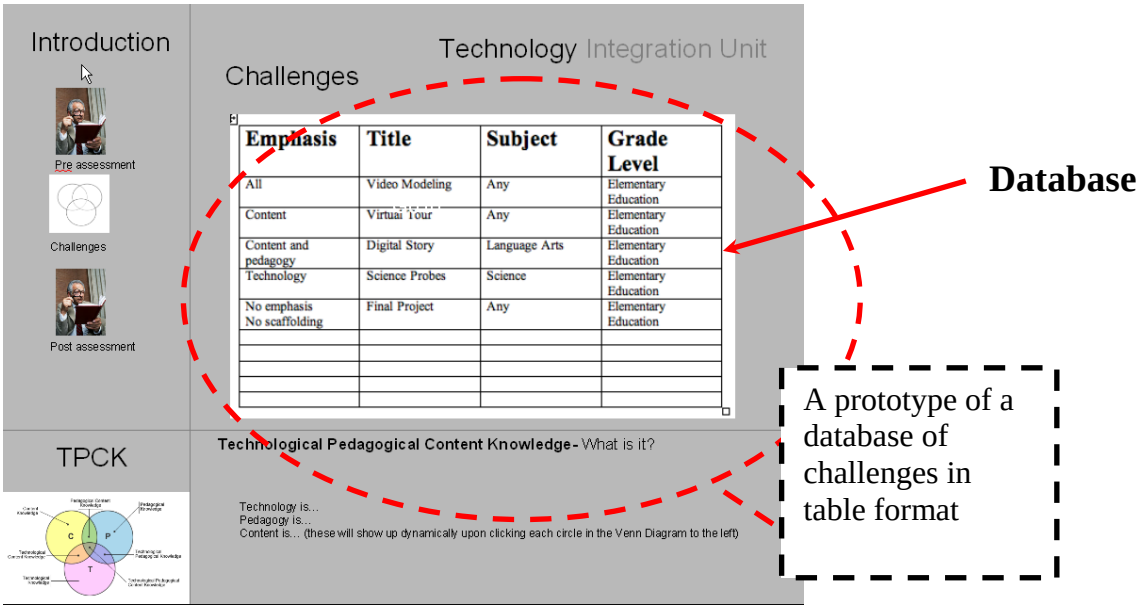

Figure 7. Displays a prototype database of challenges in table format categorized according to emphasis, title, subject matter and grade level.

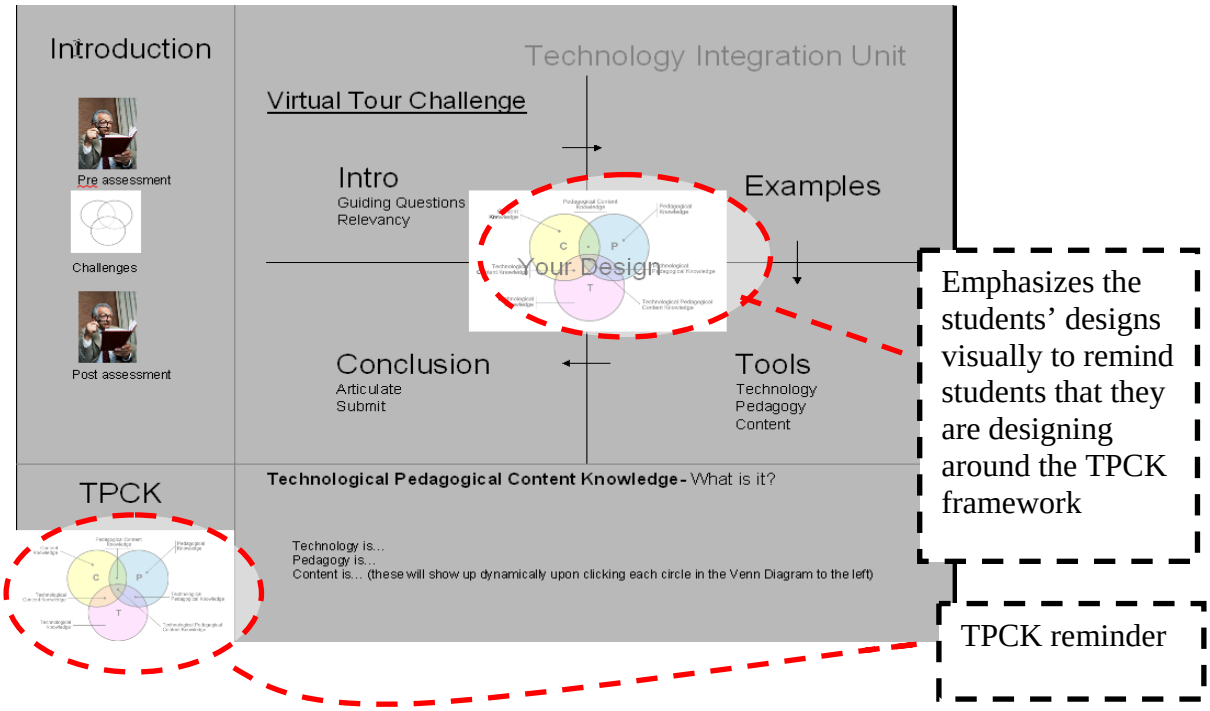

Figure 8. Prototype of the initial screen that shows the sequence for completing a challenge.

remind students of the TPCK framework while still making the design the main focus. By clicking on "Intro" a student will be taken to a screen shown in Figure 9.

The introduction page for each challenge would include a section that would motivate students to complete the challenge by showing them how the challenge is relevant to the instruction in their classrooms. The Relevance section would take students to a video or picture in which technology is supportive to instruction. The "Guiding Questions" section would allow each student to reflect on what they saw in the video or picture and apply it to their own teaching. The highlighted section of the diagram displays a visual aid for the student to keep track of their progression through the sequence of the challenge.

Phase three. During phase three of the rapid prototyping design process, much more detail was introduced in the design. The Unit Introduction took on a distinct and purposeful design. The Unit Introduction would be an important part of the design because it is the first page students see when accessing the unit online. One of the main criteria that sets phase three apart from the other previous phases is that during this phase it was decided to incorporate much more video and media rich components into the design. Rather than making this a text heavy design, it would be media rich. This is why Figure 10 shows the Unit Intro as a video with some text to accompany that video. The video would be of the instructor for the course introducing the online version and introducing him or herself to the students taking the course online.

Phase three continued to incorporate a database table from which students could choose an appropriate challenge to complete. The TPCK framework continued to be a visual strength in the design.

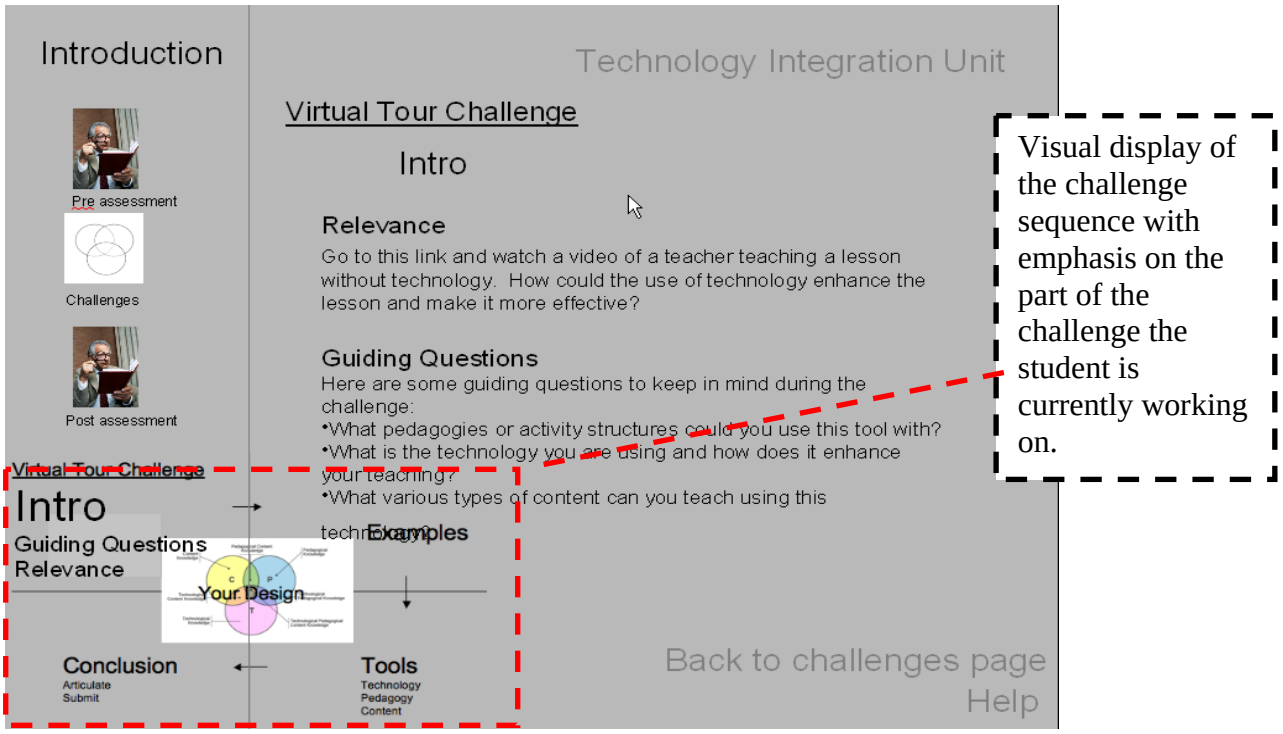

Figure 9. Prototype of the introduction page for the virtual tour challenge.

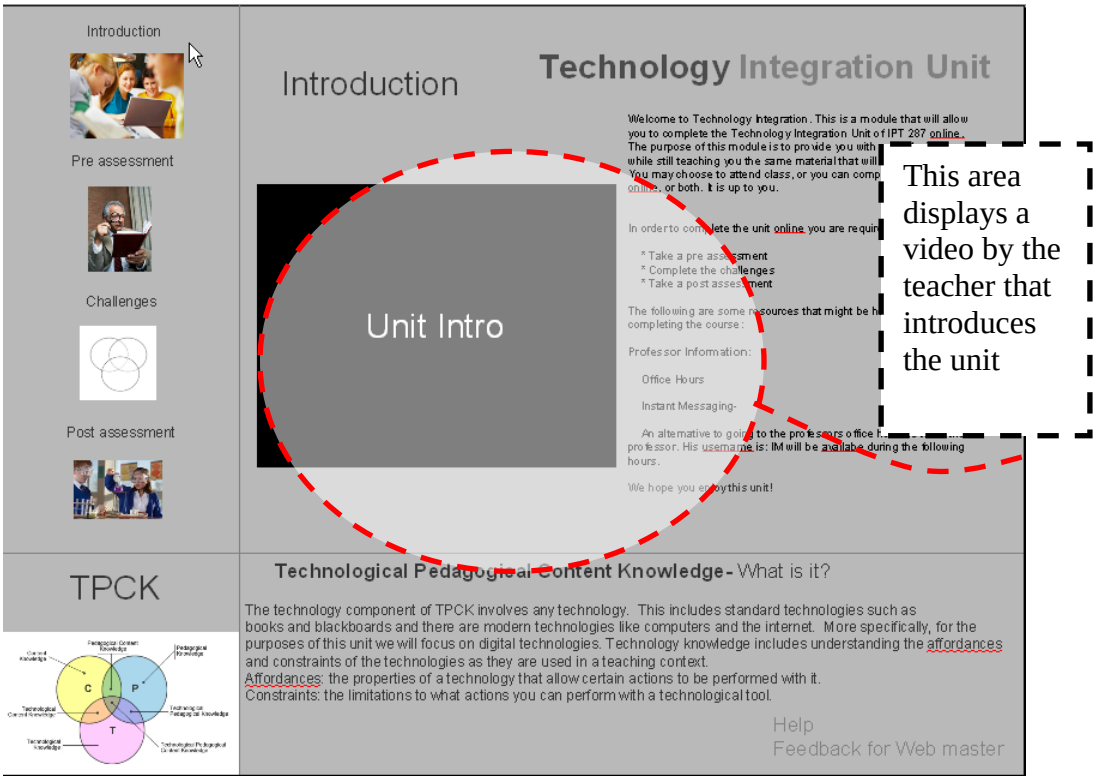

Figure 10. Prototype of the unit introduction page with a video introducing the unit.

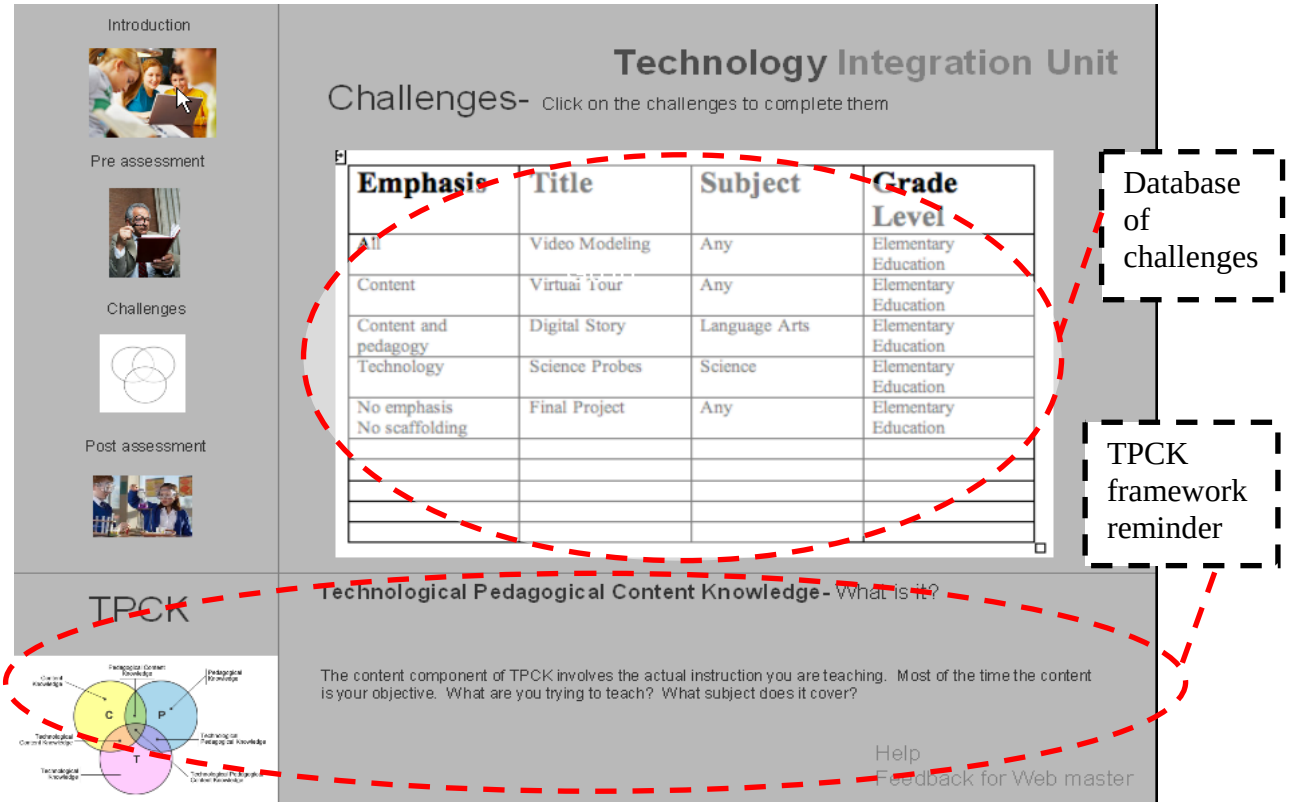

Figure 11. Prototype of the challenges database with TPCK framework reinforcement at the bottom of the page.

The table was designed to make the scalability of the course more manageable. In this way, any instructor can add a challenge to the database that meets the needs of the students in his or her class. The database makes searching and finding the correct challenge much easier since the table is organized in categories that are relevant to the student's needs.

Every challenge has a step-by-step progression for completion. The video introduces the student to the challenge, shows the student the relevancy of the instruction and tells them how to complete the challenge. The TPCK section contains instruction on the TPCK framework. The Submit section tells students how the instructor would like them to submit the challenge.

Once a student has selected a challenge, they will be taken to the screen shown in Figure 12 where they will begin the challenge by viewing some videos. The first video is and introduction to the challenge briefly explaining the challenge to the student. The second video is a relevancy video, which would allow students to see the importance and real world application of the instruction they would be receiving by completing the challenge. The last video is a step-by-step video on how to complete the challenge, a task description.

The submit screen shown in Figure 13 allows the student to reflect on the design by asking them to articulate the design by explaining it. It is also an opportunity for students to write about what they learned and how they think technology adds value to the lesson. It also would encourage the student to think of their lesson as a design and define the constraints.

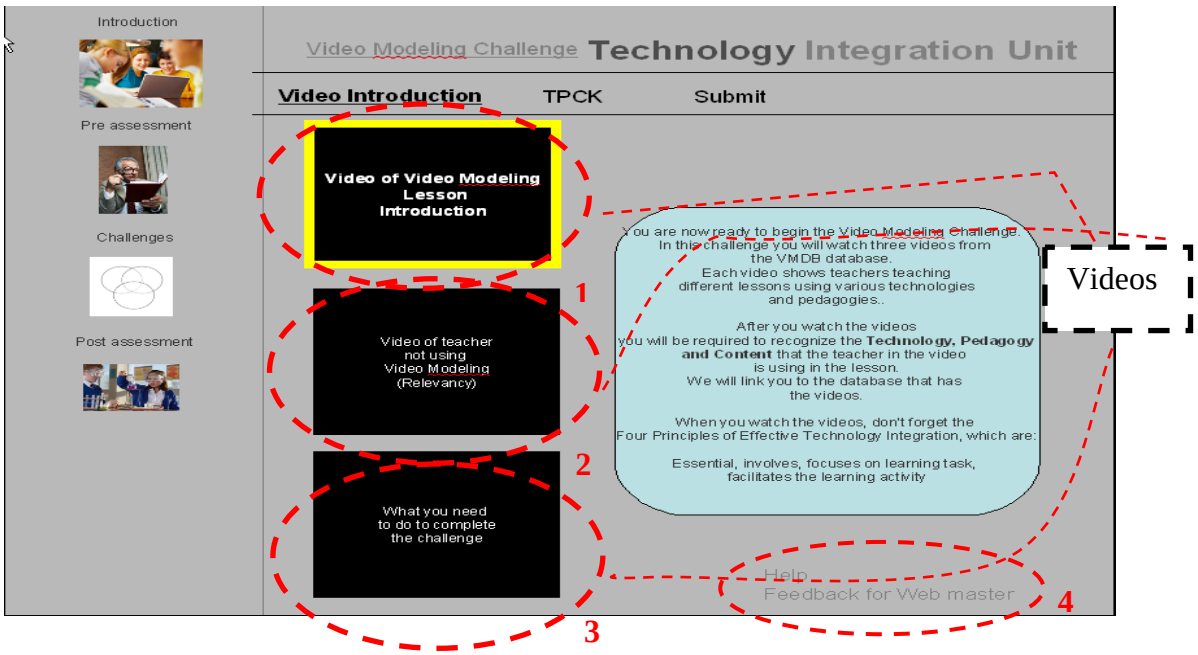

Figure 12. Prototype of a video introduction for the challenge. (1) Video introducing the challenge (2) Video of a teacher teaching without the technology to reinforce relevancy (3) Video of what to do to complete the challenge.

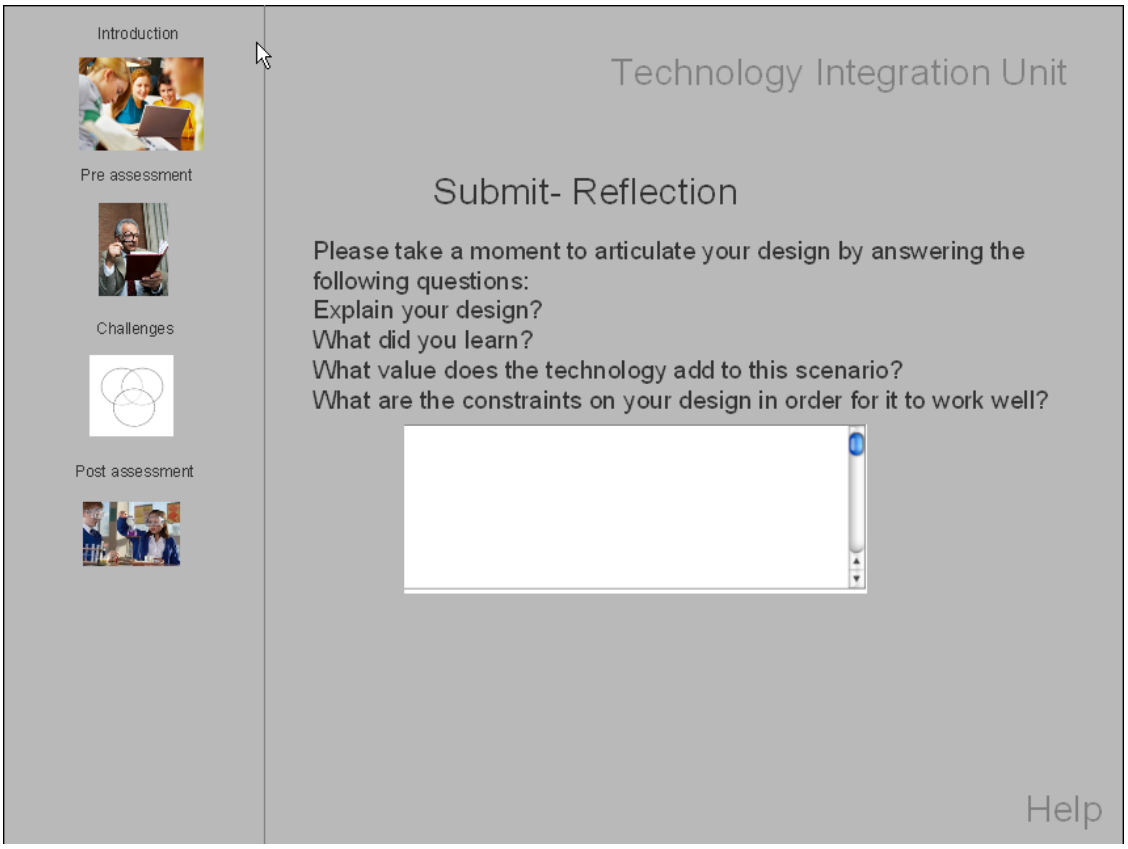

Figure 13. Prototype of the submit screen.

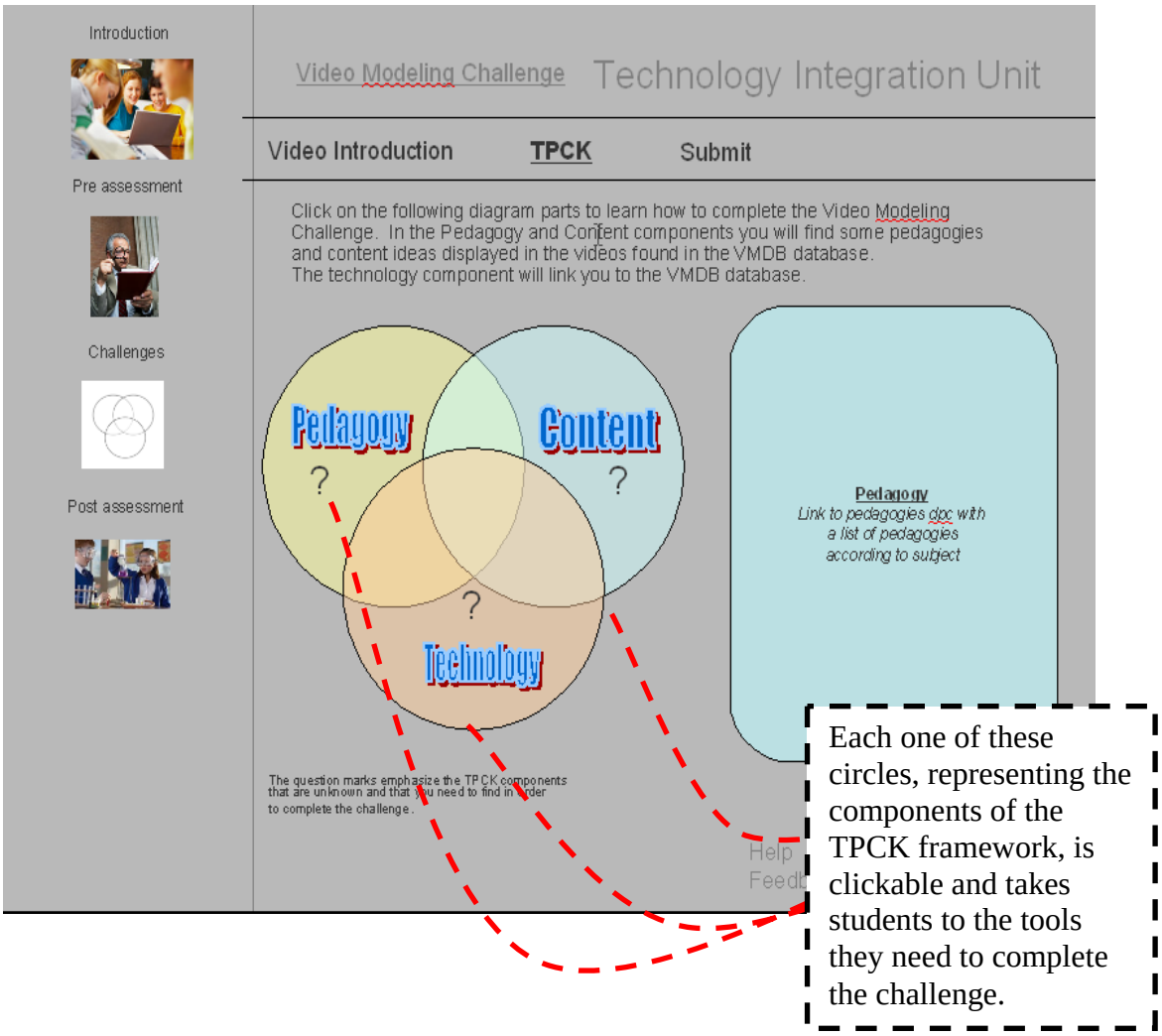

Figure 14. Prototype of the TPCK page.

In addition, this screen breaks down the parts of the challenge into the TPCK components. Each component of the circle diagram is clickable. Once a component of the diagram is clicked, the screen on the right hand side (see Figure 15) would display valuable information to help the student complete the challenge. For example, if a student was completing a challenge for Science Probes, by clicking on the TPCK section and clicking on the Technology circle of the TPCK diagram shown on the page, the screen on the right would show them links were they could go to find out all about their probe and experiments they could do with that tool. If they clicked on Content they would be shown a link to the UEN.org website where they could search for the objective that best fits their science probe experiment. By clicking on Pedagogy, they would be shown a list of general pedagogies which might give them some ideas on how to engage the students better in using those science probes to learn about a given principle.

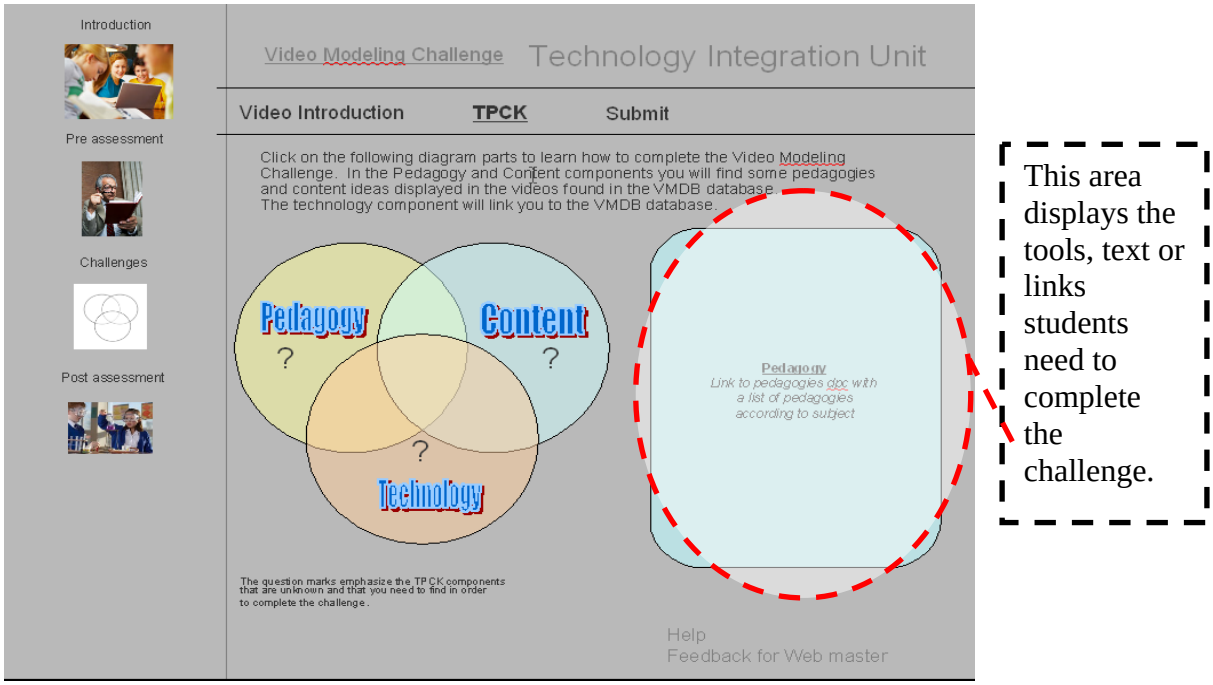

Figure 15. Prototype of the TPCK screen. Clickable TPCK diagram with accompanying text in the right hand side display.

Scope and Sequence

After the development phases had been complete, the final design began to emerge. The following sections explain in greater detail the final design of the unit interface, the challenges, and the TPCK module. The challenges and the TPCK module were the two final modules that resulted from the design.

The final design. The final design for the blended learning module became a polished version of the phase three design. One major difference in this design is the deletion of the TPCK explanation and framework at the bottom of the screen. This was deleted with the purpose of providing only the necessary information and making the page look as simple as possible to prevent confusion. Other changes include the text that students will read to become familiar with the navigation of the site, the steps to complete the unit, and how to access help when necessary. Figure 16 shows a screenshot of the introduction page for the Technology Integration Unit.

The navigation displayed in Figure 17 is constantly present throughout the website to allow students to easily navigate from step to step and reduce the chances of students getting lost. The icons were specifically selected and designed for simplicity and relation to the process each one represents. The Step 1: Unit icon represents the unit as a whole. It is the "Home" button and when clicked always takes the student back to the unit introduction page. The icons for Pre and Post assessment were selected from a clip art database of public domain icons and edited to have the words Pre and Post displayed on the icon. A camcorder was selected to be used for the Technology integration section to emphasize the multimedia aspect of that part of the unit. The Challenges section is represented by a TPCK diagram.

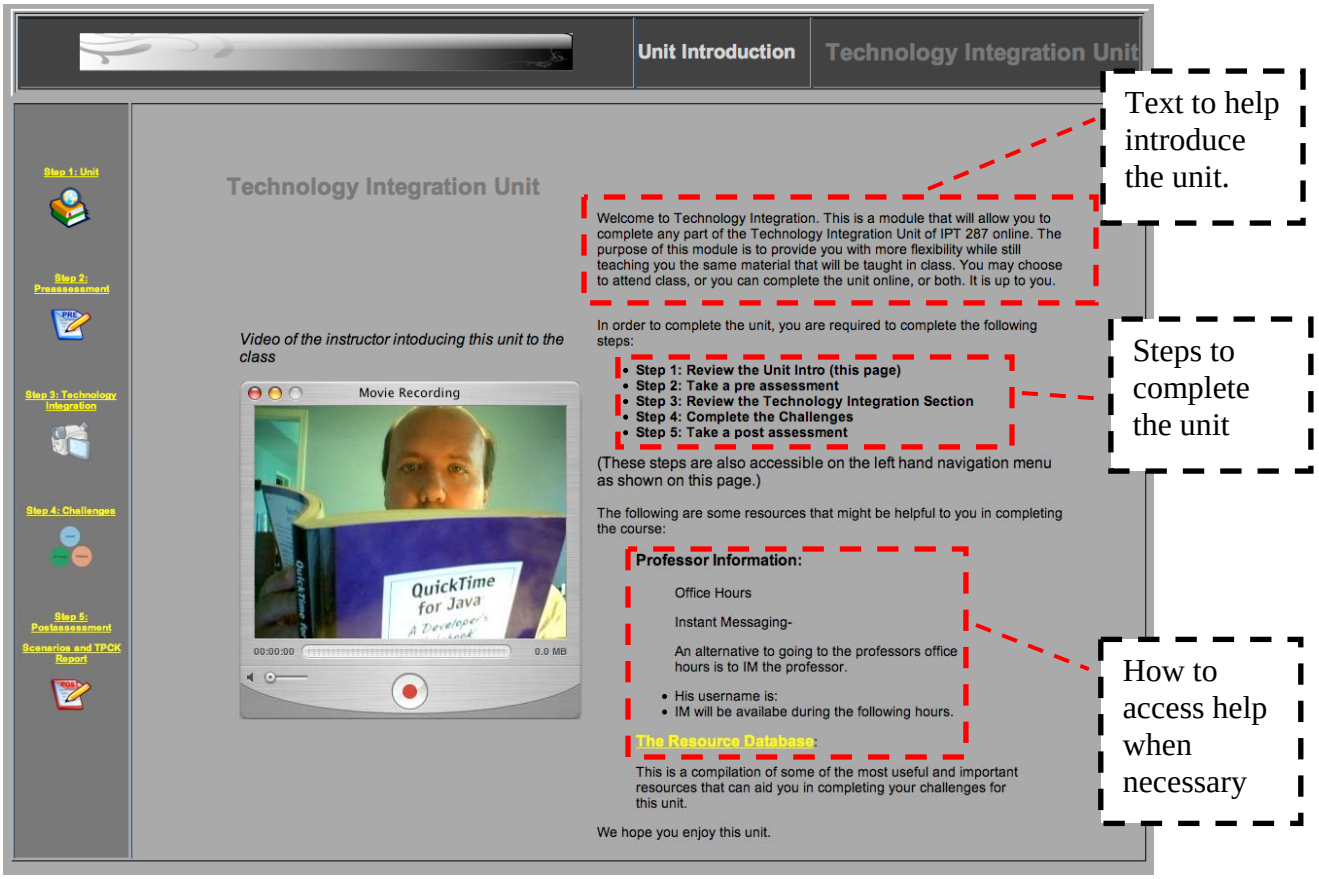

Figure 16. Screenshot of the introduction page for the unit.

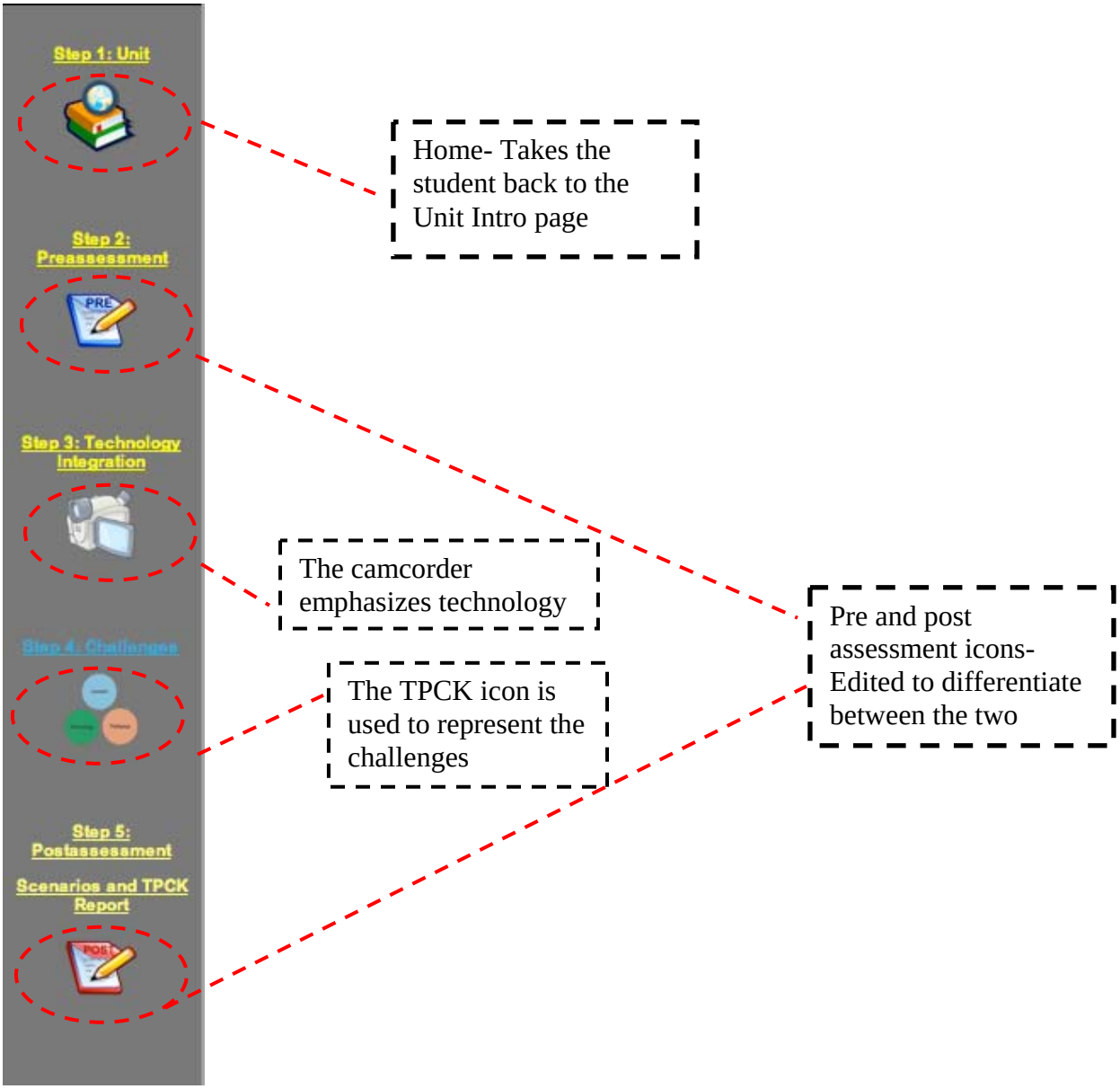

Figure 17. Left hand navigation consistent throughout the entire website.

By clicking on Step 2: Pre-assessment, a second tab opens up in a browser window and students are taken to the Survey Monkey website which hosts the technology integration pre-assessment. The pre-assessment measures the level of confidence and experience the student has when working with a variety of technologies.

Step 3: The Effective Technology Integration page (see Figure 18) will provide students and course instructors many resources for teaching and learning about the TPCK framework and how to implement it in teaching a variety of subjects with a variety of pedagogical strategies.

The first resource that this page provides is the TPCK Video Module. This is a set of videos that guides the student with examples to understanding each component of TPCK. The second option is a video that puts all the components together and teaches how the components come together to form the TPCK framework. This option is similar to the first option, the TPCK video module, but is much more concise and demands less time. This video would be more suitable for in-class instructor use. The second video in that option is "4 Principles of Effective Technology Integration." Although TPCK provides a great foundation for planning and designing the use of a technological tool effectively, the 4 Principles of Effective Technology Integration gives teachers some more specific criteria about how technology is used most effectively.

Following the videos there are a number of useful resources that can be accessed by instructors or students (see Figure 19). The first resource includes a website in which the definition and history of TPCK is explained.

This website contains hyperlinks to other references related to TPCK. The second resource is a website by the co-author or promoter of the TPCK framework, Punya

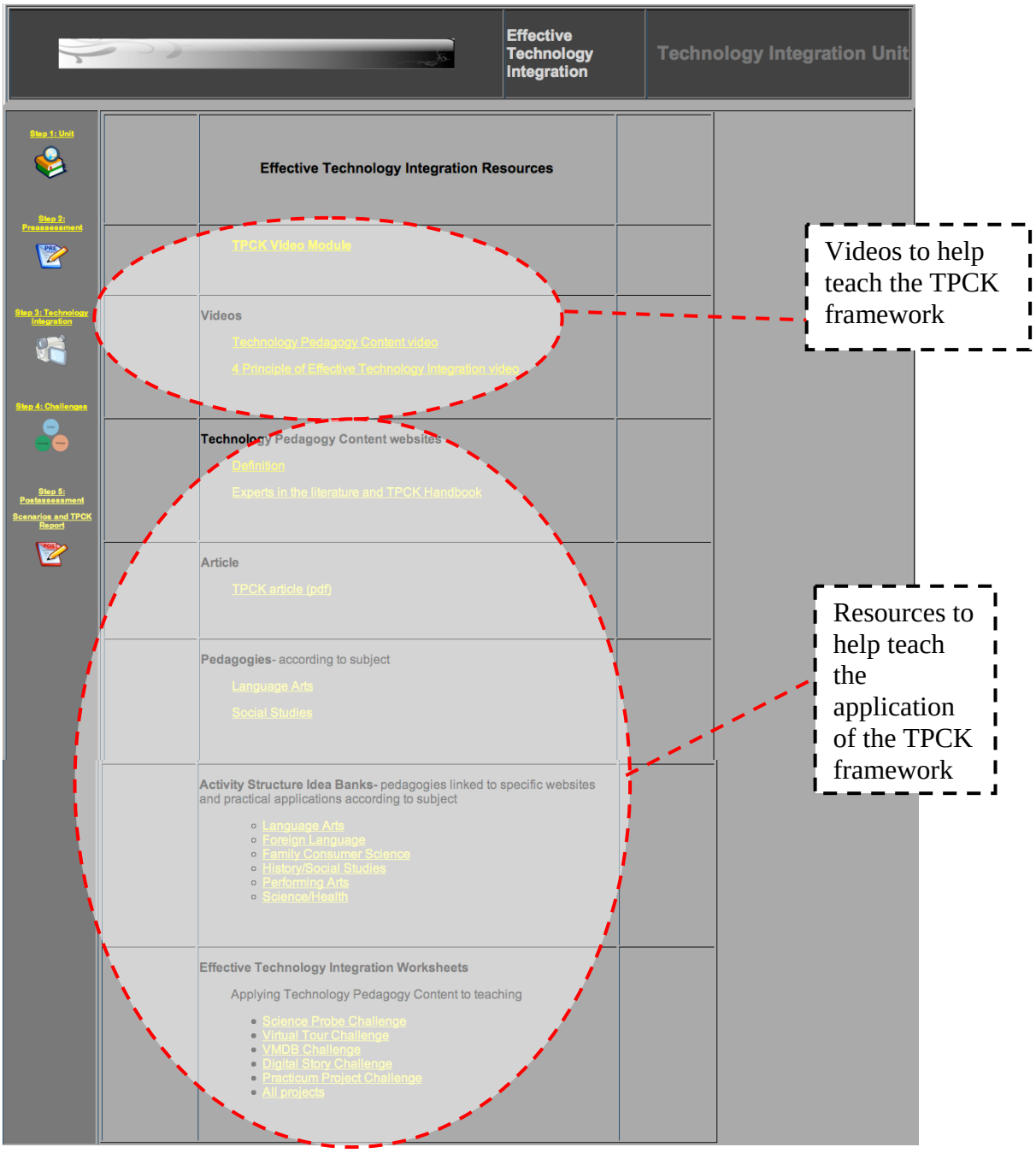

Figure 18. Screenshot of the Effective Technology Integration Resources page.

Mishra's web page. The website is a great tool for students to use since it provides up to date information on TPCK, publications, and events involving TPCK. In the database, following the websites is the article "Teachers' Technological Pedagogical Content Knowledge: Curriculum-based Technology Integration Reframed" written by the creators of the Technological Pedagogical Content Knowledge framework.

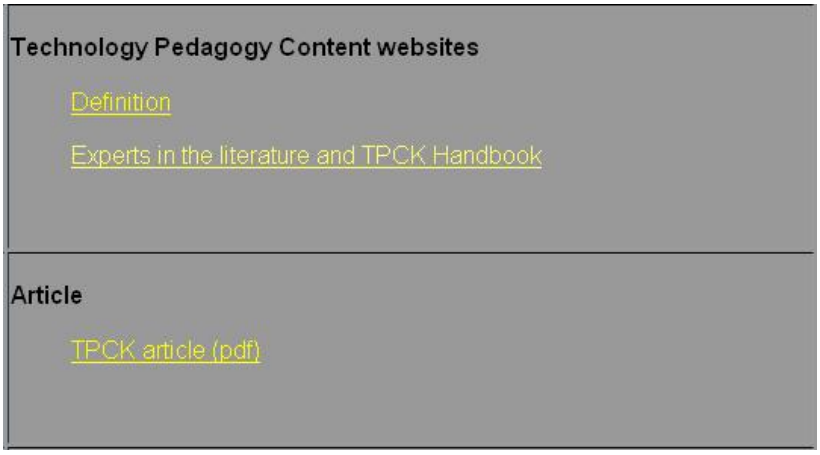

Figure 19. Part of the Effective Technology Integration Resources page that displays websites and an article by the co-creator of the TPCK framework.

The last resources on the page (see Figure 20) help students and instructor learn how to best apply the TPCK framework in specific subjects with specific teaching strategies relevant to each subject. The Activity Structure Idea Banks give specific technology tools and websites for specific teaching scenarios. It requires the pre-service teachers to think about activity structures that are specific to their subject matter and then to find and explain how an online technology can be used to enhance that activity. By clicking on these links students will be able to download examples of activity structures that can help them be creative and come up with their own ideas.

The final section on the page is a list of Effective Technology Integration

Worksheets according to each challenge (see Figure 21). This is a resource for the instructors of the course. Students can be required to fill one of these out before completing each challenge. These worksheets can also be accessed from within each challenge resource page.

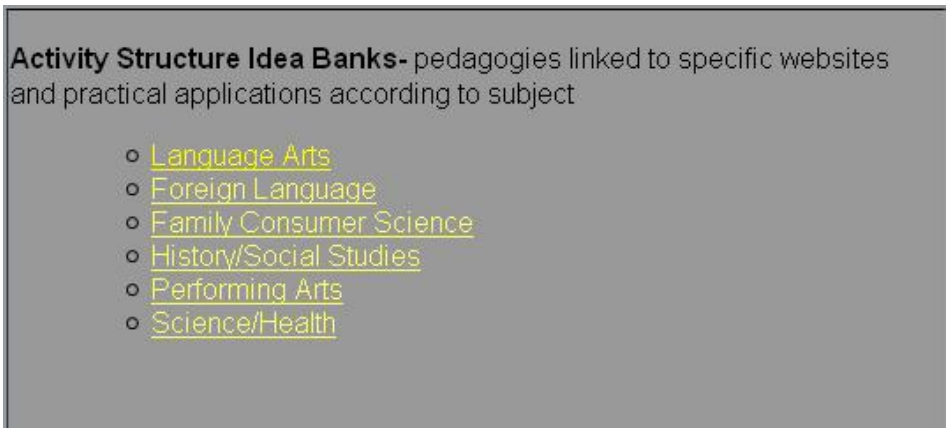

Figure 20. Part of the Effective Technology Integration Resources page that displays example activity structure idea banks according to subject.

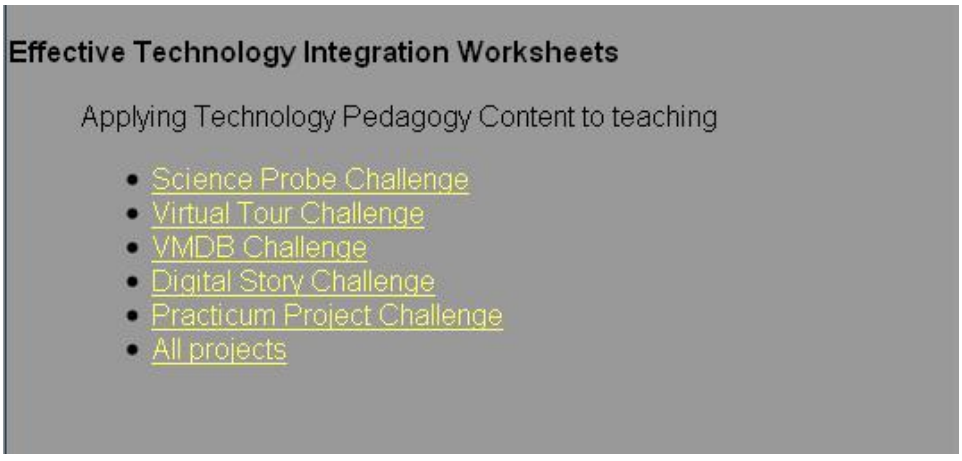

Figure 21. Part of the Effective Technology Integration Resources page that displays Effective Technology Integration worksheets for each challenge.

The Effective Technology Integration Worksheet (see Table 4) was designed along with the website. The worksheet is very similar for each challenge allowing students to think and plan the objective of the challenge and tailor their project to their students. The worksheet has a technology, pedagogy, and content section, which asks students relevant questions about each component of the TPCK framework as it relates to their project proposal. In the space provided under each column the students can enter their answers to each question. The worksheet allows students to plan their project design before beginning work on the challenge by planning out each component of the TPCK framework. It also allows the instructor of the course to see if the students are understanding the framework and are designing a project that is relevant to their subject matter, teaching objective, and chosen technology tool.

Table 4.

Effective Technology Worksheet for the Science Probe Challenge

Technology	Pedagogy	Content	Is it effective?
What digital technologies are being used in teaching and learning? What software are you using for your probe? What probe are you using?	What pedagogical strategies are being used? • Active engagement • Connection to real world contexts • Visualization • Practice and feedback • Reflection • Group Work	What are the desired learning outcomes for the content being taught? What is the core curriculum objective you plan to target with this technology?	How effectively does the technology integration enhance or support the pedagogical strategies being used? How does the technology integration improve or detract from the learning experience?

Step 4: The Challenges is the section of focus for the entire unit. This section is the most crucial section since it contains the challenges that must be completed. The database idea that was conceived early in the rapid prototyping process survived all the modifications. As displayed in Figure 22, the challenge screen displays five challenges that can be used for IPT 287 students and in the future, may be easily modified to fit the needs of IPT 286 students. At the bottom of the screen there is a link to the database of useful resources. This is a comprehensive list of resources that can be used for all the challenges. Once again, this design is very similar to the Phase 3 design except that the TPCK framework has been deleted from the bottom of the page for more simplicity.

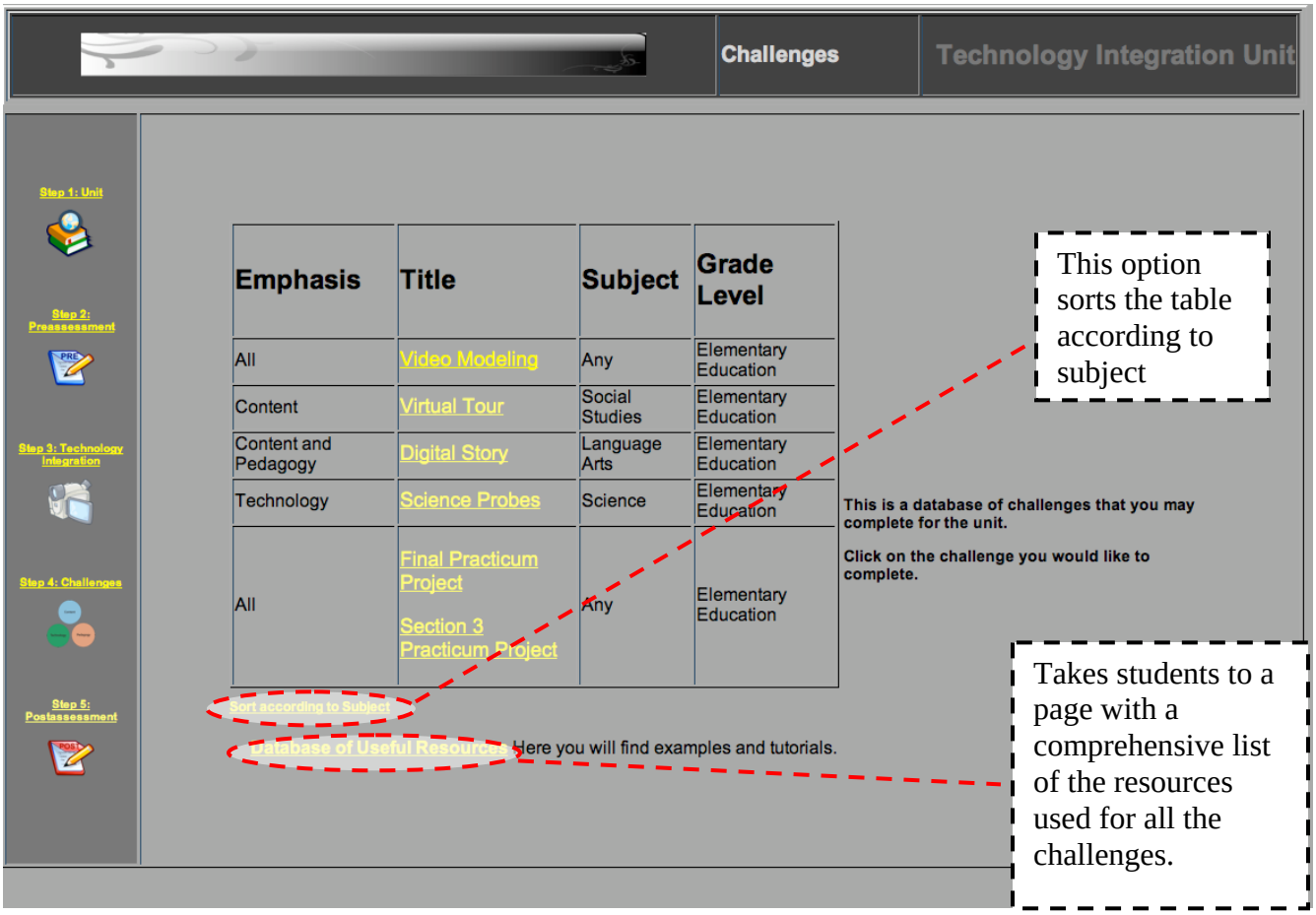

Figure 22. Final database of challenges.

The categories are TPCK Emphasis, challenge title, subject matter, and grade level. At the bottom of the table, there is a link that allows students to reorganize the contents of the table to display the challenges according to subject. Figure 23 displays the same table in Figure 23 sorted by subject matter.

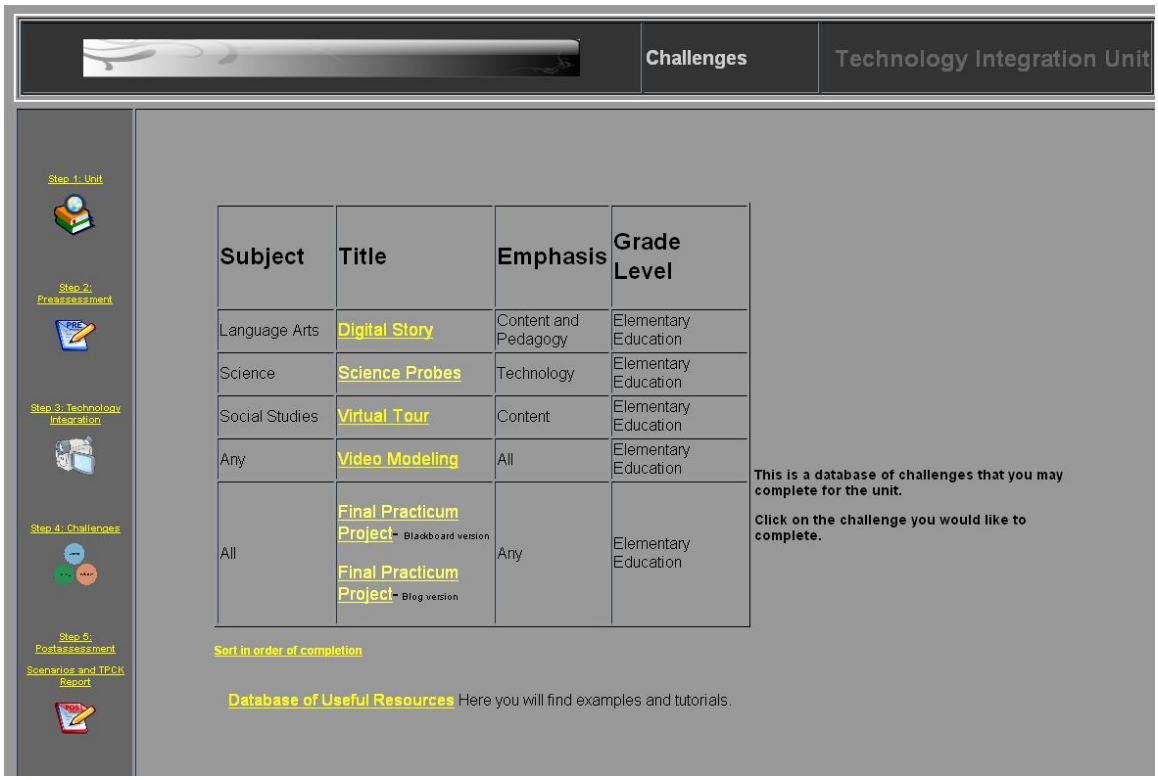

Figure 23. Final database of challenges sorted by subject matter.

One of the criteria introduced in the design was the need to make the design flexible since many of the instructors wanted to use the resources in their own way in their courses. This meant that many instructors would want to personalize their own challenges and assignments and not have students go through a pre-designed structure. Consequently, the Database of Useful Resources (see Figure 24) was created to give the instructors of the course flexibility. It is an option for the instructors in case they decide

not to use the designed challenges but would still like to give their students some ideas and resources to use for their projects. The Database also gives students a second place to go to find all the resources without having to go to any specific challenge to find something they have already learned about. The resources include tutorials and student examples.

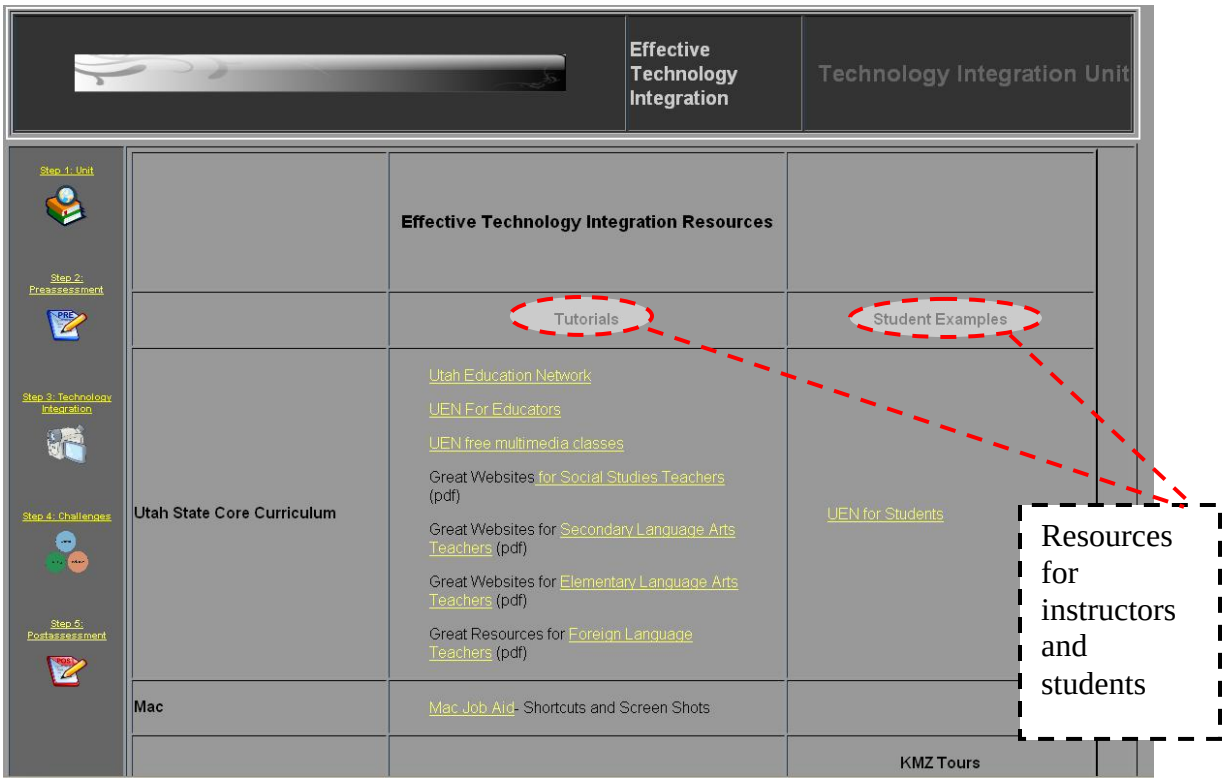

Figure 24. Database of useful resources.

Step 5: The Post Assessment is very similar to the pre assessment. The post assessment is comprised of a post assessment and an assessment of comprehension of the TPCK framework. The post assessment can be compared to the pre assessment to measure progress. The Scenarios and TPCK Report gives the students a final chance to apply the TPCK framework and also allows the instructors to measure how well students

grasped that concept. The approximated time it takes to complete the pre and post assessment is 30 minutes each.

Effective technology integration module. This section of the unit is designed to break down each component of the TPCK module into its respective parts- Content, Pedagogy, and Knowledge. As students click on each of the diagram parts they will be shown a video that will teach them about that specific element of the TPCK model. This module is designed to be used independent of the challenges and should be watched before attempting to complete the challenges to give students the understanding they need in order to successfully incorporate the TPCK framework in the challenges. This module was created in order to accommodate the criteria for flexibility that instructors of the course need as they design their course. The module is divided into five steps (see Figure 25) that should be followed consecutively.

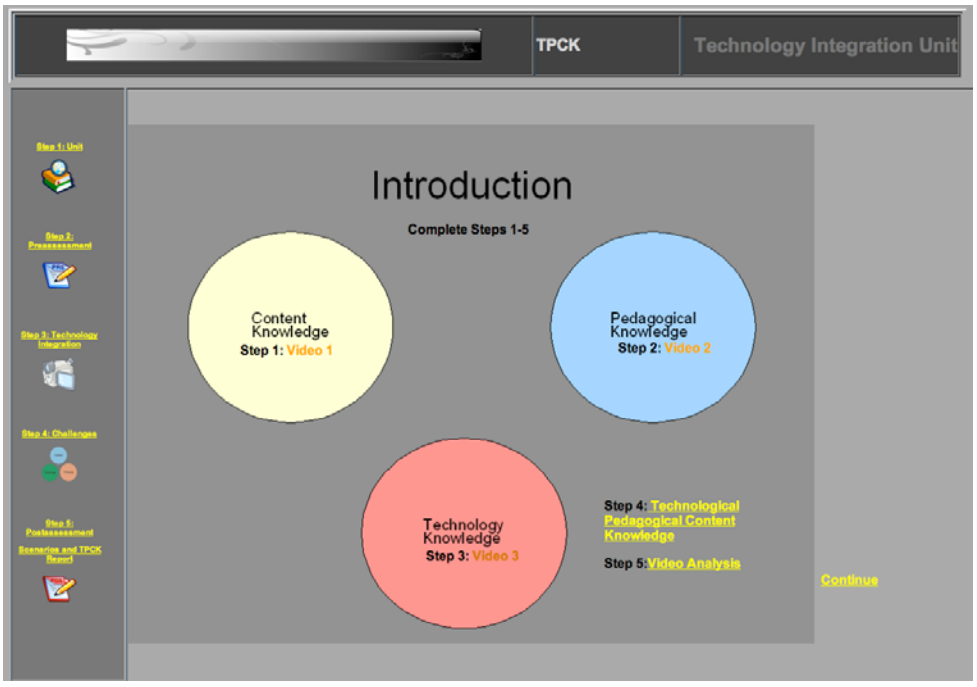

Figure 25. Five Step Technology Integration Module introduction page.

Step 1 teaches students Content Knowledge in a very simple, easy to understand way. Step 2 teaches Pedagogical Knowledge and Step 3 teaches Technology Knowledge. Step 4 brings the three components together to show how equilibrium can be achieved and to explain the TPCK framework with all three components in interplay. Step 5 is a video analysis where students watch a video in which good TPCK practices are modeled and then they are required to analyze the video.

The following figure shows the screen the students will be taken to by clicking on Step 1: Content Knowledge. The video they will watch at this screen is a big part of the materials that were developed for this project. The content of each video was planned and developed.

Figure 26. Step 1 video on content knowledge.

It was necessary to explain each concept in terms that the students are familiar with, incorporating many examples into the video instruction to make the concepts easily understandable. The main concepts explained in these videos are taken from the articles used in the literature review of this report. The most basic and critical concepts were taken and adapted to the student's level in order to make it easy for the students to understand. In addition, the video media format allows us to include visuals and music to further engage the audience, making the instruction even more effective.

By clicking on Step 3 of the TPCK module, students will be taken to the screen shown below in Figure 27. The reason they are taken to a TPCK page is to reinforce the framework and remind them, after watching each separate component video in Steps 1-3 that these elements all come together to form a framework.

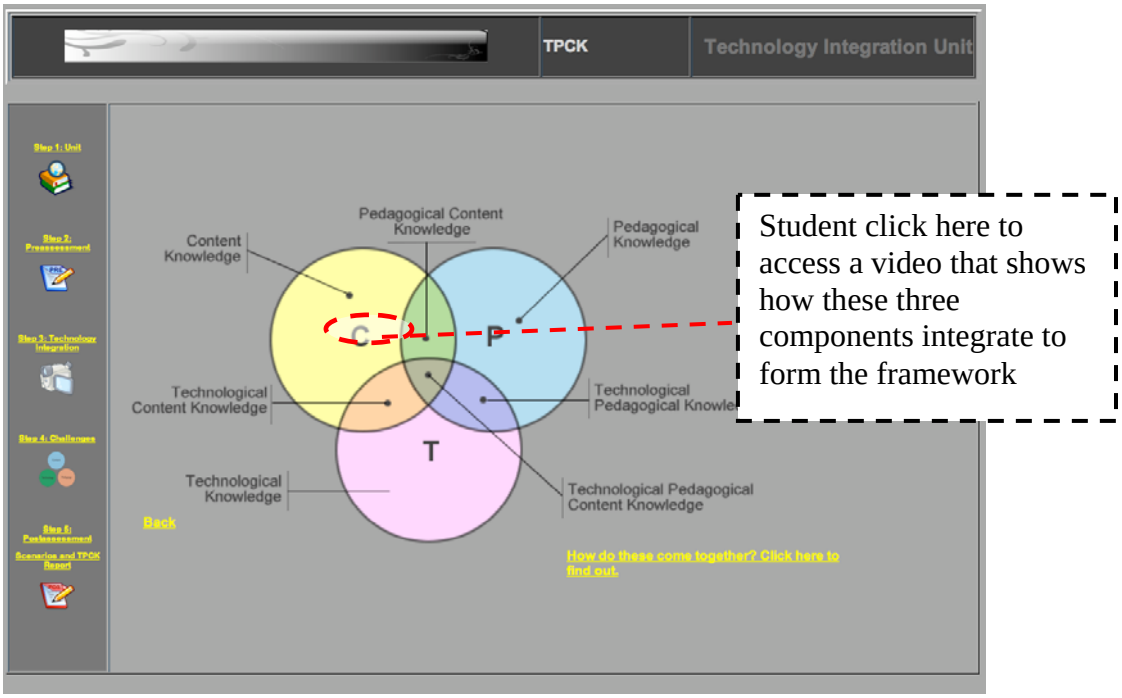

Figure 27. Step 3 is the framework that shows the integration of all three TPCK components.

By clicking on the link or clicking on the center of the framework, students are directed to the screen shown as Figure 28. This video reinforces each component of the TPCK framework and then explains and shows examples of how these components come together to achieve equilibrium in their instruction.

The last and final step to in the module is Step 5: The Video Analysis. The Video Analysis is designed to arrange a number of videos that model good practice of TPCK according to emphasis (Early Childhood, Elementary Ed., Secondary Ed., and Special Ed.). Students are required to watch the video that corresponds to their emphasis. The video will display a group or class of students similar to the age group of emphasis and it will show the students learning something. After the pre-service teacher watch this video they can click on Step 2 to download a TPCK analysis worksheet. After filling out an analysis of that video based on the TPCK framework, pre-service teachers can compare their analysis with the one provided on the site. This is a good way for students to check their understanding of TPCK and apply it in a real world context through the use of video.

In general, the Effective Technology Integration Module is a resource for course instructors and pre-service teachers to use to help them understand the TPCK framework and learn how to apply it to the challenges they will be completing during the semester. It is a module that can either stand alone or be used as a supportive resource for course instructors and students learning and teaching TPCK.

The challenges. Each challenge will have a similar structure but different content. For example, each challenge will have its own introduction, task description, TPCK.

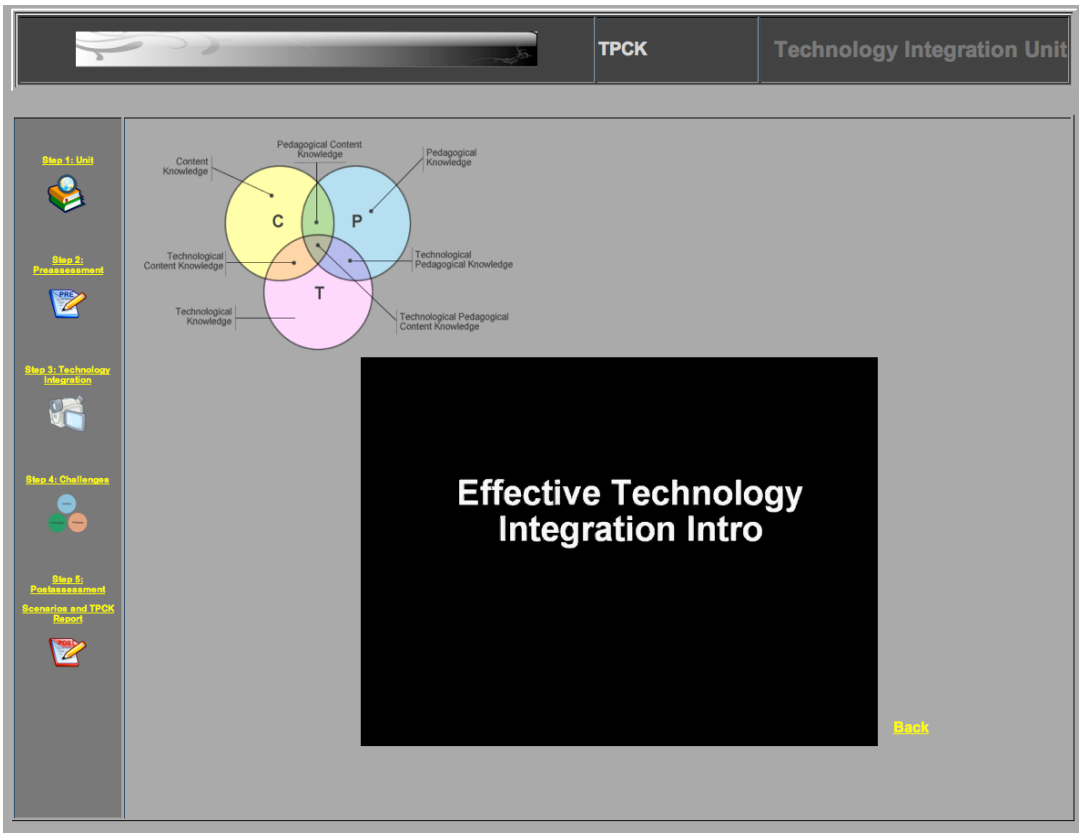

Figure 28. Video that shows how all three components come together to form the framework.

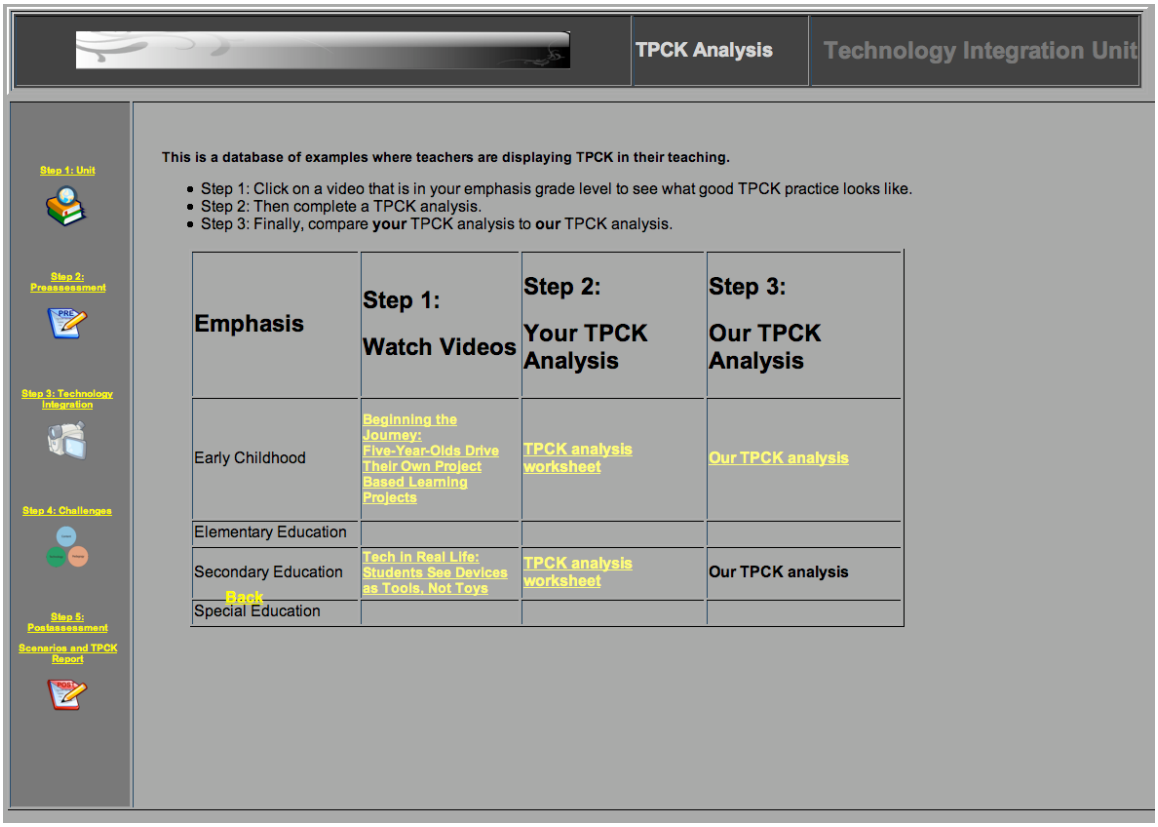

Figure 29. Step Five- Video Analysis categorized by emphasis.

resources, examples of completed challenges and submitting instructions. This structure will be the same for each challenge, but the information found within each of these sections will vary from challenge to challenge. As depicted in Table 5, this project will focus on five challenges, which are video modeling, virtual tours, digital storytelling, science probes and the final project.

Each of the figures that follow in this section appear on the website as shown in Figure 30, but for matters of space, only the main window with the challenge content will be displayed as shown in Figure 31. In other words, the left hand navigation is there, but is not shown in the figures that follow.

The introduction section (shown in Figure 30) of each challenge will provide students with a brief introduction of the challenge and what they will learn. Some of the challenges also have videos that allow the student to reflect on the relevancy of the material in the instruction and how it applies to their teaching needs. The introduction always reminds students of the four principles of effective technology integration which are, involves the students in actively using the technology, essential to the learning activity, focuses on the learning task, and facilitates the learning activity.

The task description provided on the Task page of each challenge (see Figure 32) will provide students with a detailed description of the challenge, the steps to take to the complete the challenge, and the grading criteria.

The Resource page (see Figure 33) contains the TPCK components necessary to complete the challenge: the technology, pedagogy, and content components of the challenge. It will provide all the links and resources for the student to design a solution based on the TPCK framework, using technology, pedagogy, and content knowledge.

Table 5.

Challenges to Complete Within Unit (with respective TPCK components)

Challenges	Technology	Pedagogy	Content
Video Modeling	VMDB Database	*Depends on subject*	Any
Virtual Tours	Google Earth	Virtual Tours	Social Studies
Digital Storytelling	iMovie, Advanced Powerpoint, PhotoStories	*Depends on subject*	Any
Science Probes	Science Probes	*Depends on subject*	Science
The Final Project	All of the above and more	*Depends on subject*	Any

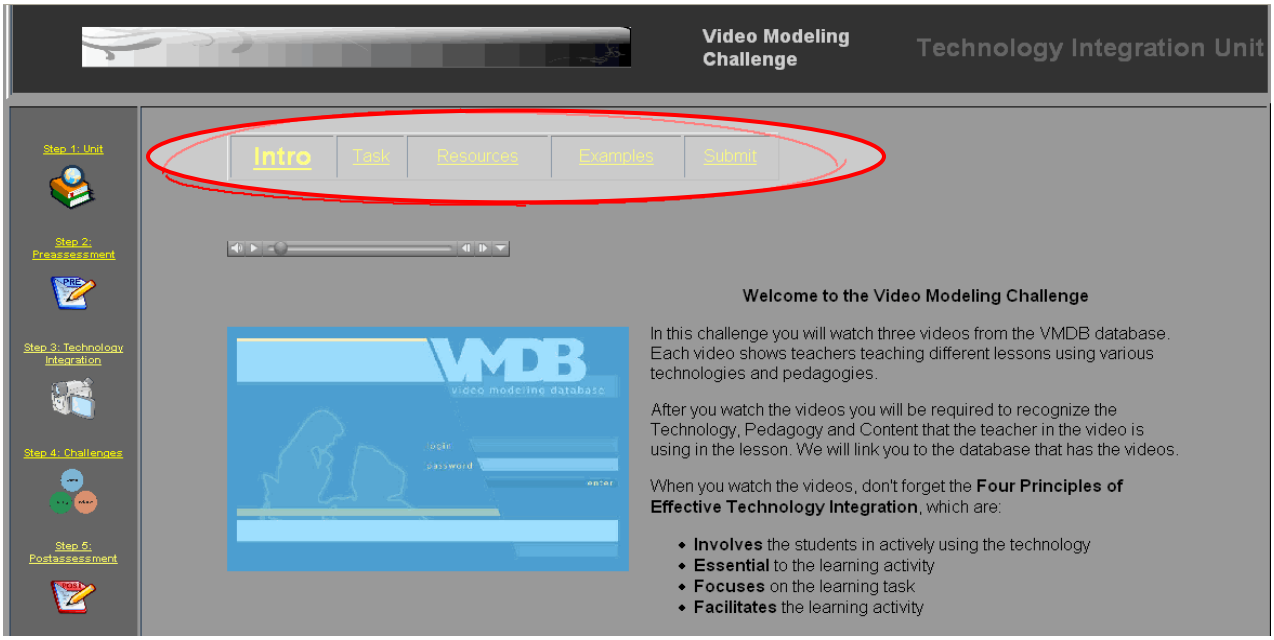

Figure 30. Introduction page of the Video Modeling Challenge

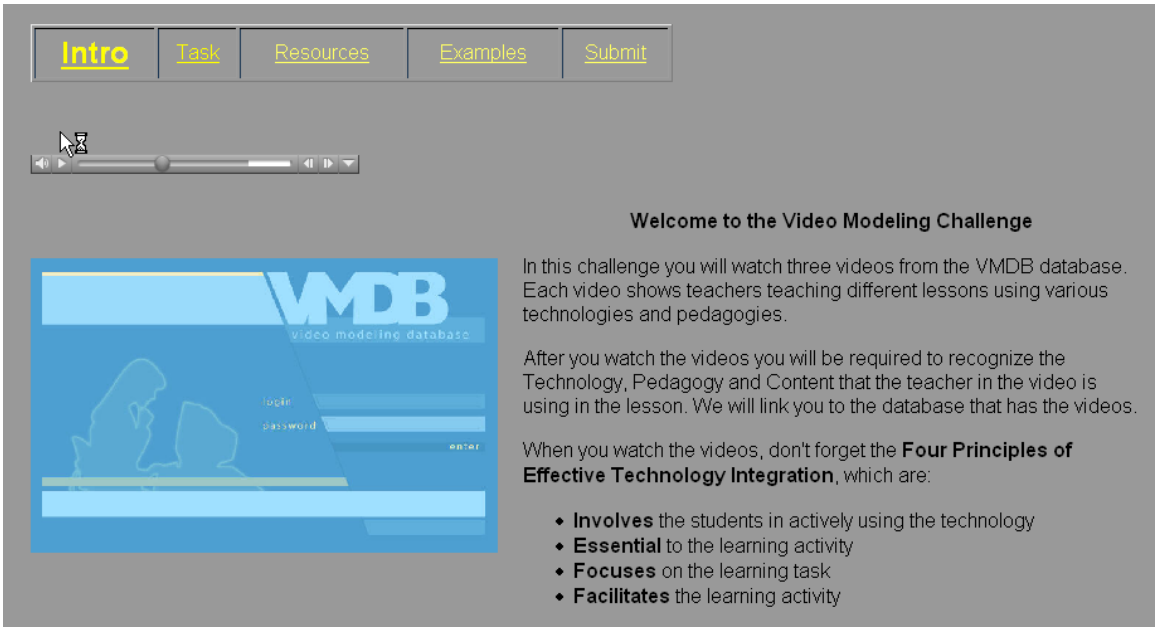

Figure 31. Zoom in on the Introduction page for the Video Modeling Challenge.

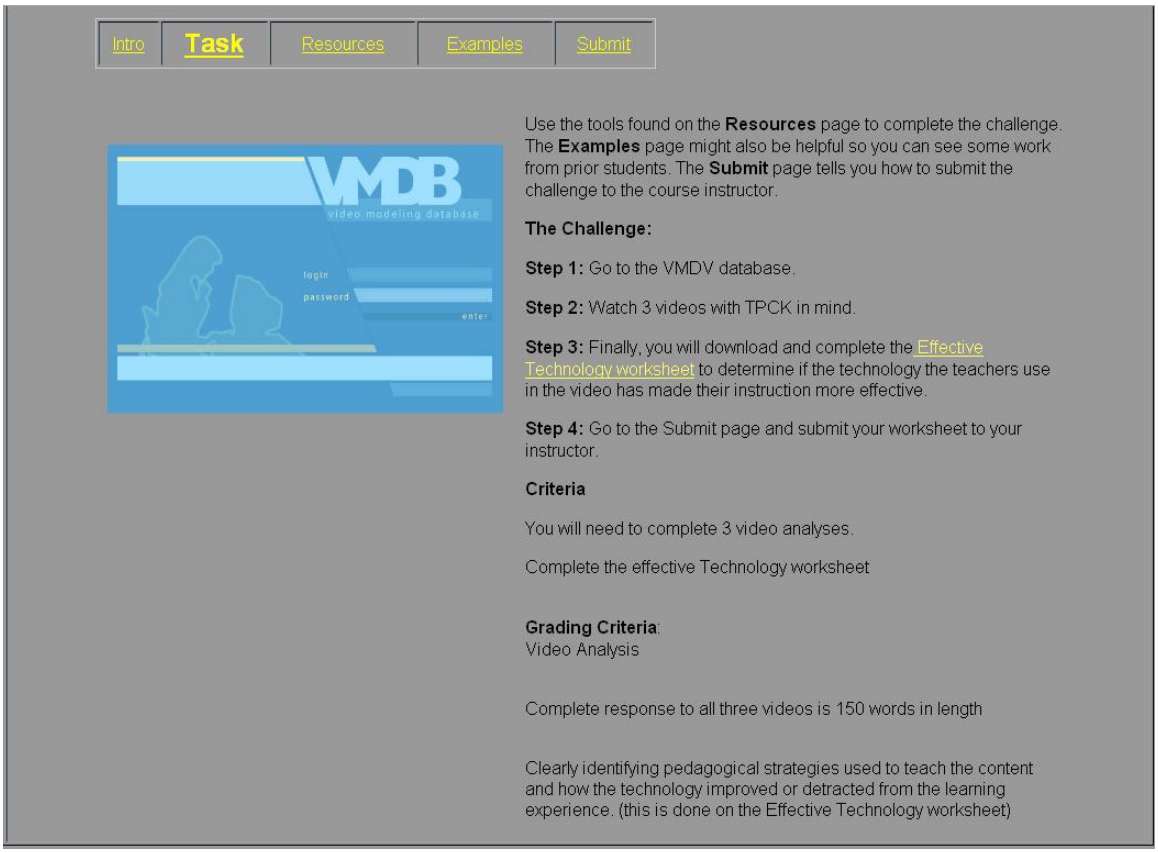

Figure 32. Task page for the Video Modeling Challenge.

The resource page will provide at least one or more of the components as a given, leaving the students to design the missing parts of the TPCK components. Table 3 shows the TPCK components for each challenge. For example, for the science probe challenge students are given the subject, which is science, but they are allowed to choose a pedagogical strategy and the specific science probe and experiment they will use to teach their content.

This page is an interactive page that requires students to click on the parts of the page to discover the information they need to complete the challenge. This page also provides students with a description of what they can find once they click in each section.

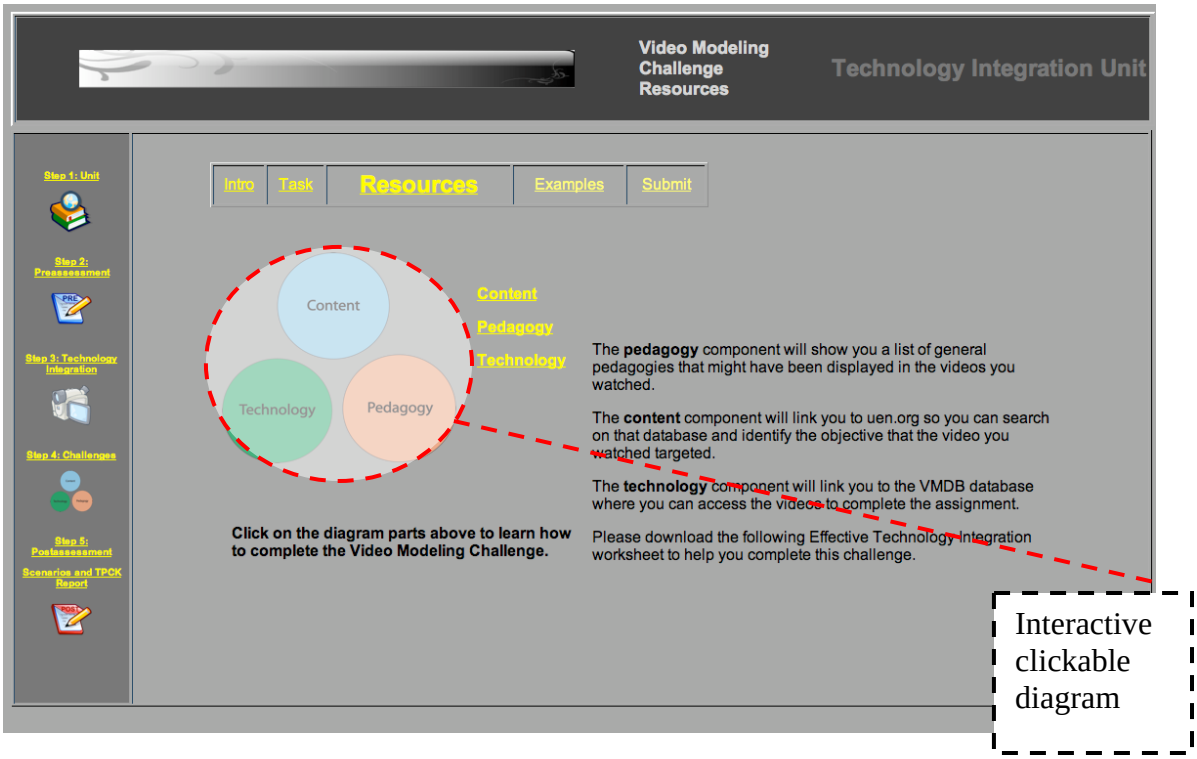

Figure 33. Resources page for the Video Modeling Challenge.

The examples section (see Figure 34) will provide students with a couple examples of prior student's work that they can use as an aid and model to complete their own challenges. This section is also meant to have a detailed TPCK explanation that will accompany the example so that students can see the TPCK components in each example and apply them to their own designs.

The example page will usually contain a video or a multimedia object with the example for the student to watch or listen to and a breakdown of the TPCK components on the right to explain how each component applied to the design of the example challenge.

Last but not least, the submit section (see Figure 35) will explain in detail, how to correctly submit the challenge. Students might be required to burn a CD, upload to a

blog, upload to Blackboard, email the course instructor, etc. The submit instructions may vary from challenge to challenge and from instructor to instructor.

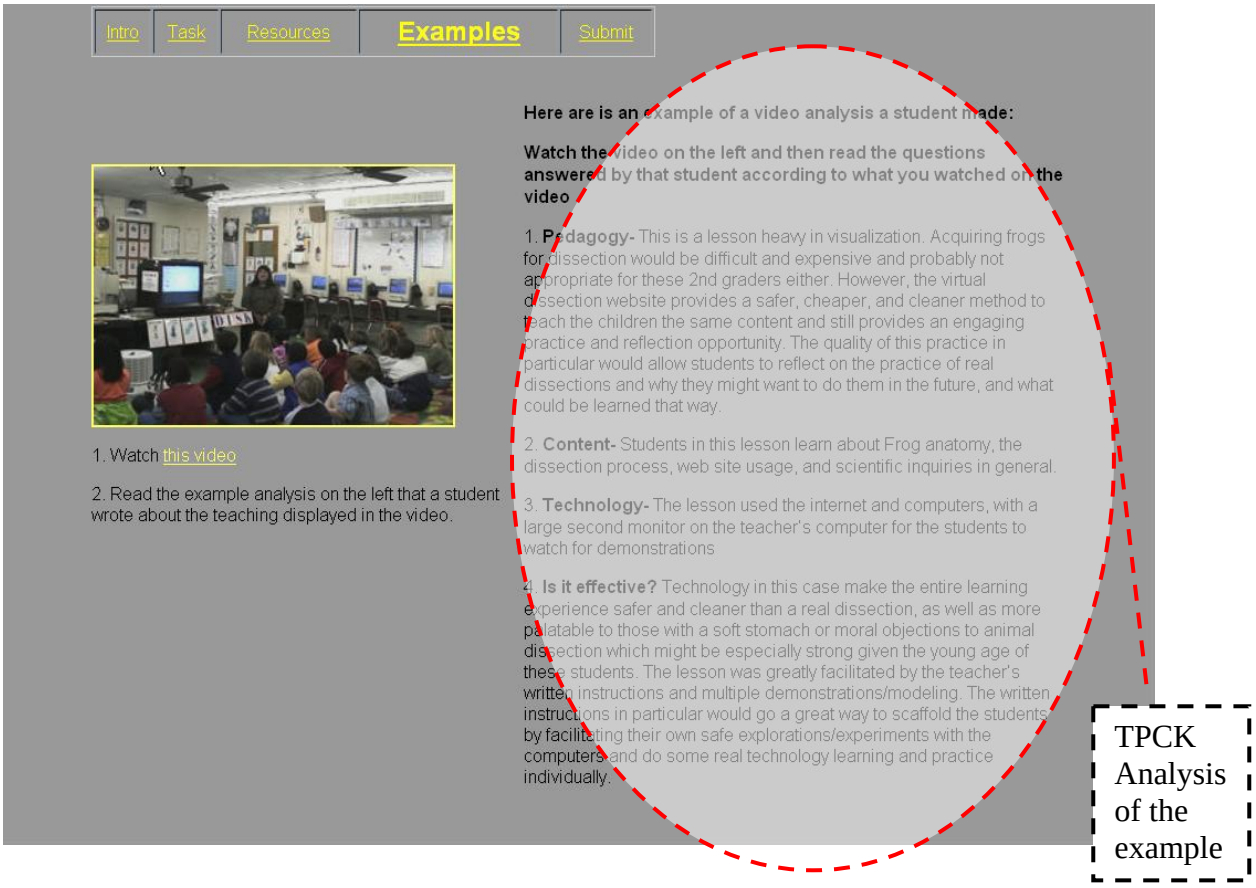

Figure 34. Examples page for the Video Modeling Challenge.

The modules were developed as web-based instruction. It was necessary to use a development tool that did not require much expertise and could easily be modified to increase the flexibility and the sustainability of the design. For this reason Dreamweaver was used, although FlexBuilder was greatly considered.

In addition, to using blended learning as the main approach to the design of the unit, each challenge has specific strategies that ideally fit certain content. Our preference in teaching students technological skills is to give students experience by allowing them

to apply their knowledge in real-world experiences. The TPCK challenges will be tailored to each target group and each unit. It will provide them with a TPCK situation in which they will be given a teaching scenario and one or more of the components of the TPCK framework (technology, pedagogy, or content). Subsequently, they will practice finding a solution to the teaching scenario by using the given components of TPCK and finding the missing components. For example, the technology integration unit will present students with real life scenarios in which teachers have to make choices about how to integrate technology into their lessons. In the module, the student will be given a specific challenge and will be given a TPCK component. For example, we may tell English teaching students that their media or technology is the Teacher Tube website (www.teachertube.com). They will need to fill in the other components of TPCK, which would be the content they will teach using this technology and the pedagogy or method they will use to teach it. In another instance, students might be given the pedagogy of "creating a journal" and the technology might be iMovie, then students would fill in their content. It might be a journal of historical data or it might be a journal of their community or it might even be a scientific journal based on experiments. Rather than just fact memorization the course emphasizes application of skills and knowledge to real life scenarios, or challenges.

The website product for this design project can be accessed at the following URL: http://ipt28x.byu.edu/tpck/Main.html.

Implementation Description

Once the project was approaching completion, there were three main groups with which we implemented the design. The first group that the design was tested on was IPT

286 section 4, Technology for Social Studies Pre-service Teachers for winter semester 2008. Only one challenge was chosen for testing on this group.

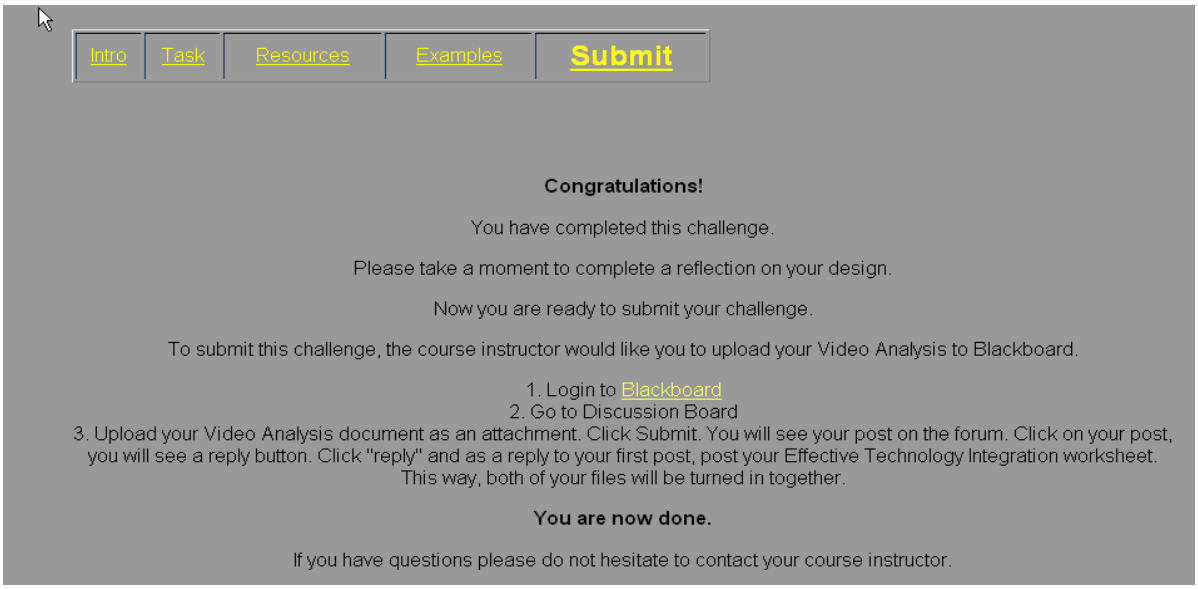

Figure 35. Submit page for the Video Modeling Challenge.

The challenge that best fit the group and would also be the most complex challenge that the blended learning unit offers is the Google Earth virtual tour challenge. The online Virtual Tours challenge was implemented as the class's second project. It was implemented at an optimal time because students had already had some experience with completing project 1. However, it gave them enough time during the semester to redo the assignment if they wished to resubmit it.

The second group, which the design was implemented with was a section of IPT 287. This is an elementary education section which was used to test the TPCK module that can be found in the Effective Technology Integration section of the unit. The module was presented to the class and after the students had some time to go through the

instruction, each student completed a survey with feedback on how the videos could be improved.

The third group used in the implementation of the design was the IPT 286/287 faculty. Every person teaching IPT 286/287 was given the link and asked to go through the TPCK module and the challenges and submit some helpful feedback for the improvement of the site. In addition, each instructor was encouraged to implement the design with any students they saw would benefit from using the online challenges to fulfill project requirements.

CHAPTER IV: EVALUATION

This project was evaluated on many different levels. Some of the evaluation consisted on comparing and analyzing student outcomes. However, most of the data collected formatively came mainly from meeting with the client, student and faculty interviews and observations made by instructors teaching the course. Summative evaluation was largely conducted by the use of online surveys and in-class focus groups. Triangulation was a focus of this evaluation in order to collect the most accurate data from as many sources possible.

Formative

Formative evaluation took place iteratively throughout Winter Semester during the design and development of phase one thru phase three and as the design was piloted with students. Part of incorporating rapid prototyping as a technique required the design, implementation and evaluation process to be done iteratively in order to better serve the students and complete the project in a timely manner. In order to make the most use of time, it became important to conduct formative evaluation throughout the development and design process that consisted of faculty observations and some informal student feedback. Much of the formative evaluation consisted of feedback from Dr. Graham, the professor that oversees the IPT 286/287 sections taught in the McKay School of Education.

Feedback from Instructors

One of the major controversial issues with designing this blended learning unit that emerged during the rapid prototyping phase of the project, was coming to a consensus with the staff on how TPCK should be taught or even if it should be taught at

all. With one year of experience with teaching the TPCK framework behind the team, some instructors teaching the class thought TPCK was a great framework and should be taught in detail including each of its components. However, other instructors thought TPCK should be taught but simplified to the point of not calling it TPCK because the name itself was a source of confusion.

Another major controversy from instructor to instructor that surfaced during the formative evaluation phase was the degree of blend each instructor chose to allow in each section. Some instructors decided to teach the course completely online, while other instructors adopted a blended approach more than others. During the course of the design and development of the project the other instructors of the course were petitioned for ideas on what tools to include in the website and other ideas to make the website more usable.

Feedback from Class

The students taking the IPT 286 course, section 4 were also instrumental in contributing formative feedback for this project. As the instructor for this section and the designer of the project, I was able to ask the class questions to help me understand what they felt was useful and how the project could be improved. For example, during one of the Phases of design I asked my class in a focus group setting what they thought about one of the challenge task descriptions. One of the most useful pieces of feedback gained by asking that question was that the task descriptions should be as concise as possible. Whenever too much detail or explanation was provided the students would become confused. Other small changes were also made from student feedback.

Findings

There were a number of changes made from Phase One to Phase Three. The following items were only some of the features that were modified during that process: icons, how much information to provide on one page, the TPCK image (circles connected, circles disconnected), color, background, so as to allow the user to intuitively navigate the page, using a non-linear approach, design for the TPCK framework instruction, and the sequence for completing a challenge. Table 6 displays some of the modifications made from phase to phase and the reasons why those features were modified.

The main instrument that was used for the formative evaluation phase was informal interviews with Dr. Graham and students currently taking the course. During these interactions, the student or professor would give feedback about the design and changes that could make the design fit the design criteria of scalability, ease of navigation, comparability to the methods and procedure used to teach the same challenges using the face-to-face approach.

The formative evaluation for this project was a process interlaced with the design and development phase, which was definitely an advantage most of the time. It was advantageous to be able to make low fidelity designs and then brainstorm in meetings how the prototype might be improved or what ideas should be conserved from one prototype to another before developing high fidelity models.

In general, this iterative evaluation revealed answers to some of the greater and more important aspects of the modules while reducing the time spent working on creating prototypes.

Table 6.

Formative Evaluation Modifications for Phase Two, Phase Three, and Final Design

Phases	Modifications	Reasons for Modification
Phase Two	1. Icons were defined	1. Adds visual symbols to represent icons
	2. Database used to display challenges	2. Ease of accessibility
	3. Higher fidelity design of each challenge	3. Clearer visualization of each challenge
	4. Bottom left-hand corner reminder of TPCK	4. Remind students of the framework
	5. Help/feedback link	5. Allow help options and feedback for evaluation
Phase Three	1. Unit intro video by the teacher	1. Adds instructor immediacy and closeness
	2. Three videos for each challenge intro page	2. Makes the instruction more clear
	3. Reflection page in the Submit page	3. Allows students to evaluate their own work
	4. Dynamic TPCK framework on each TPCK Resource page	4. Allows the content to be organized and displayed in an effective manner
Final Design	1. No TPCK framework at the bottom of the page	1. Makes each page less cluttered
	2. Final icons	2. Represent each page accurately
	3. Effective Tech Integration page	3. For instructors not using challenges but still interested in using TPCK materials to teach the framework
	4. Database of Useful Resources	4. Provides all the resources in one place for students

Answers to these questions guided the design and implementation of these modules to help us reach students more effectively and in a timely manner. In addition, during this process of iterative evaluation and implementation we were able to see that the blend approach was in fact beneficial and appealing to students.

Summative

Summative evaluation considered some of the same questions formative evaluation answered. However, summative evaluation included more formal feedback, and a more holistic approach to the finished project. Table 7 includes some of the additional detailed questions summative evaluation answered. The main purpose of the summative evaluation was to reveal if the modules effectively allowed students to learn independently and meet the course criteria. Focus groups, surveys, and the results of the completed challenge itself revealed areas for improvement in the design and content of the instruction.

In order to make a summative evaluation of the design it was necessary to break down the design into sections to evaluate parts of the unit independent of each other. It was also necessary to triangulate by using various methods of data collection and different groups as the stakeholders. The summative evaluation can be broken down into the following three parts: the TPCK modules, usability of challenges, and the final instructor feedback.

In order to know what questions would be most effective to ask on the surveys it was important to understand the objective of the website and measure if those objectives had been met (see Appendix B). The main objectives were function of the site, usability

of the different sections of the unit, student perceptions in general and faculty perceptions.

After conducting a study of the objectives, the objectives were used to derive criteria and standards for each criterion. It was apparent that the criteria would have to be organized into categories according to the target audience.

Some criteria related only to students, other criteria were intended only for instructors and some related to both students and instructors (see Appendix B). These standards allowed us to ask more specific questions to determine if our objectives had been met. Based on the standards and the target populations identified questions were generated to determine effectiveness in three areas of the project:

- TPCK module feedback from students
- Challenge module feedback from students
- Faculty Feedback

Qualtrics (Figure 36) was used to create two online surveys that would measure the level of effectiveness of the TPCK module and the effectiveness of the challenges section of the unit. The surveys were given to students in two different classes who had used the challenges or the TPCK module respectively and could contribute some useful feedback for improvement.

TPCK Module Evaluation

The TPCK module was exclusively designed to teach students the TPCK framework. A summative evaluation was done to evaluate whether the module achieved its purpose. The following sections explain in more detail the summative evaluation that took place for the TPCK module.

Table 7.

Summative Evaluation

High Level Question	Detailed Question	Data	Instrument	Measurement Procedure
Is the TPCK Module effective?	Do you understand the TPCK framework and can you apply it to specific teaching scenarios? Did the module provide enough instruction? Is the module easy to navigate?	TPCK knowledge Content on the module Usability of the module	Qualtrics Survey Focus Group	Asked students to become familiar with the module. After they became familiar with the module students were given this survey. After students became familiar with the module, the instructor visited the class and asked questions directly to the students
Is the Virtual Tour Challenge effective?	Do you have any suggestions on the design of the module? Is the content in each step of the challenge complete and effective? Are you willing to complete another online module after completing your first?	Suggestions for improvement Feedback on each section of the challenge	Qualtrics Survey Focus Group	Asked students to become familiar with the module. After they became familiar with the module students were given this survey. After students became familiar with the module I visited the class and asked questions directly to the students
What are faculty perceptions and feedback of the website?	Are the modules effective in communicating instruction? What would you change in this website to make it more useful for your purposes?	General faculty feedback	Email format Face to face interview	Instructors sent in their email and met with me in person to give me a summative evaluation of the website

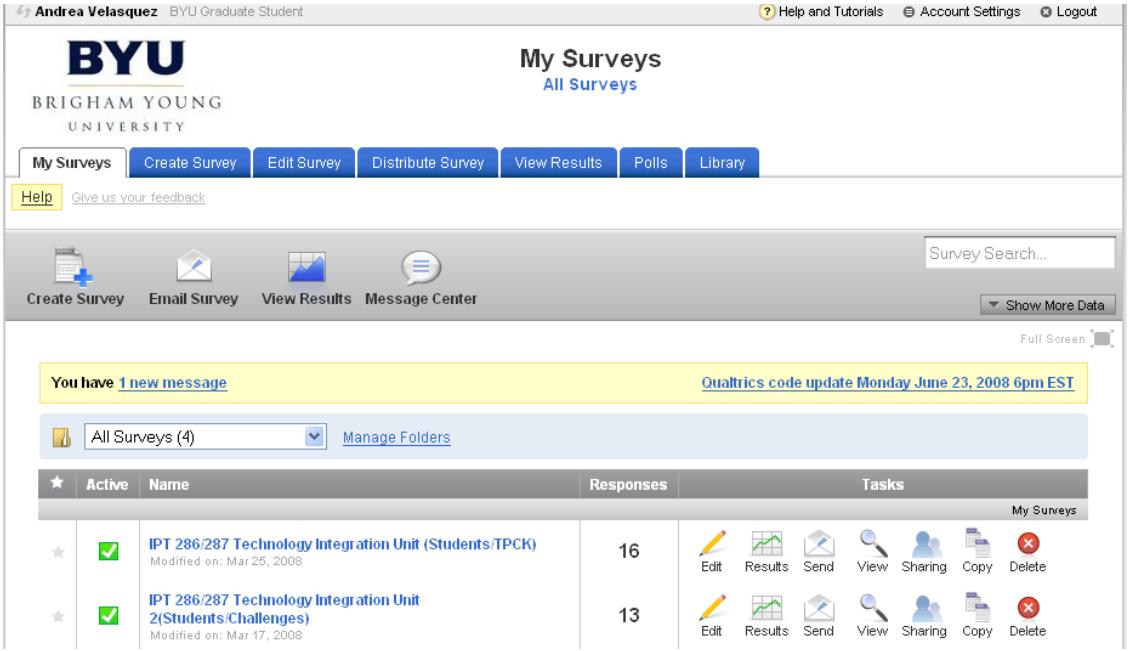

Figure 36. Two Qualtrics surveys created for summative evaluation.

Overview. The questions that were asked for the TPCK survey (see Appendix C) helped measure the objectives that the TPCK module was created to meet. The survey was administered to Dr. Graham's 287 students during Winter 2008 (n=16/21). The following is a list of aspects of the TPCK module that the survey focused on:

Understanding the components of TPCK
If it taught students how to better integrate technology and how technology relates to pedagogy and content.
Sufficient resources
Video One
Video Two
Video Three
The TPCK framework- how it all comes together?
Useful
Ease of navigation

Findings. The findings for the TPCK module indicated that the TPCK video was effective in teaching students the TPCK framework and how to apply it to specific instructional scenarios. The students were asked to explain in their own words how TPCK could help them integrate technology more effectively into their lessons. One student stated the following:

> TPCK uses pedagogy, knowledge, content knowledge, and technology knowledge; combining them together to enhance the learning of the student. It provides an optimal method of teaching by combining the teacher's knowledge and enhancing learning with technology. TPCK can help me integrate technology more fully into my teaching and the method I will be using. It then helps me choose a tool that will most effectively enhance my students' learning.

Most student answers indicated that they understood that technology, pedagogy, and content knowledge work together to make instruction more effective and that it is important for teachers to understand this interplay to be able to create an equilibrium that

fits their student's needs. Four students in the class stated answers that did not indicate a connection with equilibrium between the components of TPCK. For example, one student answered the question by saying, “it gives the students hands-on experience with the material that is studied.” Another student said that TPCK allows students to make “natural connections.” These students failed to address the equilibrium and interplay between the TPCK components.

One of the questions presented students with a scenario in which they were given the technology, a concept mapping software called Inspiration, and they had to find a way of using it to teach an English core curriculum standard effectively. As an answer to this questions, most students broke the situation down to it's components in order to answer the questions. One student said this, “He needs to combine his knowledge of the subject, the content that needs to be covered, the program Inspiration, and effective teaching methods.” Another student stated the following:

> He should first look at the content, see what he knows and research areas where he is lacking. Then consider the possibilities within the inspiration program and make sure that he can teach this in an effective way, or use proper pedagogy in the classroom. Once he knows what and how he wants to teach he can then make a lesson plan taking these things into account as he does.

When students were asked if this website had enough resources to answer these questions, 93% answered yes and 7% answered no.

Some of the main feedback in terms of the videos was that they were not engaging enough. Many students said that they videos were boring or too slow, but still easy to understand. One student said the following, “I thought that all of the videos were

clear, but a little boring. It was too slow."

Many students commented on how easy it was to understand the content of the videos. One student wrote, "I thought they presented the information in an easy to understand way."

One of the videos had a softer volume level than the rest of the videos. Many students said that they would like the volume increased for that video.

One student said they liked how the videos were divided into several videos instead of just one long video. She said, "One by itself would have been just confusing."

In terms of relevance, when the students were asked if they had any questions about the framework, they all said no. Only one student suggested putting up more examples to help them understand how it all connects. 93% said that they thought the content in the videos was useful information. While only 7% said they didn't think it was useful.

Navigation was another factor that was measured. When asked if this module was easy to navigate 15 students thought the module was easy to navigate, while only 1 said it wasn't. The student that said it wasn't recommended the following, "I found the videos easy to navigate, but what else was I supposed to do with all the steps on the left hand side? I found it confusing." Another student stated, "I would suggest placing the instructions for step 5 in a better place. At first, I was confused. Then I scrolled to the right and found the directions."

Challenges Module

The Challenges module used by the class was the Virtual Tour Challenge. After implementing this challenge with the class, a summative evaluation was done to evaluate

how well this challenge was designed. The following section explains in more detail the summative evaluation that took place for this challenge module.

Overview. The questions included in the Challenges survey (see Appendix C) helped measure the objectives that the Virtual Tour Challenge was created to meet. After completing the challenge using the website, students in my section (n=13) were given a survey. The following is a list of aspects of the challenge that the survey aimed to measure:

Clarity of Introduction
Clarity of Task Description
Ease of Resource Access
Useful Examples
Ability to download examples
Clarity of submission instructions
Relevance
The diagram
Task page
General problems
Outside resources used
Access to resources through the diagram
Examples accessed
Improvement of the examples page
Problems downloading
Approach preference
Suggestions for improvement

This group of students had already completed project one in the unit and used the online virtual tour challenge to learn how to use Google Earth. They were introduced to the online unit in class and were given the option to come to class to learn the material, to access it online, or to do a combination of both.

Findings. The instructor showed up to class and was ready to give a face-to-face lecture as usual. However, nobody showed up for face to face instruction. Only three people came into the room only to ask the instructor questions related to the criteria of the

assignment and how to submit it. The following week every student had completed a Google Earth tour.

Students were asked ten types of questions. The first set of questions were intended to measure clarity, accessibility and usability of the different parts of the virtual tours challenge.

1. The introduction was clear
2. The task descriptions were clear
3. The resource section was helpful
4. The resources were easy to access.
5. The examples were useful
6. I was able to download examples.
7. The instructions to submit this challenge were clear.
8. The introduction showed how virtual tours related directly to Social Studies
9. The technology, content, and pedagogy diagram was confusing.

The graph below (see Figure 37), displays the results for the degree to which students agreed with these statements in order from left to right. The main feedback on the Task page showed that most students found the task descriptions clear but some thought that it would be helpful if the description was less detailed and more concise. When asked to describe any confusion experienced during the challenge, one of the most confusing things for students was downloading examples from the examples page and some broken links that have been fixed.

One student mentioned, “maybe show the examples in class as some computers cannot handle so many downloads.” Another student said,

> Have a description outside of the actual tour describing the tour. If I were giving my tour file to another teacher I would explain more and give more information to him/her rather than is in the file and available to students.

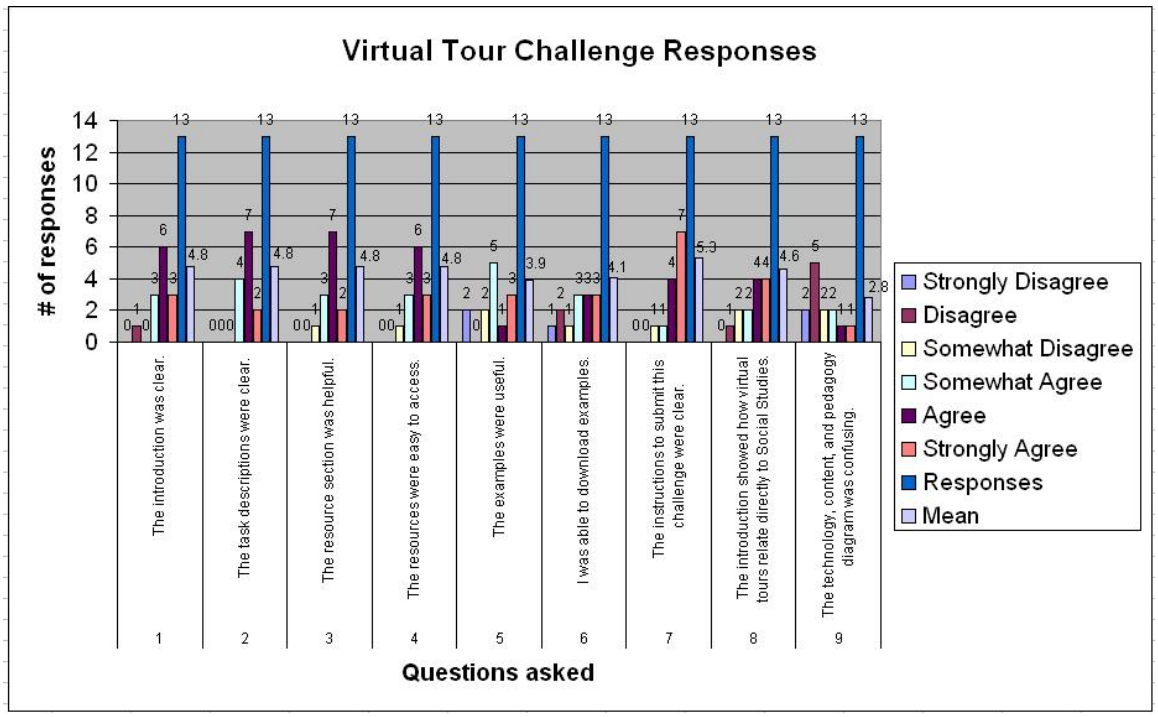

Figure 37. Qualtrics survey results for the Challenges survey.

The survey showed that the example tour accessed the most was the Civil War tour example. It makes sense that students would be most interested in examples based on their subject matter.

One of the most important aspects of the website evaluated in the Challenges survey was the clickable TPCK diagram (see Figure 38). Students were shown the diagram and asked "Was it clear to you that you could access tools by clicking on these circles?" Most students mentioned that they only knew these circles were clickable because it was demonstrated in class, but if it hadn't been demonstrated they would not have known.

Out of thirteen people surveyed, when asked if they would prefer to do this

activity in class or online, only three people said they would have preferred to do it in class. Ten people in the class said they would still have done it online.

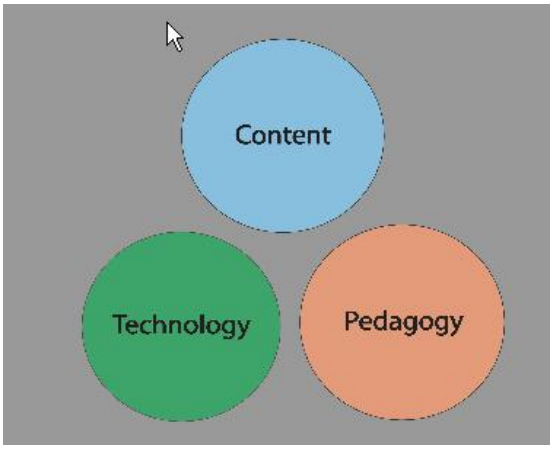

Figure 38. Clickable TPCK diagram used in each challenge.

Final Instructor Feedback

The following section explains in more detail the summative evaluation that took place with the instructors of the course as they gave feedback on the entire unit.

Overview. Overall, all the instructors liked the online unit and agreed that it was a potential tool for them to use in their sections. Each instructor added their own feedback to improve the online course according to their own experience and opinion. The instructors who were currently teaching the course provided feedback via email after having accessed the unit.

Findings. One instructor said that overall the unit was effective and usable. The instructor commented on the video of the TPCK module that was set up on a lower volume than the rest of the videos. She commented on some broken links and expressed that she liked the introduction audio clips for each challenge but that the science introduction clip should be improved with more description. She also stated,

> Also, the science challenge should not be called "science probe challenge." Instead, it should be called "science application challenge." Celestia and some of the others are NOT science probes. If these students go out into the classroom with an incorrect idea of what a science probe is, they will have trouble communicating to other teachers and science specialists.

Another instructor, Instructor 2, also commented on the volume of the TPCK module videos and usability of the module. IPT 286 Instructor 2 said the following, “For the TPCK module, I think you should have instructions (For example, click on the circles to learn more about each one).” Instructor 2 also commented on the content for the content video and other aspects such as downloading time and volume levels. He said,

> …also, it'd be nice if each video started when you click on the link. i clicked on the links, and waited for the video to load. Then, after about 30 seconds, I realized that it had loaded, but I needed to press play. Once again, just a minor personal preference from me.

Besides personal preferences, this instructor also commented on the TPCK videos:

> I feel that your video of TPCK integration helps clarify the principle, but I think there are a few things that are still missing. The main thing that I liked was when you talked about how TPCK transforms your pedagogy.”
>
> “the integration of TK, CK, and PK video has the volume way too low (you probably knew that). I think this is the most important video in the segment. I also felt that there were a few redundancies. The explanations of technology, then content, then pedagogy were covered by the first 3 videos, but maybe you're using planned redundancy. Maybe it just seems redundant to me because I'm familiar

with TPCK. On one part of that video you say "many teachers do the content part and the pedagogy part but forget the technology." I think it'd be good to include examples of how they do that, because I have a hard time seeing how anyone can teach without any technology. I can see them leaving out modern technology, but I can't imagine a lesson devoid of technology. When you show the Venn diagram with different sized circles, it'd be helpful to describe what that would look like. In scenario 1, it seems to me that she's using a chalkboard for her technology. Since the internet wasn't around, I would say she is using one of the latest technologies she had available to her. This also seems to imply that we *always* need to be using technology. If we have parent-teacher conferences, perhaps lecture would be the best method, and modern technology may not be appropriate.

The IPT 287 instructors mainly gave feedback on the final project challenge. The final project challenge has two possible versions. One makes use of Blackboard to submit the assignment parts and the other version makes use of a class blog. Both assignments are very similar but have a few differences based on the preferences of the two instructors that taught the course this semester. The main feedback they offered was on how to lay out the Task Page to make it much clearer and less redundant. Also, the examples page was changed based on their feedback to only show examples for Elementary Education.

CHAPTER V: CONCLUSION

Critique

This project was successful in many respects. It allowed students to complete a unit of work at their own pace. It was successful at achieving the blended learning criteria set forth at the beginning of the project. It was also successful at achieving the instruction by helping students reflect on the TPCK framework and allowing them to analyze the components of effective technology integration. Those were the two main objectives for this project and they were successfully met.

As stated earlier in this report, there are three main reasons for using a blended learning approach including, "a more effective pedagogy, increased convenience and access, and increased cost effectiveness" (Graham, Allen, & Ure, 2005, p. 254). There were various lessons learned in implementing a blended learning approach. The greatest one was that students responded favorably to blended learning options and were willing to learn and use the tools faculty provide for them in order to make their workload more flexible and accessible. This is one of the main reasons this course was developed as a blended learning option. Graham (2007) also states six challenges with using blended learning approaches: "(1) the role of live interaction, (2) the role of learner choice and self-regulation, (3) models for support and training, (4) finding balance between innovation and production, (5) cultural adaptation and (6) dealing with the digital divide" (p. 14). It was a challenge for the instructors to forgo live interaction and the affordances of communicating face-to-face. Despite the communication limitations, students were mostly still satisfied with the online option. Another challenge the blended option created was that training and support on maintaining the site would be necessary if the

site were put to use and maintained by the instructors. In addition, the role of learner choice and self-regulation could possibly become a challenge if students were given more flexibility and options. For example, this project only implemented one challenge with one class. This project did not evaluate the results if students were given all the challenges and given full freedom to make choices on which challenge to complete, order of challenge completion, and pace. For the purposes of this project, the online instruction was only an option for one assignment.

When creating a blended option, it is always a challenge to provide a similar experience for students who choose to complete the instruction online and those completing it in the classroom. This challenge provided the designer with problems related to finding ways to achieve the same results achieved in the classroom using certain pedagogies, by replacing the face-to-face strategies with strategies afforded by online tools. In some ways, creating the blended learning option also facilitated the improvement of pedagogy for the face-to-face approach. For example, the design of the blended learning option required the designer to break down the task and to break down the challenge and to think of ways to teach skills at a simplified level that could not only be used online, but also changed some of the ways the face-to-face section was taught.

In addition, this project was an experiment that was at the forefront of the TPCK framework movement. It is one of the first projects created to help students design instructional experiences based on the three components- technology, pedagogy and technology. The project was innovative in applying the TPCK framework to the various projects or challenges assigned in the unit. Before this project, TPCK had not been incorporated much into the challenges or assignments in the unit. One of the main

purposes this project served was in allowing the client and the designer to see the demand and utility for a blended learning course.

There are also some weaknesses to this instructional package based on the need to make it easy for all the instructors to maintain. Sustainability was a criterion for this project from the beginning, but it increasingly became a priority as the development of the project continued. Not only was it important to make the course easily sustainable, but it was important to make it openly maintainable without requiring the use of a costly software program to make modifications. It later became apparent that using internet-based creation and editing tools like wikis would have been a much better option. This was the greatest limitation of this project; it was created using a software program called Dreamweaver that individual instructors would have to purchase and learn in order to modify the unit. If the unit had been created using a wiki from the beginning it would have been more adaptive to the flexibility needed so instructors could easily make modifications that are crucial to the course. Creating more of an open course would have met the criterion better. An informal needs analysis was done at the beginning of the project in which the need for sustainability was expressed and taken into account. However, it would have been best to have conducted a more formal needs analysis that could have addressed that criterion in more detail from the beginning of the project. According to Gibbons (n.d.b) part of the needs analysis report includes "identifying needs, a statement of the detected need, and detailing the need to show evidence that the need is real and supported by data" (p. 6). Towards the end of the project it became apparent that the tool used to create the project became a key factor in the sustainability of the online course.

Another area that could benefit from improvement would be the TPCK framework videos. The videos used for this project were created by the designer but were not the focus of the project. The videos could be created in a more professional way and include better visuals and improved sound.

In addition, the dynamic TPCK visual on the Resource page could be improved to make it more obvious that the circles used to represent the TPCK framework are clickable and can be used to access more resources.

In general, the rapid prototyping technique used during the development process was very effective and useful for this project. It allowed the project to be planned and formed during a shorter period of time, while still providing the designer with feedback from the client on changes to be made from phase to phase.

The evaluation of this project was executed thoroughly by reviewing the objectives of the project and formulating questions that targeted those specific objectives. According to Gibbons (n.d.a), "Evaluation is the process by which a designer equips an instructional system with the ability to 'sense' its environment and make adaptive changes in response" (p. 1). Although the summative evaluation of this project was very informative, the instructional package could have been better equipped to produce users with on-going evaluations of the site as it went into use.

In general, this project was an excellent opportunity to find a possible solution for a "wicked" problem in design. According to Cross (1982), "People who seek the certainty of externally structured, well-defined problems will never appreciate the delight of being a designer" (p. 224). The work on this project was a delight and a tool in teaching principles of design in action.

Budget and Schedule

Figure 39 displays the tentative schedule used to complete the project. The materials used include the following: computer, developing program tool, class syllabus, class instructors, class content, and PowerPoint presentations.

	Start Date	End Date	Hours to Complete
Analysis			
Creating prospectus	7/1	8/16	20 hours total
Design	7/2	9/1	2 hours/week
Development			8 hours/week
Unit 1 preassessment	8/6	8/10	
Unit 1 module	9/3	9/14	
Unit 1 post assessment	10/29	11/2	
Unit 2 preassessment	8/13	8/17	
Unit 2 module	9/17	9/28	
Unit 2 post assessment	11/5	11/9	
Unit 3 preassessment	8/20	8/24	
Unit 3 module	10/1	10/12	
Unit 3 post assessment	11/12	11/16	
Unit 4 preassessment	8/27	8/31	
Unit 4 module	10/15	10/26	
Unit 4 post assessment	11/19	11/23	
Implementation	Fall 2007		2 hours/week
Formative Evaluation			1 hr/week
Unit 1 preassessment	9/24	9/28	
Unit 1 module	10/1	10/5	
Unit 1 post assessment	10/8	10/12	
Unit 2 preassessment	10/15	10/19	
Unit 2 module	10/22	10/26	
Unit 2 post assessment	10/29	11/2	
Unit 3 preassessment	11/5	11/9	
Unit 3 module	11/12	11/16	
Unit 3 post assessment	11/19	11/23	
Unit 4 preassessment	11/26	11/30	
Unit 4 module	12/3	12/7	
Unit 4 post assessment	12/10	12/14	
Summative Evaluation			1 hr/week
Unit 1	1/7	1/11	
Unit 2	1/14	1/18	
Unit 3	1/21	1/25	
Unit 4	1/28	2/1	

Figure 39. Proposed schedule and time budget.

Conclusion

In general, this project was a great learning experience. It was a complex design challenge to incorporate a framework that is fairly new and continually evolving, and to try to teach it using a blended approach providing similar instruction for students choosing to complete the instruction online and for those completing the instruction in the classroom. The project was successful and much experience was gained from its completion. There were many challenges faced during the course of this project about blended learning, TPCK, design process, and tools that the future of design can benefit from.

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APPENDIX A: ANALYSIS DOCUMENTS

Table 8.

Current Resource Training Analysis

Findings	Implications
1. The product will be hosted at a school university setting but it will eventually be accessed online.	This means that the online instruction must include all the resources the students will need to complete the activities. This means that the site must be user friendly and consistent. This means that the website must take into consideration BYU standards and it must be designed for the college students who will be using it. This means that the site can link to other sources that are also online but must also be kept up to date. The challenges must be easy to understand and the navigation must be intuitive.
2. The instructor is a resource that might or might not be present.	The instructor will need to make his or herself available and provide support to the students who are not understanding the instruction.

A current resource training analysis was conducted to help understand the environment in which the design will function. This document aids a designer in studying the aspects of the environment in which the design will eventually function in to give the design higher chances of survival. (Gibbons ISD book reference here) Table 4 is a current resource training analysis that details some of the aspects of the environment this project will function in and some of the implications of those aspects. One of the major implications for a blended learning environment is that the course can be accessed from any place with internet access. Therefore, the environment is almost ubiquitous. This implied that the design needed be very flexible to accommodate that increase in accessibility of the course.

A target population analysis allows the designer to analyze the target population and design instruction based on the target population's needs. Table 5 shows the target population analysis conducted for this project and the implications for the design.

A task analysis was also conducted to understand the performance requirements for the new design of this course. The following outline shows the task analysis in detail breaking it down from TPCK to each of the five challenges that students are required to complete in order to get credit for the course.

Table 9.

Target Population Analysis

Findings	Implications
1. The target population is knowledgeable about computers and how to use the internet.	This means that the modules can be designed knowing that the students will know how to use them.
2. The minimum age of the target population is 18 year olds. Most students taking the class are juniors or seniors.	This means that the instruction should be geared towards a younger audience. The appearance should appeal to young people and it should be entertaining in some way.
3. The target population is mostly college students.	The instruction should be educational and have some sort of assessment. This also means that they probably value education so the amount of motivation is important but not central to the design. This also implies that the instruction needs to be designed as it were speaking to an intelligent, educated audience.
5. The target population is all English speaking.	The instruction needs to be in English.
6. The target population is mostly females but some males.	The design should accommodate males, although the class is usually attended by females.
7. The target population has no physical limitations, but needs to complete this course in a time period of one semester.	The instruction will need to be planned for a time period of one semester. The modules need to be equivalent in time to face to face instruction.

Task Analysis

Understand the TPCK framework and apply it to your teaching
Understand TPCK (Intro)
Understand the component definitions
Read examples and resources for each component
A. Understand Activity Structures
Understand how it applies to different teaching scenarios
Understand the equilibrium necessary

A. Identify TPCK in teaching videos
a. Take a preassessment.
b. Review the TPCK framework
c. Search VMDB database
d. Answer scaffolded questions about how each component is present in the video watched.
e. Submit answers
Use the Principles of Effective Technology Integration
Use the TPCK framework
f. Assess
Use the Principles of Effective Technology Integration
Use the TPCK framework

B. Create a virtual tour
a. Take a preassessment.
b. Review the TPCK framework
c. Learn how to use Google Earth
d. Review pedagogies and activity structures in your content area.
e. Decide on the content (subject and objective) that your virtual tour will target.
f. Create the tour.
g. Submit tour
Use the Principles of Effective Technology Integration
Use the TPCK framework
h. Assess
Use the Principles of Effective Technology Integration
Use the TPCK framework

C. Create a digital story
a. Take a preassessment.
b. Review the TPCK framework
c. Learn how to use PhotoStory
d. Review a given list pedagogies and activity structures in your content area.
e. Decide on a pedagogy your digital story will be used in.
f. Decide on the content (subject and objective) that your virtual tour will

target.
g. Create digital story
h. Submit digital story
Use the Principles of Effective Technology Integration
Use the TPCK framework
i. Assess
Use the Principles of Effective Technology Integration
Use the TPCK framework

D. Teach students through the use of science probes
a. Take a preassessment.
b. Review the TPCK framework
c. Learn how to use Science Probes and Logger Pro
d. Choose a probe to use in your teaching.
e. Review pedagogies and activity structures in your content area.
f. Decide on the content (subject and objective) that your lesson will be on.
g. Decide on the pedagogy or activity structure.
h. Submit lesson plan
Use the Principles of Effective Technology Integration
Use the TPCK framework
i. Assess
Use the Principles of Effective Technology Integration
Use the TPCK framework

E. Create a final project.
a. Take a preassessment.
b. Review the TPCK framework
c. Learn how to use the technology you will be using or review it.
d. Review pedagogies and activity structures in your content area.
e. Decide on the content (subject and objective) that your lesson will be on.
f. Decide on the pedagogy or activity structure.
g. Decide on the technology.
h. Create a final project
Use the Principles of Effective Technology Integration
Use the TPCK framework
i. Assess
Use the Principles of Effective Technology Integration
Use the TPCK framework

APPENDIX B: OBJECTIVES DOCUMENT

The following document was created in order to organize the objectives to help create questions for the survey that would measure whether or not the objectives were reached. The objectives are organized according to objectives that focus on the sections of the unit, objectives that focus on the function of the site, and some of the more general objectives in terms of how the site will influence the students in general. The objectives helped to determine some criteria for the evaluation and the standards to use in measuring those criteria.

After listing all the objectives, color codes were used to differentiate objectives according to their main purpose. For example, aqua color-coded objectives are concerned with desired student outcomes. Gray color-coded objectives deal with accessibility issues and structure. Yellow color-coded objectives deal with the module and content of each challenge.

Objectives

Create a database-Technology Integration

- Demonstrates TPCK through the structure of the challenges, images, annotated examples
- Easily accessible for teachers (old and new teachers)
- Expandable and modifiable to provide future resources for teachers and students to use in blended learning.
- Inspires confidence in using technology as applied to subject matter.
- Facilitates blended learning
- Provides resources to complete tasks or challenges.
- Provides examples of effective technology in a variety of contexts.
    - VMDB
    - Virtual Tours
    - Digital Storytelling
    - Science Probes
    - Final Project

- Modules will contain an introduction, a specific task, a list of resources, examples and instructions for submission.

- Aids in teaching TPCK
- Aids in teaching the Four Principles of Effective Technology Integration
    - Lists the four principles of effective technology integration.
    - Provides audio explanation of each.

For students

Criteria
Aids in teaching TPCK and Effective Technology Integration
Standard
Students clearly understand what TPCK and the Four Principles of Effective Technology Integration are and how it can make their teaching more effective.

The website depicts and encourages effective technology integration in it's structure and content.

Criteria
Inspires confidence in using technology
Standard
Students understand that there are many resources on the web where they can learn about technology and collaborate.

Students are not fearful of learning a new technology.

Website interface and usability- user friendly
Audio
Usability-Placement of icons and structure of the website
Images

For teachers and students

Criteria
Provides resources
Standard
The resources available are for teachers and students.
The resources fit the challenges and are sufficient to complete the challenge.

For teachers

Criteria
The website is accessible, expandable and modifiable
Standard
A teacher with limited knowledge of html can create a challenge

Criteria
The website encourages blended learning

The website enables teachers to create a blended learning course.

The following is a list of questions used in summative evaluation that were generated after the objectives and criteria were determined. The questions target specific sections of the unit.

Questions for the Evaluation Instrument

TPCK

These questions help determine whether students understand the TPCK framework and how the resources included in the design can be improved to achieve this objective.

What are the four principles of effective technology integration?

Explain in your own words how to integrate technology more effectively in your classroom.

Mr. Smith has just learned about a new program called Inspiration. This program allows students to create concept maps through the use of concept mapping software. He would like to integrate it into his classroom instruction to make learning more effective. How can he use the technological pedagogical content knowledge framework to make this happen?

How can Mr. Smith use the four principles of effective technology integration to make his software integration more effective?

Does this webpage have enough resources for you to answer these questions?

Do you have any questions about TPCK?

Do you know where you can go to ask your questions or find answers?

Did you find the idea banks for you subject matter useful?

Did you find the idea banks for your subject matter clear to understand?

Did you read the TPCK article?

The Challenges

These questions help determine whether students understand the challenges and if the resources included in each challenge can be improved to achieve this objective.

Intro
Was the intro helpful in showing how virtual tours is relevant to your subject matter and to teaching social studies?

Task
Was the task clear?
What questions did you have or were you not clear on about the task description?
Did you have any problems with the task description or with the effective technology integration worksheet?

Resources
Did you find the resources for the challenge helpful?
Did you have to access other resources other than the ones provided on the website?
What were they?
Was there a problem with accessing resources
Was it helpful to have the technology, content, and pedagogy circles in the resource page?
Was it clear to you that you could access tools by clicking on those circles?

Examples
Were the examples helpful?
Which examples did you use?
Would it better to have more examples or less examples?
Was there a problem with downloading examples?

Submit
Were the submit instructions clear?
Did you have any questions about how to submit your project?
Was there a problem with submitting your project?

Was it better to cancel class and do the challenge online, or would you prefer to have done the challenge in a face-to-face environment?

(Use Voice Thread to answer this)
Were the images helpful?

Was the audio helpful?
Were you able to understand the movie tutorial even though it had no audio?

Was the layout of the module easy to understand?

For Faculty

These questions help determine whether faculty understand the online unit and how the resources included in the design can be improved to achieve this objective.

The website is accessible, expandable, modifiable.

Provides resources

The resources available on the database are excellent.

The resources are fitting to the challenges or assignments you give your class

Are there any websites or resources that could be included on the website that are not there?

Watch the TPCK and Four Principles of Effective Technology videos
Did you think the instruction and explanation found there are accurate and clear?

Do you see potential in this online module?

Do you think you would use this module if some of the projects you do in the effective technology integration unit were turned into challenges and put in the challenge database? In this case, your students could do the projects online with the option of coming to a face to face session.

Do you have any suggestions?

(Use Voice Thread to answer this)
Were the images helpful?

Was the audio helpful?
Were you able to understand the movie tutorial even though it had no audio?

Was the layout of the module easy to understand?

APPENDIX C: SURVEY INSTRUMENT

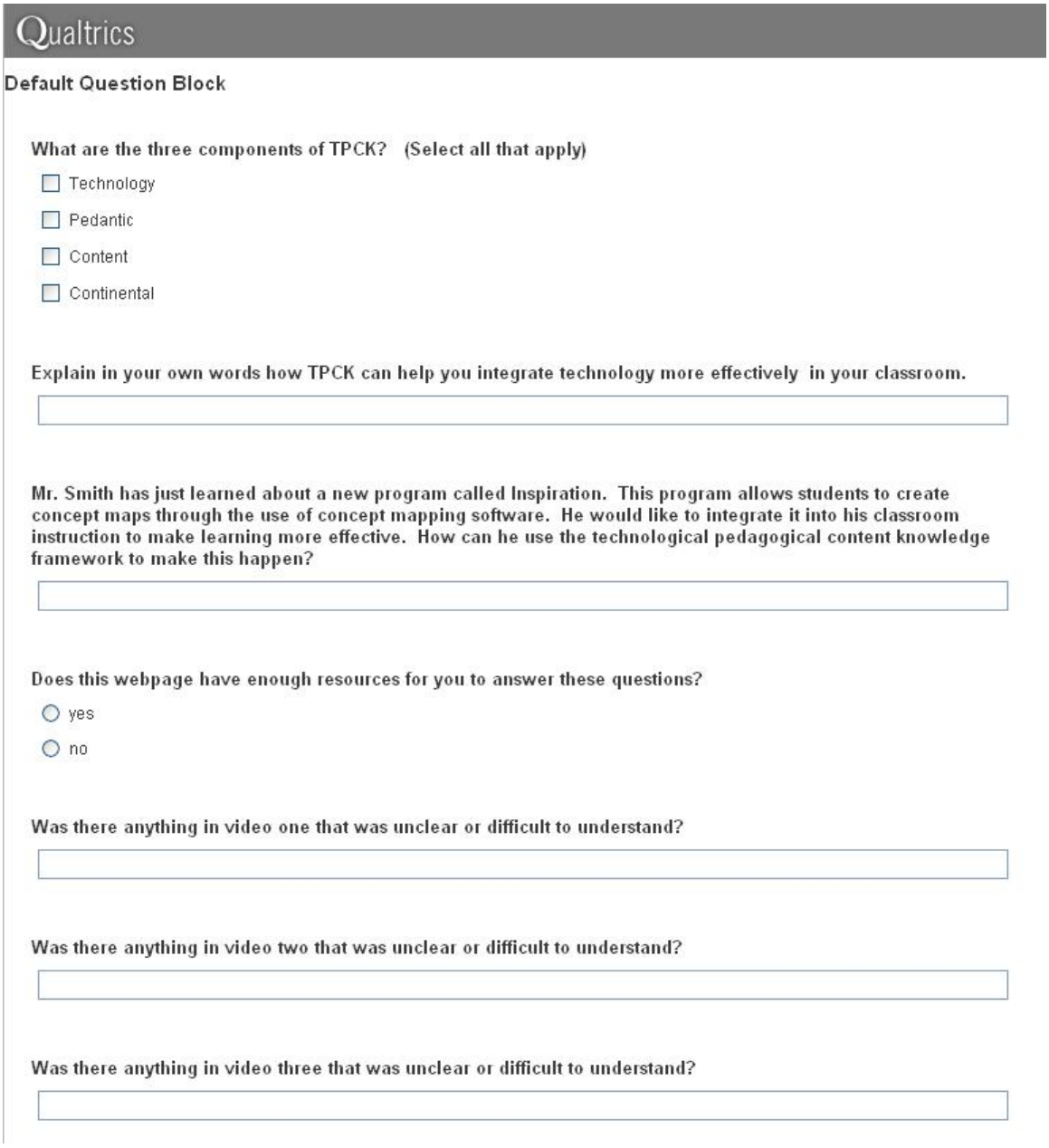


Figure 40. TPCK survey.

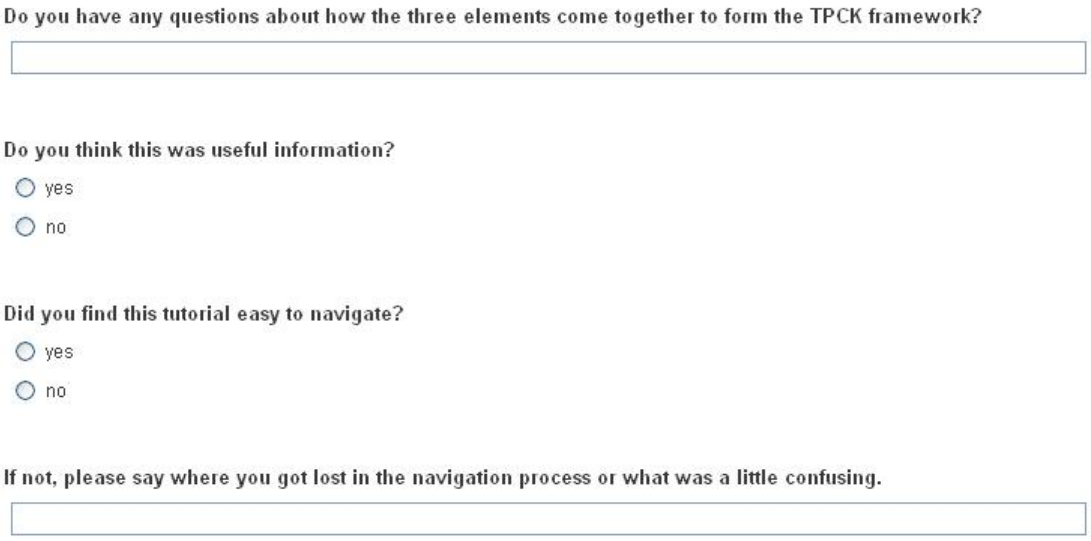
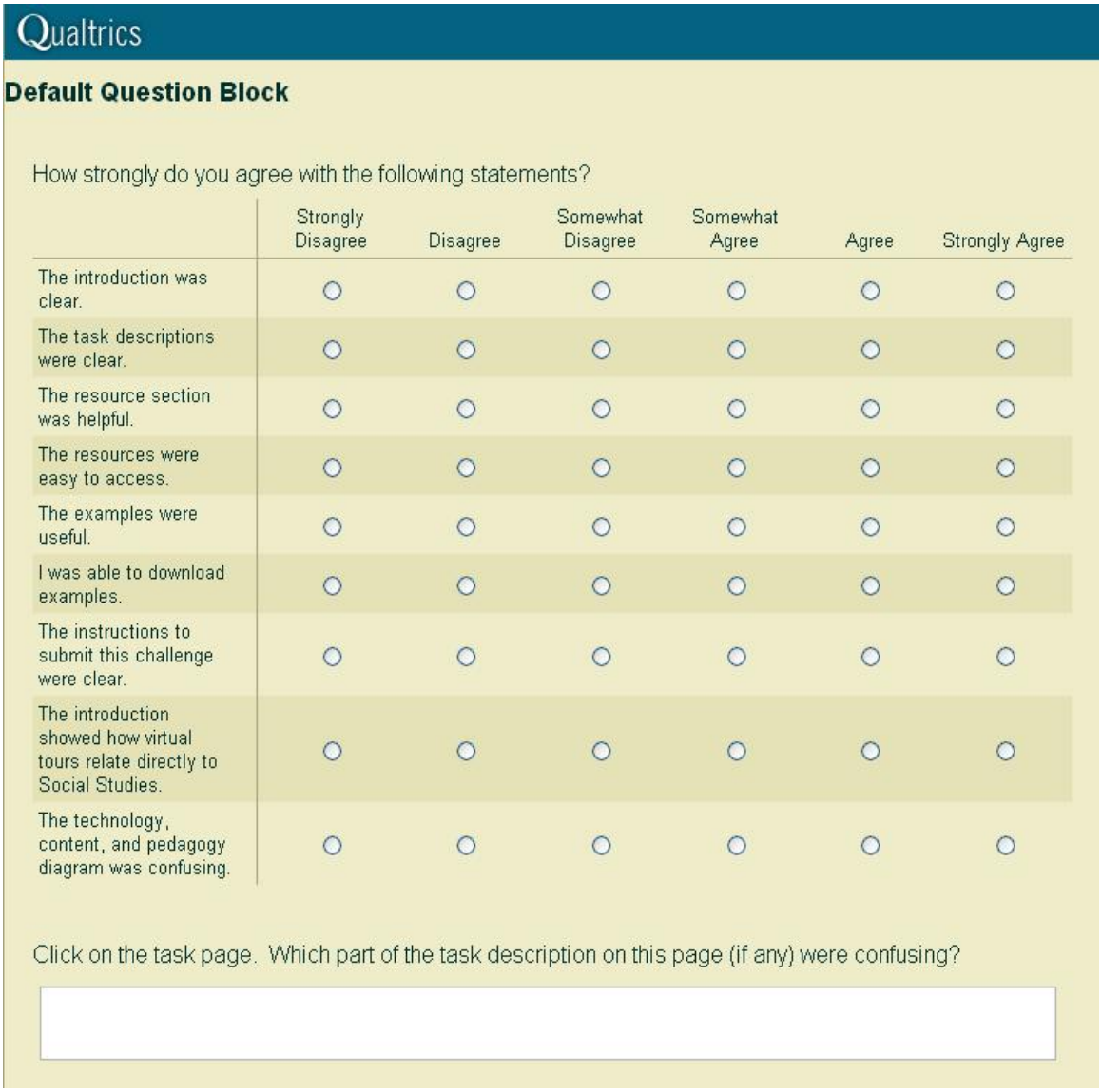


Figure 40. TPCK survey. (continued)



Qualtrics

Default Question Block

How strongly do you agree with the following statements?

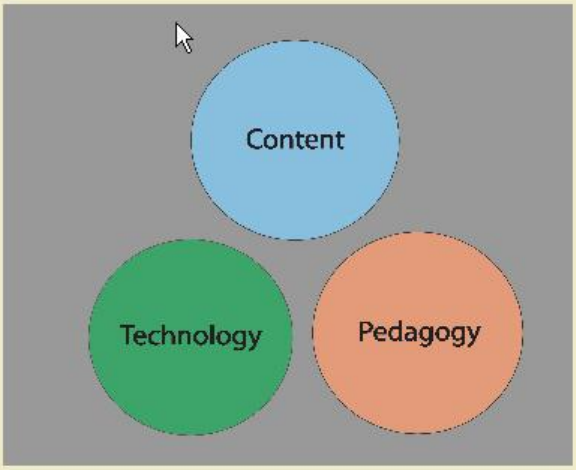
	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
The introduction was clear.	○	○	○	○	○	○
The task descriptions were clear.	○	○	○	○	○	○
The resource section was helpful.	○	○	○	○	○	○
The resources were easy to access.	○	○	○	○	○	○
The examples were useful.	○	○	○	○	○	○
I was able to download examples.	○	○	○	○	○	○
The instructions to submit this challenge were clear.	○	○	○	○	○	○
The introduction showed how virtual tours relate directly to Social Studies.	○	○	○	○	○	○
The technology, content, and pedagogy diagram was confusing.	○	○	○	○	○	○

Click on the task page. Which part of the task description on this page (if any) were confusing?

Figure 41. Challenges survey.

Please explain any problems you encountered while using this website. This may include downloading examples, submitting your challenge, accessing resources, or understanding instructions or tasks.

Which outside resources (including other people or other websites) did you access that were not on the resource page?



Was it clear to you that you could access tools by clicking on these circles?

Figure 41. Challenges survey. (continued)

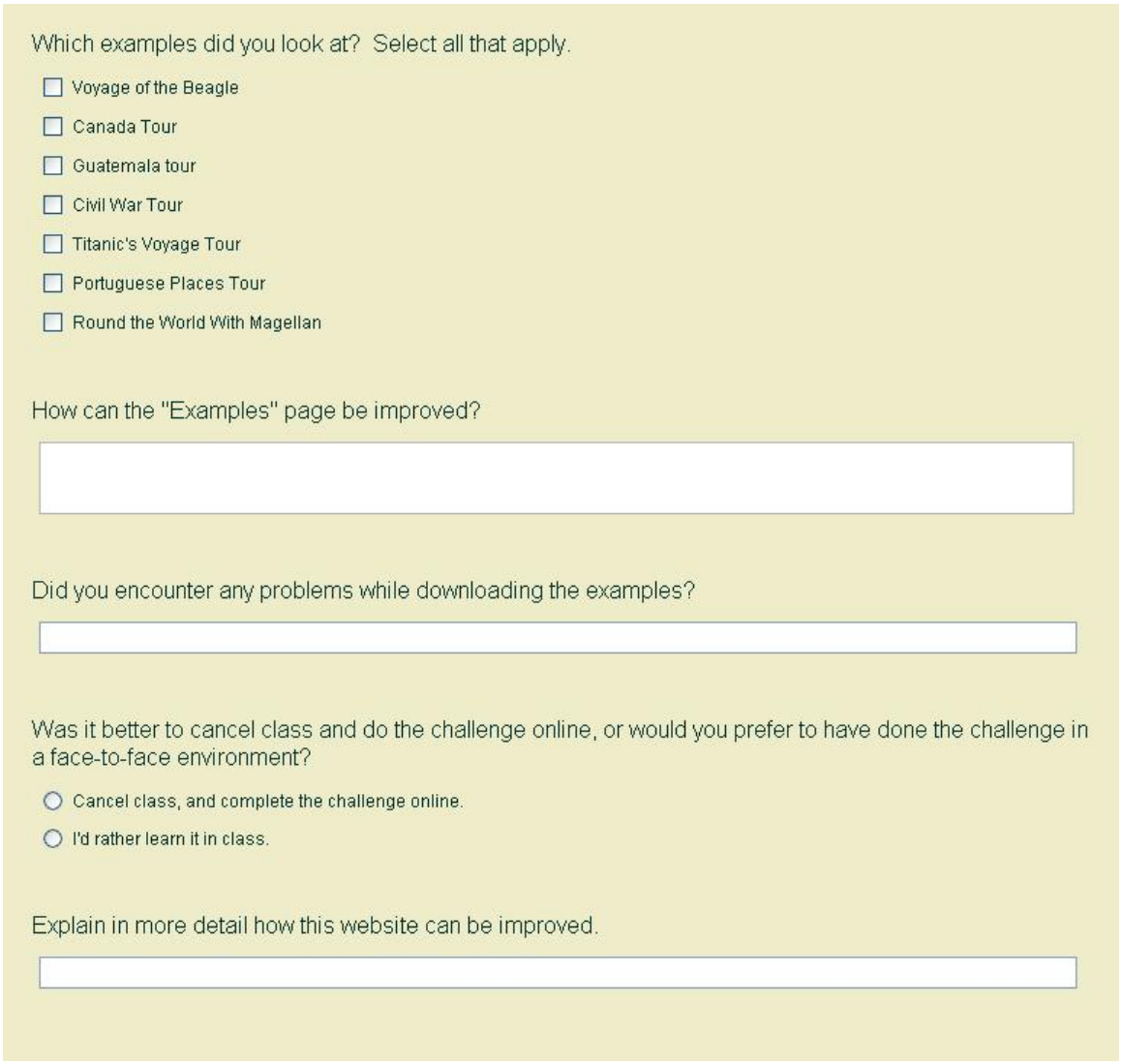


Figure 41. Challenges survey. (continued)