# BUILDING TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) AMONG PRE-SERVICE TEACHERS IN A SCIENCE METHODS COURSE USING ACTION RESEARCH

By

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To my family

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In this study I investigated the problem of helping my pre-service elementary science teachers to develop the skills necessary to intentionally design effective lessons with technology integration within content areas. I needed to develop a strategic plan of action to facilitate the development of these skills among my students. I developed a teacher education course to support the growth of technological, pedagogical, content knowledge (TPACK) among pre-service teachers within a science methods course and, through carefully planned action research, evaluated the impact of the course and how it might be improved for future semesters. Using TPACK surveys, learning activities, and an assessment rubric, pre-service teachers were introduced to the TPACK framework in an effort to guide their lesson plan development. Researcher reflections and lessons learned provided direction for changes in future science methods courses and to improve the TPACK development of my students. This research aimed to answer two questions: In what ways will my pre-service teachers' TPACK knowledge change during a carefully designed science methods course? and What teaching strategies and learning activities will support TPACK development among pre-service

teachers in a science methods course? This research study is significant in the field of education as teachers are continually challenged to meet the needs of a diverse population of increasingly digital learners. In order to meet these teaching and learning needs, graduates of teacher education programs must become competent in lesson design that effectively integrates appropriate technology with content, in pedagogically sound ways that supports student learning.

Data collection included a pre and post TPACK survey, pre and post lesson plans, exit interviews of pre-service teachers, and a researcher reflection journal. I utilized analysis of the TPACK survey to compare paired data from each survey category. The pre and post lesson plans were analyzed and evaluated using content analysis with pre-set coding and comparison of lesson plans using the TPACK-based coding criteria with percentage comparison. Researcher reflections and exit interviews of pre-service teachers were analyzed using content analysis with emergent coding.I found that pre-service teachers' TPACK knowledge increased in key areas, students' general understanding of technology integration practices increased, evidenced through pre and post lesson plan submissions, and students' misconceptions about the way to go about using technology in lesson planning (TPACK) were clarified throughout the course. The teaching strategies and learning activities that supported TPACK development among the pre-service teachers in my science methods course included assigned readings, videos, specific content resources, scaffolding of class activities, and the introduction of the TPACK lesson plan format. These and other resources guided students to revise previous lesson plans and develop new lesson plans as they put the TPACK components together. Students interacted collaboratively through peer reviews and also recommended strategies for strengthening TPACK development in future courses.

These results have implications that reach beyond my science methods classroom for pre-service teachers. Applicable in many education settings, the recommendations for TPACK development can benefit other courses within the school of education that this course was taught, as well as schools of education elsewhere who are working to prepare teachers for today's classroom.

Making research-informed decisions about changes in technology integration practices is an urgent issue in our education systems. With such an emphasis on the use of technology for instruction, it is vital that teachers be knowledgeable about ways to maintain research-based pedagogy amidst the infusion of technology in the classroom.

# CHAPTER 1
# INTRODUCTION

## Statement of Problem

As an experienced classroom teacher, I know firsthand the challenge of developing lesson plans that are both appropriate and effective. Along with decisions about the best technology tools to support instruction, teachers must be knowledgeable of and able to determine the best tools to support the curriculum-based teaching and learning needs for their specific context (Hoffer and Harris, 2010). Koehler and Mishra developed the concept of Technological, Pedagogical Content Knowledge (TPACK) and provided a descriptive framework of tools to help guide the development of lesson plans that integrate content, pedagogy, and technology (Koehler and Mishra, 2006). These researchers developed surveys, learning activities, rubrics, and other tools to support the development and assessment of TPACK related competencies with pre-service and in-service teachers. Multiple studies have shown these tools to be both valid and reliable when used to support the development of TPACK among educators (Koehler and Mishra, 2009).

In the spring semester of 2013, I developed an introductory science methods course for education majors. This course was among the first "methods" courses that education majors were required to take in their program of study. Although I have several years of experience teaching technology-rich lessons to elementary children, the task of guiding pre-service teachers to develop technological, pedagogical content knowledge was a novel experience for me.

Teacher education candidates in this particular school of education were required to integrate technology into lesson plans throughout their methods courses without first receiving explicit instruction on the pedagogical strategies necessary to purposefully integrate technology in content-based learning. As a result, it had become a critical need for my students to develop the skills necessary to intentionally design effective lessons with technology integration within content areas. To facilitate this, I needed to develop a strategic plan of action to facilitate the development of these skills among my students. In doing so, I aimed to build a bridge between theory and practice by consulting relevant literature to guide my course design. For this study, I developed a teacher education course to support the growth of technological, pedagogical content knowledge (TPACK) among pre-service teachers within a science methods course and, through carefully planned action research, evaluated the impact of the course and how it might be improved for future semesters.

## Purpose

The purpose of this action research study was to strategically design, assess, and plan a series of activities that encouraged the development of technological, pedagogical content knowledge of pre-service teachers in an introductory science methods course. Using TPACK surveys, learning activities, and an assessment rubric, pre-service teachers were introduced to the TPACK framework in an effort to guide their lesson plan development. Researcher reflections and lessons learned provided direction for changes in future science methods courses and to improve the TPACK development of my students.

## Research Question

My research aimed to answer the following questions: In what ways will my pre-service teachers' TPACK knowledge change during a carefully designed science methods course? What teaching strategies and learning activities will support TPACK development among pre-service teachers in a science methods course?

## Significance

This action research study guided my development of an introductory science methods course to support TPACK among pre-service teachers. My research is significant in the field of education as teachers are continually challenged to meet the needs of a diverse population of increasingly digital learners. In order to meet these teaching and learning needs, graduates of teacher education programs must become competent in lesson design that effectively integrates appropriate technology with content, in pedagogically sound ways that support student learning. By following an action research model of inquiry, I developed this course using intentional and systematic processes of research and reflection, which provided evidence of teaching activities and strategies that support student growth in the area of TPACK. Not only do the findings provide practical implications for application in future methods courses for me, but results and related suggestions are also applicable to the wider setting of educational methods courses taught by teacher educators.

CHAPTER 2

COURSE DESCRIPTION AND INTERGRATED LITERATURE REVIEW

## Context

### Setting

This action research study took place at a small, private, liberal arts university in North Carolina, with approximately 2,000 students residing on campus. Of these, less than 100 were enrolled in classes within the school of education. The university is located approximately 50 miles from the nearest major city. The school systems where students were placed for practicum experiences were ethnically diverse, mostly high poverty (federal Title I) schools. State test scores over the past five years have been low, with many schools' scores falling just at, or below, the state average passage rate according to No Child Left Behind data (No Child Left Behind [NCLB], 2002). The majority of graduates from our school of education obtain teaching positions in the surrounding school systems following graduation.

### Teacher-Researcher

I am a first-year university professor with past experience teaching at the elementary level as a classroom teacher. Assigned courses in the fall semester were research methods, technological applications, arts methods, and student teaching supervision; all for education majors. For spring 2013, I taught science, math, and research methods, as well as technological applications, to education majors. While in the elementary classroom setting, I gained extensive experience integrating technology into content-area teaching through use of a variety of technological tools as a result of being awarded a grant for a "21st Century Model Classroom". This grant resulted in the obtainment of a class set of laptops, iTouch devices, digital cameras, an Active Board, and other related equipment.  These technology tools were integrated into teaching and learning daily in the elementary classroom (Rowan-Salisbury School System, 2011).  It is now my passion to help prepare pre-service teachers to effectively plan technology integration to provide support for children in meeting their learning goals.

**Participants**

The participants in this study were students enrolled in an undergraduate elementary science methods course.  The course included nine females between the ages of 18 and 34 years old.  All nine students were Caucasian.  Two participated in the school's work study program, earning compensation towards university fees in return for their duties for the University.  All students had been formally admitted into the teacher education program at the time of the study and had completed introductory courses in educational technology, education psychology, and introduction to teaching.  In addition to these prerequisite courses, all nine students completed a minimum of fifteen observation hours in elementary school settings prior to the start of this course.

**Theoretical Research Basis for Initial Course Design (TPACK)**

Mishra and Koehler developed the Technological, Pedagogical Content Knowledge framework, commonly referred to as TPACK, in 2006.  This conceptual framework serves as a set of guiding principles and references that attempt to meld together each of the required forms of knowledge that educators should consider when designing instruction.  These three forms of knowledge are content knowledge, pedagogical knowledge, and technological knowledge (Koehler and Mishra, 2006). Figure 2-1, located at the end of this chapter,  provides a visual depiction of the interrelatedness of these three forms of knowledge.

Content knowledge is described as the subject matter. This knowledge is about the learning of concepts within the curriculum and the related processes. Pedagogical knowledge has to do with the teaching strategies used to promote the learning of the curriculum content. Technology is the selected tools used to support the pedagogical design and the learning of the content.

Each of these separate forms of knowledge can be combined to form distinct combinations of additional knowledge types such as Technological Content Knowledge, Technological Pedagogical Knowledge, and finally Technological, Pedagogical Content Knowledge (TPACK). When pedagogical and content knowledge are combined, the teacher is able to design learning experiences that help the learners achieve the curriculum goals in terms of content. Technological and content knowledge combine to mean understanding the impact of technological choices in relation to the curriculum. Technological and pedagogical knowledge together means the lesson design decisions for technology and strategies for supporting learning are used effectively (Koehler and Mishra, 2006). One of the key differences between the TPACK framework and the role that technology integration has had in the past is the focus on the constructs of teaching, rather than how to use specific technology tools (Mishra, et al., 2009). The premise behind this is that technology is always changing and so are the tools that we have access to as educators. If we can develop guidelines for best practices for how we use technology to support instruction, then we can focus on the components of the technology tools that make them beneficial in the classroom. Then, when the tools change, we know what to look for in choosing others. It is really the pedagogical allowances that technologies offer us that make them appropriate (or not) for use in the classroom.

The TPACK framework is used in other institutions of higher learning to guide the development of technology integration skills among pre-service students. TPACK is taught to pre-service teachers at Brigham Young University in a series of systematic and sequential steps at key points throughout the program of study. Wentworth and two other Brigham Young professors have designed this teacher education program of study to begin in the educational technology course with an introduction of technology tools for a variety of learning purposes. Then, pre-service teachers continue their study of TPACK in each of their methods classes, as they learn to merge content and pedagogy with the selection of appropriate tools to support their learning goals. Finally, students in this education program practice their TPACK integration skills in the field as they complete their final field experience. During this final field experience, students complete a teacher work sample that involves using TPACK to support active learning. Specific information about how these researchers support TPACK development throughout the education program that pre-service teachers complete at Brigham Young University is available in the *Handbook of Research on New Media Literacy at the K12 Level: Issues and Challenges in chapter 51* (Wentworth et al., 2009). The information developed by Wentworth and others at Brigham Young University provided key insights for this study (i.e. C1) and beyond as I continue to work to support the development of TPACK in the science education context and also as I develop implications for future suggestions for course and programmatic change at my university.

The TPACK framework has been used by other researchers in search for insight into technology integration practices. A study by Graham and others in 2009 examined TPACK development among in-service teachers of science. Their focus was on the measurement of the confidence that the participants had in their TPACK knowledge. The TPACK constructs that were measured were TPACK, TPK, TCK, and TK. The results of this study were used to support further development of science program coordinators in strengthening the technology content knowledge (TCK) of science teachers by exposing them to technology tools specifically useful in supporting science teaching. The Graham, et al. study is related to this research as it suggests the need for exposing my pre-service teachers to specific technology tools that support science teaching and learning, such as those listed in Table 2-3 at the end of this chapter (Graham, et al., 2009).

Polly and Brantley-Dias noted the ways that TPACK is used in association with technology integration in learning environments and in finding out what teachers know and how teachers are using technology in the classrooms. They suggested questions about how teacher education programs are currently designed and how we might further develop TPACK among teachers (Polly and Brantley-Dias, 2009). These studies suggest the need for further research about the ways that pre-service teachers are being prepared to teach using technology tools that are rapidly changing.

Thompson and Schmidt provide support for the use of the TPACK framework in the development of educational technology among pre-service teachers and others. They describe it as having entered a new phase in its use in research; its focus now being used in research and development, and no longer solely on developing a theoretical definition of the framework itself (Thompson and Schmidt, 2010). A longitudinal study is currently in progress in Taiwan where pre-service teachers were taught the TPACK framework in an introductory educational technology course and are now being tracked to determine the level of follow-through they exhibit with respect to technology integration in their classrooms. In addition, this study is focusing on the implications of modeling by professors during teacher-education classes and the transfer of associated beliefs about technology use in the classroom from professor to teacher education candidate. The premise is that Bandura's Social Learning Theory will come into play, as the now practicing teachers are teaching as they were taught through the modeling that took place in their pre-service educational technology classes (Baran, et al., 2011). The implications of the Baran et al. study on my research included the need to model what the researcher expects from the students in the instructional sequence to give these participants clear examples of how to use TPACK to develop lesson plans for children.

Another recent study using the TPACK framework was conducted by Marino and others and focused on improving use of TPACK integration with assistive technologies to provide support for children with disabilities. This study suggests the need for improving the preparedness of pre-service teachers to select appropriate assistive technology tools in support of the special education children in their regular education classes (Marino et al., 2009). The Marino et al. study is relevant to my research as it suggests the inclusion of assistive technology tools when introducing science methods pre-service teachers to technology tools that enhance the instruction of scientific concepts. Examples of assistive technology tools include tactile measuring devices for those with visual impairments, a text-to-speech software program, videos, advanced organizer software, digital recorders, Livescribe for notetaking, iPods to listen to lectures at own pace, etc.

Chai and others studied the perceived development of TPACK among pre-service teachers using an adapted version of the TPACK survey designed by Schmidt and others. The study's findings and implications suggest that the pedagogical component of TPACK should be the focus first when preparing pre-service teachers for the classroom. These researchers also determined that it is important to continually provide opportunities for pre-service teachers to practice combining pedagogy with content and technology throughout their education courses to maintain strong pedagogical skills (Chai et al., 2010). This provides insight into the development of the activity sequence for my study as participants needed to develop an understanding of how to best teach science pedagogically before moving into an exploration of the available technology tools for teaching science and how to select these to support their pedagogical needs.

Overall, this collection of recent research on TPACK supports the use of this timely and innovative framework in the development of technology integration for pre-service teachers.

**TPACK (Content) Goals**

During my science methods course, content goals drove the teaching methods that were taught. These content goals were taken directly from the North Carolina Essential Standards, which comprises the state curriculum that teachers in NC public schools are required to teach. They are categorized into three categories; life science, Earth science, and physical science. Table 1 shows these curricular goals.

Pedagogical instructional activities presented during the course focused on these content-based themes.

It was critical for the pre-service teachers enrolled in this science methods course to become knowledgeable of the content that they must ultimately be licensed to teach. Schulman notes the importance of science teachers having pedagogical content knowledge of their subject. This means that such teachers must hold an understanding of the content and also an understanding of how best to teach this content to learners (Schulman, 1986). It was important for this course to include learning activities devoted to the exploration of and understanding-building of the science standards that were ultimately the focus of the lesson plans that were developed using pedagogical approaches.

**TPACK (Pedagogy)**

Science instruction should be active, foster higher-order thinking skills, and incorporate principles of constructivist learning (Bruner, 1971). First, science experiences for children should be active in nature. Active learning puts the learner in charge of the learning by giving them a hands-on, active approach to the learning task. In the context of this study, active learning was implemented using an inquiry-based approach to teaching science to children. In 1971, Bruner described active discovery as a model of teaching science that involves the student as a key player in the learning process, interacting with the content to construct their own meaning (Bruner,1971). The science experiences designed for children among the pre-service teachers in this class focused on providing opportunities for active learning.

A second key approach to teaching science as recommended by educational theorists and commonly referred to as best practices is the use of higher-order thinking in teaching. Bloom created a taxonomy of key levels of cognitive outcomes progressing from those that promote lower-order thinking to higher-order thinking. The development of synthesis, evaluation, and analysis; higher-order thinking skills included in Bloom's hierarchical taxonomy, was the focus of pre-service teachers in my course with the goal of creating lesson plans that promote deeper learning (Bloom, 1956).

Through use of active learning and higher-order thinking skills, the pre-service teachers in the course allowed students to construct their own knowledge of science. The epistemology of constructivism, is the third key component that is relevant to my study. Piaget described the use of assimilation and accommodation through their experiences as a vehicle for the construction of knowledge among learners (Piaget, 1950). Course activities provided scaffolding for participants to learn to develop learning experiences for children where the role of the teacher is that of a facilitator who will guide children to build new knowledge using what they already know and combining this background knowledge with their new experiences.

My course focused on the introduction of *learning activity types* as classified by Blanchard, et al. (2011) to guide knowledge acquisition. Many of the *learning activity types* used in the course support constructivist teaching methods. The focus on learning activities in the course focused on the selection and development of activities that support constructive learning environments for science learning. These tools were developed to help in the operationalization of TPACK. The focus of the *learning activity types* was to provide a tool to help guide the conceptual planning process for learners. They provided a tool to guide the development of standards-based learning experiences that utilize technology. This approach differs from traditional methods of technology integration in that the selection of technology tools is not made until after the activity design and curriculum-based learning goals have been finalized (Harris and Hoffer, 2009).

These different types of activities are categorized to build conceptual knowledge, procedural knowledge, or knowledge expression. Blanchard et al. specifically developed a series of *learning activity types* for a variety of content areas. Science instruction has its own set of these types of learning activities. These activities served as a structure to provide pre-service teachers with scaffolded instructional design choices commonly aligned with student learning. Table 2-2 shows examples of each of these activity types, organized by the type of knowledge they intend to build. The full document showing science learning activity types that was developed by Harris et al. can be found in Appendix C (Blanchard, et al., 2011).

The use of these *learning activity types* was taught to pre-service teachers in the context of building constructivist learning opportunities.

More than a decade ago, in 2000, researchers Flick and Bell argued the importance of utilizing the growing number of classroom technologies while maintaining student-centered teaching and learning practices. As a result, they proposed a set of guidelines to provide support for using technology in the preparation of pre-service teachers. I would argue that these guidelines are still applicable today and relate to the TPACK framework. The suggestion of particular interest from this set of guidelines for the preparation of pre-service science teachers using technology is that the use of technology in science should focus on important science content with appropriate pedagogy. This was an important guideline to keep in mind when introducing pre-service teachers to science technology tools and guiding them to use these tools in their lesson planning to support pedagogically sound teaching (Flick and Bell, 2000). When designing their lesson plans, pre-service teachers were taught to focus on the important content as defined by the NC Essential Science Standards and use the technology tools that were most appropriate to meet the pedagogy being used.

A recently published study by Glassman and Karno provides a call to action for changing the ways that science education is taught to meet the needs of today's learners and utilize the resources that are now available via the World Wide Web. They describe the increased emphasis on science education in response to recent STEM (Science, Technology, Engineering, and Math) initiatives and the ability of teachers to engage their classrooms in science in new ways using web-based technology tools (Glassman and Karno, 2013). This article by Glassman and Karno provided important guidance for my study by providing support for works aimed at altering the pedagogical strategies of science educators to include embracing technology to support instruction. The teaching activities relating to pedagogy in my course centered on the work of constructivist theorists and current researchers in educational technology.

**<u>T</u>PACK (Technology) Goals**

The overall course technology goal was for pre-service teachers to learn the functional uses of a variety of technology tools to support science teaching and learning. The standards for the use of technology in teaching and learning are set by the National Education Technology Standards for Students and Teachers (NETS*S and NETS*T). The NETS*S and NETS*T provide a guide of best practices in using technology to support digital age learning. There are six main standards, with several objectives aligning with each. The six NETS standards focus on creativity and innovation, collaboration, research and information, critical thinking, digital citizenship, and technology operations (ISTE, 2012). The teaching activities and tasks within my science methods course aligned to these six NETS standards so that the pre-service teachers in my class were prepared to guide their children in meeting the NETS in their own classrooms.

The technology tools found within the science *learning activity types* document served as the basis for the technology goals. It was important for the pre-service teachers to learn about these tools so that they could develop lesson plans that combine TPACK through the student tasks in Table 2-2. The technology tools that students were expected to learn (see Table 2-3) are organized into the three types of knowledge building activities in an effort to stay consistent with the organizational pattern found in Table 2-2. Due to the limitations of this class, not all of the technology tools included in Appendix C were included in the technology goals for this course. I selected a sample of these tools for students to become familiar with and utilize in their lesson planning.

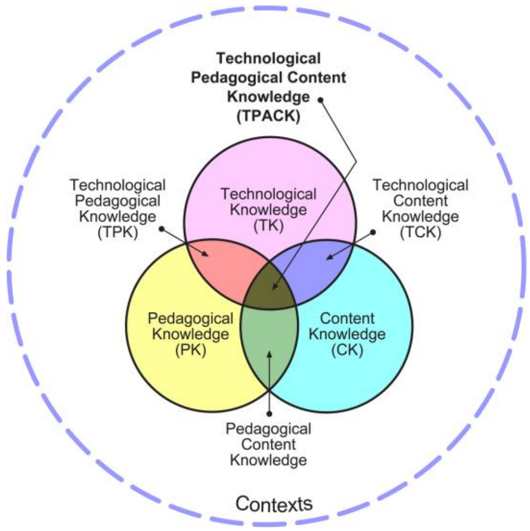
### Tying Together Technology, Pedagogy, and Content Knowledge

In my science methods course, the science content that the pedagogical teaching methods focused on fell within the *learning activity types* categorized by Blanchard, Harris, and Hoffer (Blanchard, et al., 2011). Teaching activities were developed to introduce pre-service teachers to a variety of learning activity types to complement the elementary science concepts. Elementary science concepts were derived from the NC Essential Standards for K-5 science learners and were categorized as Earth Science, Physical Science, or Life Science.

TPACK was introduced and developed using the *learning activity types* and associated technology tools suggested in Appendix C as a guide. Pre-service teachers were guided in selecting activity types that support the development of the type of knowledge most closely related to their teaching goals. These teaching goals, taken from the NC Essential Standards, were the basis for lesson plan development. Teaching activities focused on providing scaffolding for the process of aligning teaching goals with activity types that fostered learning through the support of appropriate technology tools. This process was designed to develop the TPACK of these pre-service teachers.

## Instructional Design

Student assignments were developed with the main goal of providing opportunities for students to build their own TPACK through a series of scaffolded tasks. These tasks were directly associated with teaching activities. Although a plan for this series of teaching activities and learning tasks are outlined here, changes were made as necessitated by the needs of the course and are documented in the results. Table 2-4 shows the initial plan for teaching activities, along with associated student learning tasks, to support the development of TPACK among the pre-service teachers enrolled in this course. To view screenshots from the course Blackboard, refer to Appendix I.




http://tpack.org/.

Figure 2-1. TPACK diagram. Reproduced by permission of the publisher, © 2012 by tpack.org

Table 2-1. NC Essential Science Standards Kindergarten-Fifth Grade

| | |
|---|---|
| Physical Science Goals | Forces and Motion<br>Matter, Properties, and Change<br>Energy: Conservation and Transfer |
| Earth Science Goals | Earth Systems, Structures, and Processes<br>Earth In the Universe<br>Earth History |
| Life Science Goals | Structures and Functions of Living Organisms<br>Ecosystems<br>Molecular Biology<br>Evolution and Genetics |

Table 2-2. Science Learning Activity Types Organized by Type of Knowledge Facilitated

| Conceptual Knowledge | Procedural Knowledge | Knowledge Expression |
| --- | --- | --- |
| Read Text | Participate in a Simulation | Learn and Practice Safety Procedures |
| Attend to Presentation/Demonstration | Explore a Topic/Conduct Background Research | Measure |
| Take Notes | Study | Practice |
| View Images/Objects | Observe Phenomena | Prepare/Clean Up |
| Discuss | Distinguish Observations from Inferences | Carry Out Procedures |
| | Develop Predictions, Hypotheses, Questions, Variables | Observe |
| | Select Procedures | Record Data |
| | Sequence Procedures | Generate Data |
| | Organize/Classify Data | Collect Data |
| | Analyze Data | Collect Samples |
| | Compare Findings with Predictions/Hypotheses | Compute |
| | Make Connections Between Findings and Science Concepts/Knowledge | |

Blanchard, M. R., Harris, J., and Hofer, M. (2011, February).

Table 2-3. Technology Tools Organized by Type of Knowledge Facilitated

| Conceptual Knowledge | Procedural Knowledge | Knowledge Expression |
|---|---|---|
| Websites, video, presentation software, Word Processing software, wiki, concept mapping software, digital camera, blog, and interactive whiteboard and other as desired and accessible | Web-based simulations, web search engines, wikis, websites, presentation software, video clips, simulation, database, spreadsheet, word processing, and concept mapping and others as desired and accessible | Content-specific interactive tools, web-based software, simulation, web cams, digital video cameras, web-based data sets, Glogster, video creation software, and others as desired and accessible |

*Tools shown in blue were introduced in the course. Tools shown in green were introduced in the educational technology course that is a prerequisite to this science methods course.

Table 2-4. Initial Plan for Course Teaching Activities with Student Learning Tasks

| TPACK Component(s) Being Built | Teaching Activities Planned to Develop TPACK | Associated Student Learning Tasks<br>*pre-TPACK lesson plans will be created before students are introduced to TPACK framework<br>*TPACK survey will be given before students are introduce to TPACK as well |
|---|---|---|
| Content Knowledge | -Introduce content knowledge | -Create a "science autobiography", reflecting upon the development of science knowledge<br>-Create overall concept maps of each K-5 goal |
| Content Knowledge | -Review content within each theme to build and refresh pre-service teacher content knowledge | -Student-centered science labs for each theme<br>-Science collaborative journal of reflective learning (blog) |
| Content Knowledge Pedagogical Knowledge | -Introduce the notion of content and pedagogy combining to create the methods for teaching science | -Complete online learning module about the history of science education |
| Pedagogical Knowledge | -Introduce pedagogical knowledge | -Explore, describe and provide examples of constructivist teaching methods (Piaget, Vygotsky, and active learning)<br>-Research current trends in science education (focusing on methods) |
| Pedagogical Knowledge | -Introduce *learning activity types,* focusing on the three types of knowledge building activities | -Explore *learning activity types*<br>-Categorize learning related to each content-based theme within the three types of knowledge building activities |
| Pedagogical Knowledge | -Model choosing *learning activity types* based on determining types of knowledge needed to be built among learners | -Guided practice in small groups to select *learning activities* to match the needs for knowledge building<br>-Individual practice selecting *learning activities* to match the needs for knowledge building |
| Pedagogical Knowledge Content Knowledge | -Model combining content and pedagogical knowledge using *learning activity types* | -Use *learning activity types* to develop plans for teaching science content |
| Technological Knowledge | -Introduce technological knowledge | -Define technological knowledge |
| Technological Knowledge | -Introduce technology tools to support science teaching and learning | -Explore technology tools with science<br>-Evaluate usefulness of a variety of technological tools |

| | | |
|---|---|---|
| | | for science teaching and learning (no emphasis on pedagogy) |

Table 2-4. Continued

| TPACK Component(s) Being Built | Teaching Activities Planned to Develop TPACK | Associated Student Learning Tasks |
|---|---|---|
| | | *pre-TPACK lesson plans will be created before students are introduced to TPACK framework<br>*TPACK survey will be given before students are introduce to TPACK as well |
| Technological Knowledge<br>Content Knowledge | -Model combining technological knowledge with content knowledge | -Develop lesson plan to teach science content with technology (no emphasis on pedagogy) |
| Technological Knowledge<br>Content Knowledge | -Provide opportunities for exploration with different technology tools in building pre-service teacher content knowledge | -Science labs using technology to continue building content knowledge of pre-service teachers<br>-Science collaborative journal of reflective learning continued (blog) |
| Technological Knowledge<br>Content Knowledge<br>Pedagogical Knowledge | --Use *learning activity types* document (Appendix C) to introduce and model choosing technology tools to go along with selected learning activities | -Scaffolded practice selecting technology tools to support science learning using *learning activity types* document in small groups<br>-Individual practice selecting technology tools to support science learning<br>-Create post-TPACK lesson plan (draft) to be evaluated by self and peers using the *Technology Integration Assessment Rubric* developed by Harris and others. |
| TPACK evaluation | -Provide opportunities for pre-service teachers to evaluate the usefulness of the tools that they select to support teaching and learning and model this type of evaluation | -Using the *Technology Integration Assessment Rubric*, evaluate the usefulness of the technology tools intended to support teaching and learning from peers' lesson plans (Harris et al., 2010) |
| TPACK revision | -Model revision of lesson plan based on self and peer evaluations using the *Technology Integration Assessment Rubric* (Harris et al., 2010) | -Revise lesson plan based on peer feedback (post-TPACK lesson plan)<br>-Complete post-TPACK survey |

# CHAPTER 3
# METHODS

The purpose of this action research study was to strategically design, assess, and make plans for future changes to a series of activities that encourage the development of technological, pedagogical content knowledge of pre-service teachers throughout an introductory science methods course. The main research questions were:

- In what ways will my pre-service teachers' knowledge of TPACK change during a carefully designed introductory science methods course?
- What teaching strategies and learning activities will support TPACK development among pre-service teachers in a science methods course?

## Research Methods

Action research was used to study my introductory science methods course. Action research is an inquiry process that involves careful planning, action, observation of implementation of planning, evaluation and reflection that is then used to plan future instruction (O'Brien, 2001; McNiff, 2002). Action research, also referred to as teacher research, is the process by which teachers study their own practice. They reflect on their practice and decide upon changes to impact their students (Cochran-Smith and Lytle, 1993). They follow a systematic process as they ask questions about their practice, collect data to give them information about their question, analyze their data with support from current literature that is related to their topic of study, change their practice as a result of their findings, and share their findings with others (Dana and Yendol-Silva, 2003).

The use of action research by teachers to improve classroom-based technology outcomes has been described by Dawson and others to lead to positive educational change as well as improved practice. The action research model provides a systematic process to guide teachers through an intentional study of the ways that their integration of technology impacts the learning of their students as well as a vehicle towards a change in the conceptual beliefs of the teacher about how to go about integrating technology (Dawson, et al., 2009).

Some action research studies that specifically involve the TPACK framework can be found within literature in the field of educational technology. One study conducted by Larkin, et al., studied TPACK with two cohorts of mathematics education pre-service teachers in Australia. They used their data to inform changes aimed at improving the pedagogical technological approach to strengthen student learning and to align the mathematics education course with the expectations of students once they graduate and become teachers (Larkin, et al., 2012). Another study was just published that used action research to study the perceived development of pre-service teachers Instructional Material Design (IMD) competencies through a college course for elementary pre-service teachers following a TPACK framework. These results showed growth among the 22 pre-service teachers in the study (Sancar, et al., 2013). Although the currently published studies are helpful to teachers with similar interests and contextual concerns, additional practical research is needed to further support research-based instructional design involving technology integration.

## Data Collection

### Pre and Post TPACK Survey

Pre-service teachers in my science methods course completed the TPACK survey (see Appendix A) both prior to and following their development of content-based lesson plans. The purpose of this survey was to collect data about the knowledge of students in each of the TPACK domains. This survey has been tested many times and has been found by its developers to be both valid and reliable (Schmidt, et al., 2009). The developers of this survey instrument conducted a pilot study on 124 pre-service teachers. Through this study, they found this TPACK survey to have a range of internal consistency reliability from .75 to .92 for the seven subscales in the survey, which is considered to be a solid range for reliability. This particular instrument is different from others that have been created to assess TPACK because it focuses on the self-assessment of pre-service teachers' development of TPACK as opposed to their use of technology integration or attitudes about the use of technology (Schmidt, et al., 2009). Schmidt and others conducted a study of elementary and early-childhood pre-service teachers' TPACK using this survey instrument. They aimed to find out how TPACK of pre-service teachers changed throughout an introductory course that was guided by the TPACK framework. They collected pre and post data from pre-service teachers and found that the students showed significant increases in their TPACK throughout the course (Schmidt, et al., 2009). Based on the previous development, assessment, and use of this survey instrument and its designed intentions for use, I selected this to guide data collection in my study.

**Pre and Post Lesson Plans**

Lesson plans were developed by participants both before and after implementation of TPACK teaching strategies. Students have had a previous introductory technology applications class prior to beginning my science methods course. This prior knowledge about the integration of technology into content teaching served as their knowledge baseline for developing the pre-TPACK lesson plan. The post-lesson plan was written following explicit instruction of TPACK integration strategies as described in Table 2-4.

Lesson plans were used as a data source because they are a regular artifact produced in my science methods course. These documents provided rich information to inform the inquiry process by allowing me to track student productivity over time (Dana and Yendol-Hoppey, 2009). Lesson plans have been used in previous studies as a source of data collection. These documents were used to inform a year-long TPACK integration study of math and science teaching using over six hundred lesson plans as data (Dawson, et al., in print). Lesson plans have also been used to show evidence of teacher practices for National Board Certification (Darling-Hammond, 2010).

Teaching strategies used in the course included instruction and guided activities using the TPACK framework and *learning activity types*. These tools were used to development the TPACK lesson plan format (Appendix F) that was used during my science methods course. This lesson plan format provided scaffolding to support the thoughtful integration of TPACK into science lessons by including a space to describe content, pedagogy, and technology integration as well as a space for self-evaluation of the TPACK integration within the lesson plan.

The coding criterion for lesson plan data (see Appendix B) was developed to assess the quality of the technology integration within lessons. These criterion were developed using the *learning activity types* (Harris and Hoffer, 2009), the science content standards, NETS*S standards, levels of cognitive demand (Silver, et al., 2009), and the levels of integration developed by Sandholtz and others in 1997 (Sandholtz, et al.,1997). A similar TPACK lesson plan assessment tool was developed by (Dawson, et al., in print) to study the TPACK integration practices of math and science teachers who were involved in a technology integration initiative.

**Exit Interviews of Pre-Service Teachers**

*E*xit interviews were conducted with the pre-service teachers at the conclusion of the course to determine their perceptions of TPACK growth. Sample quotes from these interviews will be included in the results section to represent what the students believed they got out of the course and how it was beneficial (or not) to them in their technology integration with science teaching content. Interview questions also elicited student suggestions for how the course could be improved. The exit interview guiding questions are located in Appendix G.

The interviewer was the secretary for the school of education at the university. She does not have any influence on student grades during their time in the education program. Our students know her and should be comfortable sharing their thoughts with her openly. She was provided a guide sheet with directions for administration of the interview (see Appendix H) as well as the interview questions. She was trained to extract detailed responses from the participants using probing questions to gather specific descriptions from the interviewees that relate to the questions asked. She practiced using these probing questions with me prior to administering the interview to the pre-service teachers participating in the study.

### Researcher Reflection Journal

I kept a reflective journal throughout this study. This reflective journal allowed me to capture my thoughts about the study as it progressed. I completed reflections within 24 hours after each class meeting related to the research.

The teacher-researcher reflective journal were organized by the following set of guiding questions that are also charted in Appendix D.

*Guiding Questions*
What activities/strategies worked and why?
What activities/strategies did not work and why?
How did the students respond?
What (if any) misconceptions emerged through this activity/strategy?
How can I facilitate correction of students' misconceptions?
What evidence of growth (if any) emerged through this activity/strategy?
How could I improve this activity/strategy for next semester?

## Data Analysis

My data analysis was guided by recommendations for analysis of teacher research from Dana and Yendol-Hoppey (Dana and Yendol-Hoppey, 2009). They recommended "careful scrutiny" that is done systematically through a process of making sense of the learning that has occurred throughout the study (Dana and Yendol-Hoppey, p. 118, 2009). Based on these recommendations, I analyzed data from each component (lesson plans, surveys, interviews, and researcher reflections) individually. Then, after I completed an individual analysis for each data type, I analyzed data from across the four data collection methods in hopes of identifying common themes.

### Analysis of TPACK Survey

I utilized analysis of the TPACK survey to compare paired data from each survey category.  Since the data are paired and given in pre/post form, the TPACK survey was analyzed by comparing the means with standard deviations from pre to post survey. The results of this comparison revealed any changes in perception of pre-service teacher knowledge for each domain area while accounting for the standard deviation. I used percentages to show change in scores between the pre and posttests (Krathwohl, 2004).

**Analysis of Pre and Post Lesson Plans**

I analyzed and evaluated each set of student lesson plans using the teacher-researcher developed TPACK coding criteria for lesson plans.  I coded the lesson plans using the preset coding criteria.  After completion of this initial coding, two education professionals reviewed the coded lesson plans to check for accuracy.  These professionals included a science instructor and a professor with past experience teaching both science methods and technology applications for pre-service teachers.

I followed the guidelines for coding of qualitative data described by Krathwohl to code lesson plan artifacts.  I determined all coding categories by using the *learning activity types*, software and hardware, science topics, cognitive demand, and levels of integration.  I scanned each of these components, noting repetitions and relationships throughout these categories.  In an effort to maintain a clear “audit trail”, records were kept as ideas came to mind about the relatedness of the data as I worked to code the data.  Mind maps showing the developing organization of the data were created. “Stacks” of coded data were placed into each categorized label.  I changed coding labels as needed to ensure a best fit for the data.

Once all data were coded and categorized based on similar themes, I reviewed the results and conducted a search for any overlap or redundancy.  By doing so, I was allowed the opportunity to think about whether or not the codes reflected what was important in the data. Changes were made as needed. As I made changes, the "audit trail" was updated.

Finally, I created a code definition and statements wrote statemetns describing what I believed I could best conclude from the data. These statements focused on "…generalities, general perceptions or perspectives, typologies of individuals, actions, situations, central actions or events, processes, strategies, (and/or) interactions..." (Krathwohl, p. 310, 2004). I utilized lesson plan examples to support the code definitions (Krathwohl, 2004).

I completed analysis of student pre and post lesson plans using content analysis with preset coding and comparison of lesson plans using the TPACK-based coding criteria (Appendix B) with percentage comparison. For example, I compared the percentage of pre and post lesson plans meeting criteria for different levels of integration (Sandholtz, et al., 1997). Each of these categories of levels of integration has a definition formed by Sandholtz et al. As teachers develop skills in technology integration with content and pedagogy, they are predicted to move through levels of integration defined by Sandholtz and others in 1997. These levels are identified as entry, adoption, adaptation, infusion, and integration. Lower levels of technology integration occur when teachers use the technology in the entry level and progress to a level in which the technology use is essential for the lesson at the transformation level (Sandholtz, et al., 1997). I was aware of the progression of pre-service teacher technology development and indicated any observed changes through the researcher reflections. It is possible for a lesson plan to use a combination of more than one level of integration. For example, a plan may include a presentation using technology given by the teacher (entry) but also allow children the opportunity to select a technology tool to use in creating a digital product (adaptation). In this case, the lesson plan would meet both the entry and adaptation levels of integration (see APPENDIX K, Student Sample Post-Lesson Plan Artifacts # 2, 4, and 6). Although it will be important for the set of post lesson plans to show higher levels of integration, they are likely to also show more than one level of integration throughout the different parts of the lesson plan. I selected representative lesson plans showing examples of growth between pre and post plans to support the qualitative analysis (Appendix K)..

**Analysis of Researcher Reflections**

I completed the analysis of researcher reflections by using content analysis with emergent coding. I reviewed the reflections in an effort to identify relationships and patterns that repeat within a set of reflections. I identified and noted similarities and specific situations that are important to recognize (e.g., repeated terminology). As this set of data was reviewed, categories began to emerge based on the relatedness of the data. In keeping with the "audit trail", records were kept as ideas came to mind about the organization and relatedness of the data. I created a tentative categories list and coded data using this list.

Once I coded researcher reflections according to tentative categories, the data were sorted under these categories. I changed coding titles as needed in order to make a better fit for the data.

Once I had sorted all reflections, the results were reviewed and any occurrences of overlap or redundancy were identified. I changed particular codes that were found not to reflect what was important in the data.

I then created a graphic of the reflection data. Codes were defined with support through quotes from my reflections. Statements were made to describe the ideas that I decided could be drawn from my data and have been kept with the audit trail (Krathwohl, 2004).

**Analysis of Exit Interviews of Pre-Service Teachers**

I analyzed interview data using content analysis with emergent coding as suggested by Krathwohl. I utilized this process, as described in the researcher reflection analysis above, to determine common themes related to student perceptions about the course. Coding themes centered on student comments about the usefulness of course activities and processes in developing their TPACK integration skills as well as their suggestions for how the course could be improved (Krathwohl, 2004).

**Analysis of Complete Data Set**

After coding all data, and pre and post data were shown through frequency distributions and change analysis, data analysis for this study was broken down into four distinct steps.

1. Review the entire data set to obtain a description.
2. Make sense of the data.
3. Construct statements of learning.
4. Determine implications.

(Dana and Yendol-Hoppey, 2009)

First, I read and reviewed the entire set of data with the goal of gaining a descriptive sense of the information collected. Second, after reading through the data set and focusing on these questions, I attempted to make sense of the data. I made notes within the data artifacts and put the data into groups based on themes. This part of the process focused on organizing the data.

The third step of my data analysis focused on my construction of statements that expressed what I've learned and what this learning means to me in my practice. The main goal of this step was to interpret the meaning of the data. To do this, I analyzed the themes and patterns of the data that were coded in step two.

Finally, the fourth step of data analysis suggested by Dana and Yendol-Hoppey is to focus on the implications of the study. To do this, I had to interpret what I've learned and make a plan of action for future courses. I also gleaned future questions from this step of analysis (Dana and Yendol-Hoppey, 2009).

**Limitations of the Study**

This study had several limitations that were outside of my control. The science methods course that was selected for this study had low enrollment of only nine students. Fortunately, all nine students participated in the study. All of these participants are female, all Caucasian, and all are within the age range of 18-34 years old. A more diverse population of participantsmay have yielded data representing a greater variety of perceptions and viewpoints.

The study was also limited by the scheduling logistics of the class sessions. This class met once a week for three hours. I found myself trying to "cram too much into each session". In the future, scheduling changes will be requested to allow for students to meet two to three times each week, for one to one and half hours for each session. This schedule change may reduce students' sense of being overwhelmed by so many learning activities during a single class session, by enabling me to distribute activities across more class meetings.

Table 3-1. Data Analysis for Each Data Set by Research Question

| | Pre/Post Survey | Pre/Post Lesson Plans | Teacher-Researcher Reflections | Pre-service Teacher Exit Interviews |
|---|---|---|---|---|
| In what ways will my pre-service teachers' TPACK knowledge change during a carefully designed science methods course? | Mean, standard deviation, and difference | Content analysis with preset coding and comparison using percentages (Krathwohl, 2004) | Content analysis with emergent coding (Krathwohl, 2004) | Content analysis with emergent coding (Krathwohl, 2004) |
| | | | Teacher-Researcher Reflections | Pre-service Teacher Exit Interviews |
| What teaching strategies and learning activities will support TPACK development among pre-service teachers in a science methods course? | | | Content analysis with emergent coding (Krathwohl, 2004) | Content analysis with emergent coding (Krathwohl, 2004) |

CHAPTER 4
RESULTS

## Overview

My pre-service teachers' TPACK knowledge increased during the course in key areas. The general understanding among my students about how to integrate technology increased as they participated in the sequence of course activities. Misconceptions that students had about ways to properly integrate technology into lesson planning were uncovered and clarified throughout the course. The assigned readings, videos, and specific resources throughout the course supported the development of TPACK among my students. The scaffolding of class activities provided building blocks to guide students through this development process. The use of the lesson plan format provided a guide to support the revision of student lesson plans to aid them in putting the TPACK components together. Peer collaboration throughout the course aided in TPACK development of students. Strategies for further improving the increase in TPACK development among students in future courses were recommended by participants. A summary of the results for each of my research question as shown through the data analysis is as follows.

- **Research Question # 1**: In what ways will my pre-service teachers' TPACK knowledge change during a carefully designed science methods course?
    - **Finding # 1** Students' TPACK knowledge increased in key TPACK areas.
    - **Finding # 2**: Students' general understanding of technology integration practices increased as evidenced through pre and post lesson plan submissions.
    - **Finding # 3:** Students' misconceptions about the way to go about using technology in lesson planning (TPACK) were clarified throughout the course.

- **Research Question # 2**: What teaching strategies and learning activities will support TPACK development among pre-service teachers in a science methods course?
    - **Finding # 1:** Assigned readings, videos, and specific resources supported TPACK development among students.
    - **Finding # 2:** Scaffolding of class activities provided building blocks to guide students through the process of developing TPACK.
    - **Finding # 3**: Introduction of the TPACK lesson plan format as a guide for revising previous lesson plans and developing new lesson plans supported students' efforts to put the TPACK pieces together.
    - **Finding # 4**: Peer collaboration supported successful TPACK development.
    - **Finding # 5**: Student interviews and researcher reflections recommended strategies for strengthening TPACK development in future courses.

**Research Question # 1:** In what ways will my pre-service teachers' TPACK knowledge change during a carefully designed science methods course?

**Finding # 1**: Students' TPACK knowledge increased in key TPACK areas. Perceptions of the pre-service teachers on the TPACK survey showed growth in key areas related to course implementation of teaching strategies and learning activities supporting TPACK development. Using means and standard deviations, growth occurred in categories for science content knowledge (CK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technology content knowledge (TCK), and technological, pedagogical, content knowledge (TPACK). The graph, Figure 4-1, shows average pre and post scores on the survey for each category, along with growth percentages, for each of these key areas.

There was an 18% increase in average scores from pre to post survey in the science CK category. The TCK category increased from pre to post survey by a 19% increase in average scores for the TCK category of the survey. For the TPACK category of the survey, there was a 17% increase in the average score. In the PCK category, there was a 12% increase in average survey score. The TPK category scores increased by 11%.

**Finding # 2:** Students' general understanding of technology integration practices increased as evidenced through pre and post lesson plan submissions. Lesson plans were collected from each student representing before the course (pre-TPACK) and after the TPACK-related course activities (post-TPACK). A total of 18 lesson plans were collected; a pre and a post from each of the nine participants. These lesson plans were coded using preset categories (see Appendix B). Evidence of use of NETS*S, learning activity types, number of technology tools, low level demands, and high level demands were among the preset categories. Throughout the data analysis, I was looking for an increase in the use of NETS*S standards, Learning Activity Types, and technology tools as well as an increase in activities requiring high levels of cognitive demand. Increasing use of the NETS*S provides children with more 21$^{st}$ century experiences that build creativity, collaboration, research, critical thinking, digital citizenship, and technology operations skills. Including more learning activity types in a lesson plan makes it more likely for children to be given opportunities to build a variety of types of knowledge (conceptual, procedural, and knowledge expression). Increasing the use of technology tools, in several cases from no technology tools being used to more than one being used, also provides children with a greater variety of opportunities to build knowledge in meaningful ways. Including activities that support the use of high levels of cognitive demand helped children to better retain the information that they are working with (Silver et al., 2009).

### Lesson Plan Evaluation Protocol Components

Changes in technology integration following the TPACK model were found as evidenced through comparison of pre and post lesson plans submitted by participants. In general, I found that there were increases in many of the categories associated with TPACK activities from within the course.

### NETS*S

I included the National Education Technology Standards (NETS*S) in the lesson plan evaluation protocol components because these standards guide teachers in developing activities aligned to best practices in supporting 21st century digital age learning (ISTE, 2012). There was an increase in the use of the National Education Technology Standards for Students (NETS*S) to guide instruction. The average increase in number of NETS*S Standards from the set of pre to post lesson plans is five. This increase shows that the set of post lesson plans provided children with more opportunities to build 21st century skills than the set of pre plans did.

### Learning Activity Types

I found the set of learning activities evaluated in the lesson plans support constructivist learning opportunities and were properly organized to determine the types of knowledge that children would build (conceptual, procedural, and/or knowledge expression) (Blanchard, et al., 2011). Evaluating the quantities of learning activities included in students' lesson plans helped me to determine the amount of opportunities that students were planning for their learners to receive in each category. I found that the number and variety of *learning activity types* used in the lesson plans increased. From the set of pre to post lesson plans, the average number of *learning activity types* increased by six, adding to the opportunities that children are given to develop knowledge about the concepts taught through the lesson plans.

### Technology Tools

It was important for me to analyze the numbers and types of technology tools being used in the lesson planning of my science methods students. By evaluating this lesson plan component, I was able to determine whether or not my students were increasing the quantities of technology tools being used from their pre to post lesson plans. I found an increase in the average number of technology tools used by teachers and/or students in each lesson plan by three. Several pre lesson plans did not include the use of technology. All of the plans in the post set contained at least one technology tool to be used. Many of these plans included a technology tool being used by the teacher to present information and also at least one technology tool being used by the children. This increase in technology tools being used gives children more opportunities to build and/or express knowledge.

### Levels of Cognitive Demand

The levels of cognitive demand that my students' lesson plans required of the learners they were written to teach were also included in this evaluation because research shows that activities requiring learners to use higher levels of cognitive demand as defined by Silver provide a deeper level of learning than activities that require lower levels of demand (Silver et al., 2009 and Bloom 1956). Being able to analyze the quantity of activities requiring these levels of cognitive demand gave me a better understanding of the degree of learning that my students were using the technology tools to help their learners attain. There was also an increase in the average number of activities requiring higher levels of demand (Silver, et al., 2009). I found that the pre lesson plans had activities requiring low levels of demand more than twice as often as those requiring high levels of demand. The set of post plans reversed this ratio to include activities requiring high levels of demand more than those that require lower demand levels. This increase in activities promoting higher levels of cognitive demand makes it more likely that children will learn more and remember more of the content that they are learning because they are interacting with the content on a deeper level.

**Levels of Technology Integration**

Particular attention was given to the levels of technology integration. These levels of technology integration categorized the lesson plans of my students that use technology themselves, to present to the children, those that use a single technology tool, those that allow children to choose the tool that will aid them in creating a digital product, those that require the use of technology as an integral tool to support their learning and engagement in the lesson, and those that use technology as an essential tool in carrying out the lesson, making the lesson impossible if the technology is removed (Sandholtz et al., 1997). If I could see a noticeable change in the levels of technology integration between the pre and post lesson plan data sets, I knew that my students were increasing their ability to integrate technology into these plans in more meaningful ways. There was an increase in levels of technology integration between the set of pre-TPACK lesson plans and those within the post-TPACK set. On average, the post lesson plans moved up nearly three levels of technology integration.

The percentage increase for each level of technology integration (entry, adoption, adaptation, infusion, and transformation) is shown in Table (4-3). The percentages shown in the pre and post lesson plan columns indicate the percentage of lesson plans within the set of lesson plans that included each level of integration. The percentage change represents the increase in levels of technology integration for each category from the pre to the post lesson plan sets.

I also analyzed the data for the levels of technology integration for the set of pre-TPACK and the set of post-TPACK lesson plans using percentages. Sample pre and post lesson plans can be found in Appendix K. Specific examples of increase in levels of integration are shown through the following samples taken from lesson plans. Figures 4-2 and 4-3 show samples taken from Student 4's pre and post lesson plans. This student's pre lesson plan had the entry level of technology integration. The teacher used the PowerPoint and video clip about the topic being studied, parts of a plant, to present information to the children.

Her post plan, showed entry, adoption, and infusion. In this plan, the teacher still used a video clip to present to the children. After the active inquiry portion of the lesson, the teacher used a reflective blog post to provide children with the opportunity to reflect on their learning as they recorded their inquiry process, what they did throughout the process, their observations, and a summary of what they learned.

Another example of growth in TPACK knowledge through a student's increase in levels of integration is shown in Figures 4-4 and 4-5. These are samples from Student 2's pre and post lesson plans. The pre lesson plan included no technology integration, level 0 and off the chart.

Her post plan included entry, adaptation, and transformation levels of technology integration. Children view a video that presents information about how to conduct the experiment. After completing the experimental part of the lesson, an extension opportunity is provided to give children the opportunity to create an online video as they explain what they have learned. By providing this key component of the lesson, the explanation of children, the transformation level of integration is met as this task requires the use of technology to complete.

A third example of growth in TPACK knowledge through application in lesson plans can be seen in the pre and post samples from Student 1, shown in Figures 4-5 and 4-6. This student's pre lesson plan, although promoting active inquiry and some high levels of demand from children, did not include the integration of technology, also a score of 0 for this coding category.

The post lesson plan from Student 1 shows evidence of entry, infusion, and transformation. She used a video clip to show the parts of the plant, digital cameras for children to take pictures of their flowers at different points in time as they conducted the experiment, and the use of blogging to record their explorations, observations, and discoveries. Throughout this lesson, the use of technology tools to support the lesson and engage children is evident. The children would not be able to complete the expected tasks without the use of the digital cameras and blogs to share their work.

Significant change in students' TPACK knowledge is clear through results of this data analysis of lesson plans and associated evidence provided through samples taken from these lesson plans.

**Finding # 3:** Students' misconceptions about the way to go about using technology in lesson planning (TPACK) were clarified throughout the course. Student misconceptions arose during the course and were recorded in my reflection journal. After the analysis of the pre-TPACK surveys taken on the first day of class, I noted my perception of an over-confidence in the students' ability to integrate technology into lesson design. Additionally, the common idea was held that instructional planning should center on the technology tools (prior to the related TPACK lessons).

As student misconceptions were noted in my reflection journal, so were evidences of student growth. As the course activities related to TPACK development were completed by students, they thought more intentionally about technology tool integration and eventually began applying these TPACK integration skills into their lesson planning once introduced to the TPACK lesson plan format.

Students had "ah-ha" moments as their misconceptions were uncovered and clarified throughout the course. These corrections of student misconceptions are related to three main ideas that were discovered by students as evidenced through their midcourse reflection responses: (1)There are different ways that technology can support content and pedagogy. (2) There are more technology tools "out there" than a projector and a Smartboard, and (3) The most important thing is deciding on the best way to implement the task using technology.

**Technology can be used to support content and pedagogy in different ways.** Students realized that there are different ways for technology to support content and pedagogy. One student admitted that she "had never really paid attention to the different types of ways that technology can support content and pedagogy (Student 4, Blackboard discussion forum, February 28th, 2013)." She shared this as she reflected on a course activity that gave her the opportunity to evaluate technology tools for their use with children. Another student said that "these (two) tools opened my eyes to all of the different ways technology can be brought into your classroom to help students learn

(Student 6, Blackboard discussion forum following use of the *Evaluating Technology Tools To Support Content and Pedagogy Chart*, February 28th, 2013).”

**There are a variety of technology tools “out there” other than just a SmartBoard and projector.** Another “ah-ha” made by my students is that there are more technology tools “out there” than a projector and a Smartboard… there is so much more you can do with technology and keep it new, exciting, and very easy to work with (Student 8, Blackboard discussion forum following use of the *Evaluating Technology Tools To Support Content and Pedagogy Chart*, February 28th, 2013)”. Another student felt that this assignment “…changed how I thought about teaching technology a great deal. I never knew there were so many different ways to bring technology into the classroom. I found two tools that I think students would really enjoy using to learn about science and technology, (Student 6, Blackboard discussion forum following use of the *Evaluating Technology Tools To Support Content and Pedagogy Chart*, February 28th, 2013) .” A third student “...found a ton of helpful sites and links that can be used to engage the students in learning (Student 1, Blackboard discussion forum following use of the *Evaluating Technology Tools to Support Content and Pedagogy Chart*, February 28th, 2013).”

**The most important thing to do when integrating technology is deciding on the best way to implement the task using the technology tool(s).** The third “ah-ha” theme found within my students’ midcourse reflection responses was the importance of deciding on the best way to implement the task using the technology tool(s). Student quotes are used here to describe their corrections of misconceptions.

- "We have always found the technology before we even knew what we were teaching.  It is supposed to be the opposite" (Students 1 and 4, group discussion reflection, February 21st, 2013.)
- "This has changed my view because I now know that while technology is nice it is also just an aid and that the most important thing about your lesson is the content of your lesson.  Choosing your task and then deciding on the best way to implement that task using technology is how teaching should be done to the best degree" (Student 8, Blackboard discussion forum following use of the *Evaluating Technology Tools To Support Content and Pedagogy Chart*, February 28th, 2013).
- "I no longer view technology as just a student playing a math game on the computer.  Technology must be properly integrated into a lesson.  Students must be engaged in the activity they are participating in on the computer, even if it is a game it must fall within the TPACK guidelines" (Student 2, Blackboard discussion forum following use of the *Evaluating Technology Tools To Support Content and Pedagogy Chart*, February 28th, 2013).
- "It's not about finding a standard to go with a tool but the other way around" (Student 1, Blackboard discussion forum following use of the *Evaluating Technology Tools To Support Content and Pedagogy Chart*, February 28th, 2013).

Changes in student thought processes about the ways that they approach lesson plan development in general, and particularly the integration of technology into lesson plans became evident as the study of TPACK progressed in the course as evidenced through these student quotes from multiple student reflections.

**Research Question # 2:** What teaching strategies and learning activities will support TPACK development among pre-service teachers in a science methods course?

**Finding # 1:** Assigned readings, videos, and specific resources supported TPACK development among students. Midway through the course students read and discussed an article I assigned entitled, "TPACK and systematic technology integration part 2", written by Mark Fijor (Fijor, 2011).  After reading this article, students began developing a more sophisticated understanding of how best to integrate technology. The main idea shared through student reflections was to "start with the learning task and THEN included technology IF it fits and supports what and how I want to teach" (Student 9, article reflections, February 21, 2013). Similar ideas were shared by all students as they reflected on the assigned article reading. Another student shared a similar plan, stating that she will "prepare the task first…then incorporate technology IF it fits in and enhances what I want to teach" (Student 2, article reflections in small groups, February 21, 2013). Another said that she will, "apply the concept of choosing a task first and then finding the appropriate tools to aid the task" (Student 8, article reflections, February 21, 2013). A summary written by a group of students to explain how to integrate TPACK ends with "determine what tool is best to use for the student task" and "plan and focus on the task and not the tool" (Students 4 and 1, article reflections in small groups, February 21, 2013.

The researcher reflection journal that I kept throughout the course provided evidence that the use of readings, videos, and specific resources helped support the development of TPACK among students. This journal consisted of a set of guiding questions that were answered following each class session (see Appendix D.). The purpose of this reflection journal was to provide opportunities to note activities that worked well and those that did not, students' responses to the course activities, student misconceptions, evidence of growth, and recommended improvements for this course and future courses. These data were coded using emergent coding (Krathwohl, 2011) and resulted in a set of themes that appeared throughout the researcher reflections. Videos viewed, scaffolded student activities, specific resources that were provided, and peer collaboration seemed to lend to positive student responses. Evidence of student misconceptions and growth emerged throughout the course, as well as areas needing improvement.

The assigned readings and videos that were provided to students prior to our class sessions built the background knowledge of students, providing them with a base to build from as they worked to complete course activities (researcher reflection journal, February 14, 2013 and February 21, 2013). Prior to class on February 14th, students viewed a video created by Steven Anderson introducing them to *learning activity types (*Anderson, 2012). As they viewed this video, they recorded their responses about what they found important and interesting in a chart. They also read the science *learning activity types* document created by Blanchard, Harris, and Hoffer (Blanchard, et al., 2011). Prior to class on February 21st, students viewed two TPACK introductory videos, one created by Royce Kimmons and the other by Candace Figg (Kimmons, 2011; Figg, 2011). Their assigned reading for this class was to read and record the main ideas from three short TPACK related wiki articles written by Mark Fijor (Fijor, 2011). At the beginning of each of these class sessions, I asked students to discuss the videos and articles with their peers. These peer-to-peer discussions were the basis for my reflection journal notes about the benefit of assigned videos and articles to students' TPACK knowledge development.

Student understanding was recognized through their comments made during discussions of videos they viewed were noted in my reflections more than once, giving evidence that these were beneficial to student growth in TPACK development.

I provided specific resources to students to provide structure for their TPACK development, including several web-based resources to aid different course activities.

The Sciencebuddies.com site was used to provide structure for the development of student science experiments.  As students worked on these projects their science content and pedagogical knowledge grew.  As they explored the Science Buddies site to gain ideas for their assigned science projects, they developed a better understanding of the differences between a demonstration and an experiment (researcher reflection journal notes, February 7, 2013).  RICE.edu was used to provide science activities for each of the main science content areas (life, Earth, and physical science) that follow the new Common Core standards.  This web-based resource provided examples of inquiry-based science activities to help scaffold my students as they developed their own. Through use of this resource, students were able to complete the assigned task of developing an inquiry-based science lesson within the area of life, Earth, or physical science (researcher reflection journal notes, January 17th, 2013).  Students 1, 2, and 7 worked collaboratively to develop a physical science activity plan using the RICE.edu site as a resource.  A summary of their activity plan is shown in Figure 4-9.  Through guided exploration and experimentation with different sound-producing objects, this activity provides opportunities for children to engage in an active-inquiry science lesson. I introduced the Glogster.edu web tool to students for their science autobiography site to give them experience using a web tool similar to one that they may use in their own classrooms in the future.  Students explored the Glogster tool by creating their own glogs to share with our class.  They gained knowledge of ways to use a simple, online, multimedia tool to create a product to share with others.  I have provided a sample glog in Figure 4-10.

In addition to these web-based resources, I provided the TPACK lesson plan format (Appendix F) and TPACK integration evaluation chart (Appendix B) to students to structure their peer evaluations on lesson plans and their own lesson plan development. Through use of the technology integration evaluation chart, students assessed technology tools for their appropriateness and evaluated their own lesson plans for TPACK integration. Figure 4-11 shows an evaluation chart completed by Student 8 as she reviewed Google Blogger for use in a lesson plan to provide students with opportunities to discuss what they have learned.

**Finding # 2:** My scaffolding of class activities provided building blocks to guide students through the process of developing TPACK. Careful scaffolding of student assignments allowed students to learn to implement pieces of the TPACK framework before being challenged to put all of the pieces together. One such task that I presented to students prior to them being introduced to the full TPACK framework was designing learning activities to provide their own children with opportunities for conceptual knowledge building; procedural knowledge building, and knowledge expression, students developed learning activities that would support best practices in science. The TPACK components being emphasized for this particular activity were the combination of pedagogy (P) with content (CK). These activities were largely active in nature, keeping consistent with recommendations from best practices. The chart below, Table 4-3, describes a sample of learning activities developed by pre-service teachers in the course for each category.

The coding of researcher reflections showed several specific scaffolding support strategies provided to students that were particularly beneficial. The creation of concept maps for each area of science (life, Earth, and physical science) showed an increase in knowledge among students (researcher reflection journal, January 17, 2013 and January 31, 2013). Students' use of science experiences from the course textbook to guide development of engaging activities for children was noted as being particularly helpful in giving students a guide with which to use when developing appropriate science activities for their own children (researcher reflection journal, January 31, 2013). Later on during the course, students worked in groups to create diagrams to show the relatedness of each of the TPACK components to one another in the technology integration process. My researcher reflection notes show that this activity worked very well and that students were able to create and explain diagrams that showed their clear understanding of the relatedness of the TPACK components (researcher reflection journal, February 14, 2013). Figure 4-12 shows a sample TPACK diagram with student descriptions of each TPACK component made by a small group of students on February 21, 2013.

The TPACK lesson evaluation chart provided students with self-evaluation practice as well as peer-evaluation of lesson plans. Finally, the TPACK lesson plan format itself provided prompts and questions to guide thoughtful inclusion of each of the key components of TPACK and the careful integration of each of these to form a quality lesson (see Appendix F).

**Finding # 3:** Introduction of the TPACK lesson plan format as a guide for revising previous lesson plans and developing new lesson plans supported students' efforts to put the TPACK pieces together. In addition to the lesson plan coding analysis that shows significant growth in TPACK levels of integration, student exit interview data provides evidence that the lesson plan format helped to build students' TPACK development. The most beneficial activity shared by students was the use of the TPACK lesson plan format (Appendix F) to help support the implementation of suggested revisions from previous lesson plans that did not use this format. Through the exit interview, two students shared that the TPACK lesson plan activities helped them to "integrate technology, pedagogy, and content into lesson plans and balance all three" (Students 2 and 3, exit interview, March 1, 2013). One of these students stated that she "can now integrate technology into every subject area" (Student 3, exit interview, March 1, 2013). Students also recognized that "there are many different tools to choose from and that using the tool that best fits the plan (and not vice versa) is the best way of integrating technology" (Student 7, exit interview, March 1, 2013). Two students discovered that "teachers should not just present with technology but (that) tools should be integrated into students' use with the content" (Students 8 and 4).

**Finding # 4:** Peer collaboration supported successful TPACK development. Students were noted to have been successful in course activities providing them with opportunities to work in groups with their peers to build their TPACK knowledge. As noted in my researcher reflection journal, peer collaboration was found to be a practice that worked well throughout the course. The communication in the form of explanations that occurred during the creation of concept maps for each science content area (life, Earth, and physical science) helped students to clarify the vertical alignment of Common Core standards throughout grades K-6 (researcher reflection journal, January 17, 2013 and January 31, 2013). The discussions of the assigned articles, textbook reading, and videos, were noted as being beneficial in strengthening the understanding of course content by providing opportunities for students to verbalize and synthesize the information that they had read and/or or viewed as it related to teaching science (researcher reflection journal February 21, 2013).

Along with the TPACK diagrams that students created as described earlier, group discussions about TPACK took place as students worked together to develop their own definition of TPACK and a short presentation to share with the class. The following quotes share student comments as they discussed TPACK in preparation for these short presentations related to how to integrate technology into teaching. Their developing understanding of TPACK can be seen through these comments that students made during this group work after being introduced to the complete TPACK framework:

- "The middle (of the TPACK diagram) is when you're pretty much an awesome teacher; you do it all" (Students 6, 2, and 3, group definition of TPACK poster presentation group work, February 21, 2013).
- "TPACK, (the middle of the chart), is how they work together to support enhanced learning" (Students 5 and 7, group definition of TPACK poster presentation group work, February 21, 2013).
- "You have to know your task before you choose the technology" (Students 9 and 8, group definition of TPACK poster presentation group work, February 21, 2013).
- "There has to be a balance of them (the components of TPACK) all" (Students 9 and 8, group definition of TPACK poster presentation group work, February 21, 2013).
- Another student commented that the TPACK discussion "…is the hardest discussion yet!" (Students 5 and 7, group definition of TPACK poster presentation group work, February 21, 2013).

**Finding # 5:** Student interviews and researcher reflections recommended strategies for strengthening TPACK development in future courses. The coding of my researcher reflection journal resulted in a list of improvements that I feel are needed. A major improvement that is needed as noted in multiple reflection entries is the need for more time to provide additional opportunities for guided practice of many of the course activities. To help alleviate the misconceptions related to science content, I could move the content paper to earlier in the course with students being given access to content experts for collaboration and support related to science content (researcher reflection journal, January 31, 2013). I also noted that student attendance was a problem during several weeks of the course. Although the course syllabus includes an attendance policy where students may miss no more than one class session before points are deducted from the final grade, clearer communication of the attendance expectations, along with reminders throughout the course, could be helpful in alleviating this problem (researcher reflection journal, January 17, 2013, January 24, 2013, and February 7, 2013). I noted the need for more modeling overall to provide further support of student learning of TPACK integration strategies (researcher reflection journal, January 17, 2013, February 7, 2013, and February 21, 2013). More details were needed for a few of the assignments to provide clearer student expectations (researcher reflection journal, January 31, 2013). A better set of web-based resources needs to be available to students to guide the creation of their technology resource lists (researcher reflection journal, January 31, 2013). Additionally, I found that it will be important not to try to "cram too much" into each class session or into the course in general in the future (researcher reflection journal, January 31, 2013, February 14, 2013, and February 21, 2013). A summary of the improvements needed for future courses is shown in Figure 4-13.

In addition to the improvements to future courses suggested by my researcher reflection journal data, students recommended changes through exit interviews.

Students gave three main recommendations for improving TPACK activities for future courses.

- “TPACK should be introduced earlier.” was a common suggestion (Students 3, 7, 1, 5, and 8, exit interview, March 1, 2013).
- “Introducing TPACK and using it in all classes, methods and educational technology…” was recommended by two students (Students 3 and 5, exit interview, March 1, 2013).
- The third recommendation was to include more teacher “modeling of how to build a TPACK lesson; creating all of the components” (Student 7, exit interview, March 1, 2013).

Figure 4-14 shows students’ perceived benefits and recommendations for future courses. The analysis of pre and post TPACK surveys, pre and post lesson plans, researcher reflection journal entries, and student mid-semester reflection and end-of study interview responses has given insight into what specific activities and teaching approaches worked well and what could be improved to help build TPACK development of pre-service teachers.

## Summary

My results demonstrate that students showed themselves to be highly capable of changing their previous lesson plan development practices when provided support, differing expectations, and scaffolding throughout the process. The different pieces of data show multiple perspectives. My own perspective is clearly shown through the researcher reflection journal. Students’ perspectives are shown through their survey responses, mid-semester reflections, and end of study interview responses. The lesson plans provide triangulation of data from both perspectives as they provide concrete evidence that support the findings found from the other three data sources. In particular, the combination of data provide insight into the specific teaching strategies and learning activities that led to significant growth in knowledge of the TPACK framework among pre-service teachers and how they became able to integrate the TPACK components into lesson plans for children.

Table 4-1. Summary of Results

| Component | Pre Mean | Pre SD | Post Mean | Post SD | Difference |
|---|---|---|---|---|---|
| Content knowledge | 3.21 | 0.64 | 4.11 | 0.55 | 0.90 or 18% |
| Pedagogical Content Knowledge | 3.50 | 0.70 | 4.08 | 0.44 | 0.58 or 12% |
| Technological, Content Knowledge | 3.36 | 0.96 | 4.33 | 0.60 | 0.97 or 19% |
| Technological, Pedagogical, Knowledge | 3.94 | 0.46 | 4.51 | 0.42 | 0.57 or 11% |
| Technological, Pedagogical, Content Knowledge | 3.36 | 0.87 | 4.19 | 0.50 | 0.83 or 17% |

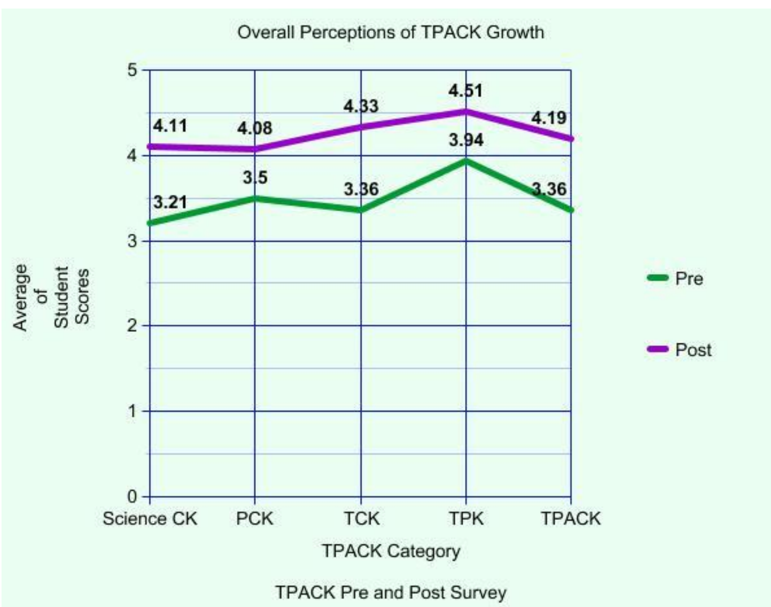



Figure 4-1. Average pre and post scores on the survey for each category, along with growth percentages, for each of these key areas.

Table 4-2. The percentage increase for each level of technology integration (entry, adoption, adaptation, infusion, and transformation.

| | Whole Class Avg. | | |
|---|---|---|---|
| | Pre Lesson Plan | Post Lesson Plan | Percentage Change |
| Entry | 33% | 78% | 45% |
| Adoption | 22% | 44% | 22% |
| Adaptation | 0% | 56% | 56% |
| Infusion | 11% | 56% | 45% |
| Transformation | 0% | 33% | 33% |

B. Lesson Development: Est. Time: 35 minutes

- I will first tell the students we are going to stay at their desks today. I will have the power point of **Plant Parts** up on the smart board.
- We will go through each slide and I will read and explain them.
- After we have been through the power point I will pull up the video of the Blueberry Life Cycle. **http://www.youtube.com/watch?v=8pDtQGCxHOs**
- The students will be told to really watch the video and look for the different signs of the plant parts.
- Once the video is over I will ask students about the flower of the blueberry bush, the stem, the roots, and the leaves.
- I will then pull up the **Parts of a Plant worksheet** that is pre-labeled. We as a class will go over the parts and I will define them.
- Afterwards I will have students clean their desks off and I will give them a blank, **Parts of a Plant Worksheet** for them to fill out. I will tell students to be sure to write the name of the part and a brief definition of what it does.
- When students are finished I will have them put their sheet on the back table and pick up a piece of writing paper.
- On the board I will write, "Take a look at our blueberry bush and write an informative piece telling about the different parts of our plant and what they look like."

Figure 4-2. Student 4's pre lesson plan sample with entry level technology integration using PowerPoint and video clip.

**Group/Independent Activity:**
Part I: Build your beach model
1. Pour 300 ml of sand into your soda bottle. Use a piece of paper rolled up into a funnel.
2. Add 300 ml of water.
3. Carefully put the bottle on its side. Make sure your sand has settled into the end of the bottle to make the beach.

Part II: Making Waves
1. Sketch your beach in your journal.
2. Blow gently through the straw. The air will move across the top of the water to make waves.
3. Continue to blow for 10 breaths. Make a sketch of the beach after the waves have washed on it.
4. Repeat one more time, but this time blow harder through the straw to make bigger waves.
5. Draw what happened in your journal.

**Closure:**
Students will use Google Blogger to summarize what they have learned and what their observations were while completing the task.

**Summative Assessment:**
~ Students will complete a unit test at the end of the unit.

**TPACK Components:**
**Content-** The content is the different changes of the Earth's surface.
**Pedagogy-** We will learn more about this by doing an experiment and watching a short video on erosion.
**Technology-** The students will use computers and Google Blogger to complete a blog to explain what they did and what they observed.

Figure 4-3. Student 4's post lesson plan sample with entry, adoption, and infusion.

- Explain to students that today they will be cleaning the pulp and seeds out of the pumpkins and that they will need to save the seeds in the bowl provided. Students can help cover work space with newspaper.
- When the pumpkins have been cleaned and the work area is cleaned up, bring the children back together in a circle.
- Show the students a bowl of water. Explain that it is for seeds to be soaked overnight, so that tomorrow they will be able to split them open and see the embryo inside that starts the life of the pumpkin.
- Let each child add a seed (you can add a few extra in case of "problems" that may come up).
- Let children go back to their small groups so they can lay the rest of the seeds out on cookie sheets to dry.
- Explain that some of them are for planting (tomorrow) and that you will be baking some for them to taste.
- After class, can salt (or not) and bake the laid out seeds for tasting tomorrow.

C. Closure 5 minutes
Ask students to recite some facts about pumpkins that they learned from the lesson.
D. Extension 10 minutes
Teach them the pumpkin life cycle song.

Figure 4-4. Student 2's pre lesson plan sample with no technology integration.

**Title:** Layering Liquids

**Summary:** Students will learn why certain liquids lay below and on top of each other rather than mixing together when poured into a cup. This is because different liquids have different densities.

**NC Essential Standard for Science:**
5.P.1 Understand force, motion and the relationship between them.

| **Materials:** | **Teacher Technology Tools:** |
|---|---|
| • Light corn Syrup<br>• Water<br>• Vegetable Oil<br>• Dawn dish soap (blue)<br>• Rubbing alcohol<br>• Honey<br>• Large clear glass<br>• Food coloring,<br>• Turkey baster<br>• Plastic cup | • The teacher will present a short video from YouTube. The video shows students performing a mini layering experiment and defining what miscible and immiscible means over and over during the 2 and a half minute video. (Entry)<br><br>**Learner Technology Tools:**<br>• An extension activity is for students to create an online video of themselves explaining what the difference are between miscible and immiscible liquids are. If students are unable to complete this at home, this activity can be worked into a center. |

Figure 4-5. Student 2's post lesson plan sample with entry, adaptation, and transformation technology integration.

I. Lesson Objectives:

A. NC Standard Course of Study
Science 3.03 Using shadows follow and record the apparent movement of the sun in the sky during the day.

B. Content Objectives(s):
Learn how shadows are formed by the sun change shapes and positions throughout the day.

C. Skill Objective(s):
Physical education. Observation, communication, good sportsmanship

*II. Key Vocabulary:*
Light
Sun
Shadow
Opaque
Translucent

*III. Materials/Technology/Preparation;*
Worksheet (assessment)

IV. Instructional Process:

A. Lesson Introduction Est. Time: 10 minutes
Without light, we would have no shadows. Shadows are formed when light is blocked by opaque or translucent objects. The shadow takes the form of the object that blocks the light. The exact shape of the shadow is determined by the angle and the distance between the light source and the object. Since the shadow created depends on the location of the light source, people are able to determine the time of day by the shadows created by the sun. The longer your shadow is the later in the day it is.

B. Lesson Development: Est. Time: 40 minutes
Take your students outside early in the morning (on a sunny day). In an open area, tell them to find their shadows and describe them to you. Are they long or short? Help the class observe where the sun is in relation to the school building and where their shadows fall. Around midday take the class outside again and tell the students to observe their shadows. Compare these current positions to those you noted in your science journal earlier this morning. Repeat the activity again as late in the day as possible. They should notice how the sun's position changes the direction, size, and shape of their shadows. While you are outside the last time have the students play a game of shadow tag. This activity makes them aware of shadows. The person

Figure 4-6. Student 1's pre lesson plan sample with no technology integration.

| | |
|---|---|
| **Summary:** Students will understand that plants absorb water and nutrients through its roots and transports it up through the stem to the petals/leaves by observing this process take place. | |
| **NC Essential Standard for Science:** 3.L.2.1 Remember the function of the following structures as it elates to the survival of plants in their environments: <br>• Roots- absorb nutrients <br>• Stems- provide support <br>• Leaves- synthesize food <br>• Flowers- attract pollinators and produce seeds for reproduction | |
| **Materials:** <br>• Fresh White Flowers <br>• Glass or Clear Cups <br>• Water <br>• Food Coloring <br>• Observation Sheet <br>• Video clip or slideshow of parts of a plant. <br>• Sharpies <br>• Digital Cameras | **Teacher Technology Tools:** <br>• Present a video clip or slideshow of parts of a plant. <br><br>**Learner Technology Tools:** <br>• Digital Cameras to take pictures of their flowers throughout the experiment. <br>• Blog about what the explored, observed, and discovered. |

Figure 4-7. Student 1’s post lesson plan sample with entry, infusion, and transformation technology integration.


Figure 4-8. Learning Activities Supporting TPACK Development

**Grade Level: 2**

**Standards: 2.P.1**

**Essential Question(s): What is sound? Do we each hear things the same?**

**Materials: Pictures of sound waves and various instruments, science journal, paper and drawing utensils and sounds.**

**Engage: Sound Activities**

**Observing - Ask students to listen to the sound clips and compare and contrast pitch and loudness based on what they have heard.**

**Explore: How will you provide opportunities for meaningful exploration?**

**Organizing - Organize pictures of sound waves and sort based on pitch and length.**

**Questioning - Ask students to look for patterns in the pictures that they have sorted and write three questions about the patterns that they have found. They will then find another student to exchange and ask questions to.**

**Explain: How will explanation take place?**
**Representing - Draw a picture of their interpretation of pitch and loudness (sound waves etc).**

**Elaborate: How will elaboration on learning take place?**
**Experimenting - Ask students to experiment with different objects that make sounds, then they will draw their own picture of the sound waves or match the pictures that they sorted to the instrument.**

**Evaluate: How will evaluation of the learning take place?**
**Sharing - Have students partner and share what they know about sounds and sound waves they will then create a picture that reflects what they have learned.**

Figure 4-9. Summary of Students 1, 2, and 7’s physical science activity plan.

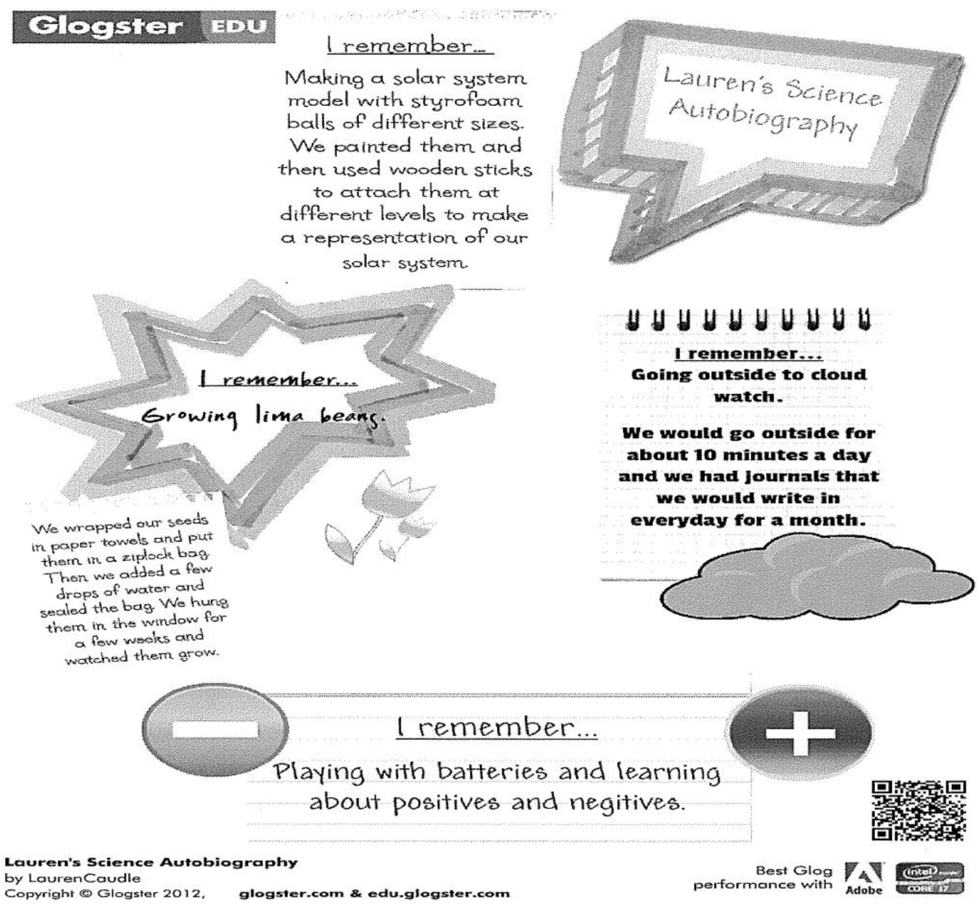



Figure 4-10. Sample Glog of Student's Science Autobiography

**Evaluating Technology Tools To Support Content and Pedagogy Chart**

| Creativity and Innovation | Collaboration | Research and Information | Critical Thinking | Digital Citizenship | Technology Operations |
|---|---|---|---|---|---|
| Apply existing knowledge to generate new ideas, Products, or processes | Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media | Plan strategies to guide inquiry | Identify and define authentic problems and significant questions for investigation | Advocate and practice safe, legal, and responsible use of information and technology | Understand and use technology systems |
| Create original works as a means of personal or group expression | Communicate information and ideas effectively to multiple audiences using a variety of media and formats | Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media | Plan and manage activities to develop a solution or complete a project | Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity | Select and use applications effectively and productively |
| Use models and simulations to explore complex systems and issues | Develop cultural understanding and global awareness by engaging with learners of other cultures | Evaluate and select information sources and digital tools based on the appropriateness to specific tasks | Collect and analyze data to identify solutions and/or make informed decisions | Demonstrate personal responsibility for lifelong learning | Troubleshoot systems and applications |
| Identify trends and forecast possibilities | Contribute to project teams to produce original works or solve problems | Process data and report results | Use multiple processes and diverse perspectives to explore alternative solutions | Exhibit leadership for digital citizenship | Transfer current knowledge to learning of new technologies |

***Learning Activity Types*** (Blanchard, et al., 2011)

| Conceptual Knowledge | Procedural Knowledge | Knowledge Expression |
|---|---|---|
| Read Text | Participate in a Simulation | Learn and Practice Safety Procedures |
| Attend to Presentation/Demonstration | Explore a Topic/Conduct Background Research | Measure |
| Take Notes | Study | Practice |
| View Images/Objects | Observe Phenomena | Prepare/Clean Up |
| Discuss | Distinguish Observations from Inferences | Carry Out Procedures |
| | Develop Predictions, Hypotheses, Questions, Variables | Observe |
| | Select Procedures | Record Data |
| | Organize/Classify Data | Generate Data |
| | Analyze Data | Collect Data |
| | Compare Findings with Predictions/Hypotheses | Collect Samples |
| | Make Connections Between Findings and Science Concepts/Knowledge | Compute |

**Technology Tools** (Blanchard et al., 2011)

| Conceptual Knowledge | Procedural Knowledge | Knowledge Expression |
|---|---|---|
| Websites | Web-based Simulations | Content-Specific Interactive Tools |
| Video | Web Search Engines | Web-based Software |
| Presentation Software | Wikis | Simulation |
| Wiki | Websites | Web Cams |
| Concept Mapping Software | Presentation Software | Digital Video Cameras |
| Digital Camera | Video Clips | Web-based Data Sets |
| Blog | Simulation | Glogster |
| Interactive Whiteboard | Database | Video Creation Software |
| Other | Spreadsheet | Other |
| | Word Processing | |
| | Concept Mapping | |
| | Other | |

| Low demand | High demand |
|---|---|
| Recall | Justify |
| Define | Compare |
| Remember | Assess |
| Implement | Analyze |
| Apply Facts | Evaluate Facts |

**Levels of Integration** (Sandholtz et al., 1997)

| Entry | Adoption | Adaptation | Infusion | Transformation |
|---|---|---|---|---|
| Teacher uses technology to present to students | Students use single technology tool | Students choose technology tool to create a digital product | Technology is an integral in supporting learning and student engagement | Technology is an essential tool in carrying out the lesson- lesson would not be possible without the technology tool being used |

Figure 4-11. Student 8's Evaluation Chart of Google Blogger

Table 4-3. Sample of Learning Activities Developed by Pre-service Teachers

| Conceptual Knowledge Building | Procedural Knowledge Building | Knowledge Expression |
|---|---|---|
| Students discuss their hypotheses about whether or not an object will sink or float. | Students will measure the specified amount of liquid in a graduated cylinder. | Students will develop a game to help the class learn a particular topic. |
| Students will view nature objects (butterfly wings, grass, etc.) using a microscope. | Students will collect samples and study items in person using appropriate technology tools. | Students will discuss opposing viewpoints within science. |
| Students will gather information needed for a presentation when they will teach the class about a concept. | Students will go outside and observe the clouds. | Students will create an image to demonstrate what they know. |

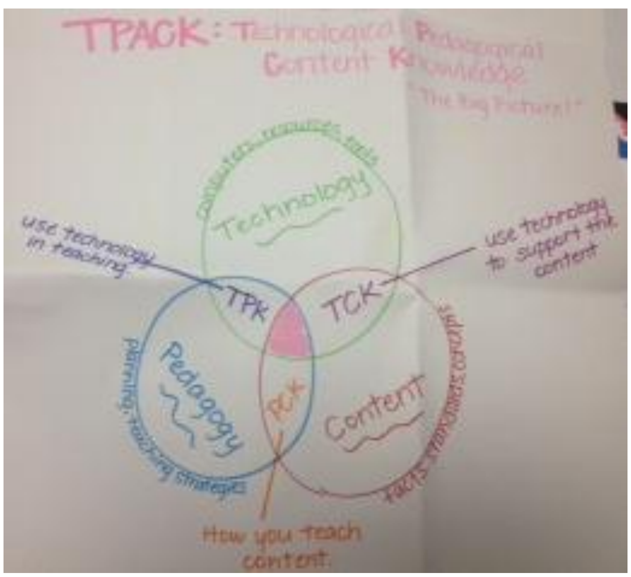



Figure 4-12. Sample TPACK Diagram with Student Descriptions of Each TPACK Component

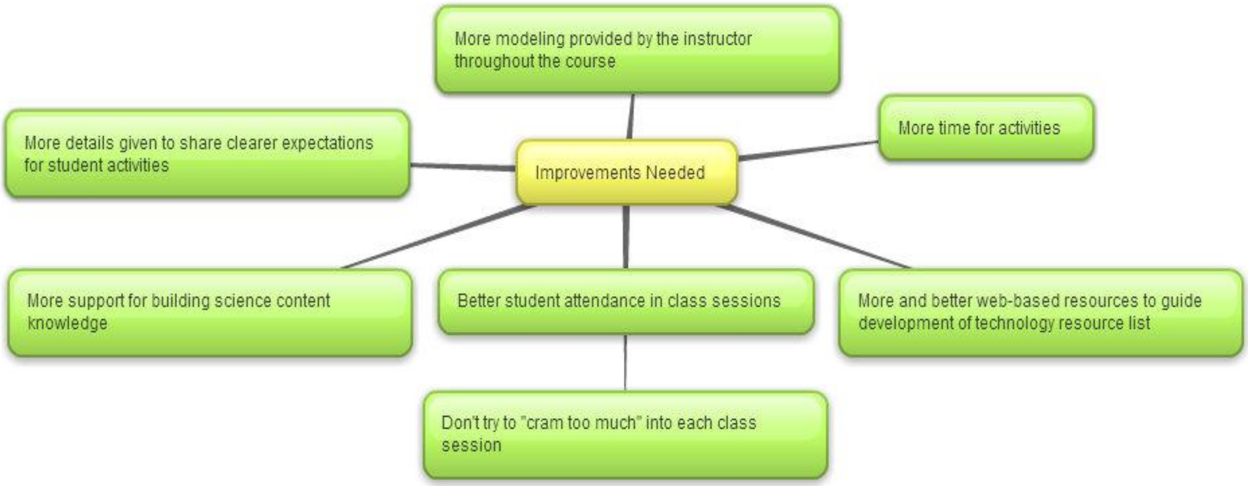



Figure 4-13. Improvements Needed for Future Courses

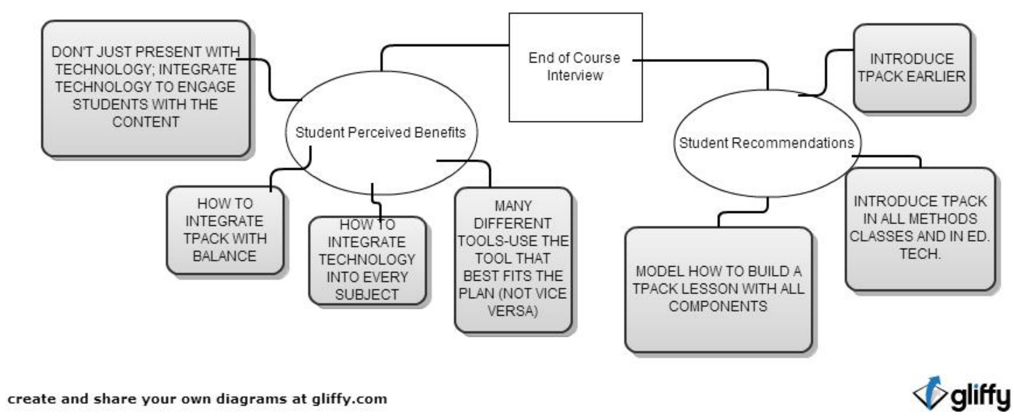



Figure 4-14. Students' Perceived Benefits and Recommendations for Future Courses

CHAPTER 5
DISCUSSION

## Discussion of Results

The main goal of this study was to provide insight into best practices for developing TPACK knowledge among pre-service teachers in a science methods course. The two main research questions that I aimed to answer in this study were "In what ways will my pre-service teachers' TPACK knowledge change during a carefully designed science methods course?" and "What teaching strategies and learning activities will support TPACK development among pre-service teachers in a science methods course?" For my first research question, all four data sets provided valuable evidence of change in TPACK knowledge of my pre-service teachers. My second research question was answered mainly through the analysis of my researcher reflections and the student reflections and interview data. By determining the ways that TPACK knowledge changed for the pre-service teachers in this course, as well as the activities and teaching strategies that supported this development, this study has provided valuable insight into my plans for future teacher-education courses including science methods, introductory educational technology, and other methods courses within the education department.

**Research Question # 1:** In what ways will my pre-service teachers' TPACK knowledge change during a carefully designed science methods course? TPACK surveys completed by the pre-service teachers in my science methods course during the beginning and end of the study provided answers to my first research question. As indicated through the growth in TPACK areas of science CK, PCK, TCK, TPK, and TPACK, the students in my science methods class did indeed report an increase in knowledge of and abilities to implement this research-based approach to technology integration, according to their self-perceptions (i.e. C4, Finding 1). As suggested by Mishra and others (i.e. C2), the TPACK framework focuses on the constructs of teaching (Mishra et al., 2009). The approach used in this course was different for my students who were used to the traditional approach of focusing on how to use specific technology tools and then making their lessons fit the tools. So, this information tells me that the course activities relating to CK, PCK, TCK, TPK, and TPACK were successful in building the development of TPACK knowledge among my students. The areas of TK and PK did not change as much, as shown in the data analysis of the survey. As I discussed in Chapter 2, TPACK literature focuses on the interrelatedness of each of the TPACK components (Koehler and Mishra, 2006). The whole purpose of the TPACK concept is to provide a framework to show the importance of thinking of technology integration as the melding together of technology, content, and pedagogy, in all of the possible permutations. Knowing this, I question why the survey results did not show much increase in TK and PK. A few thoughts come to mind as I wrestle with this question. Looking at the questions in the TK section of the survey, I wonder if students' response to "I know how to solve my own technical problems" were low for both the pre and post survey because they were thinking about problems related to the Internet signal problems prevalent on campus during the time of this study (TPACK survey question #1, Graham, et al., 2009). It is certainly true that we did not spend time in the course working specifically on finding solutions to technical problems.

There are six questions in this survey category. There was a slight increase in pre to post TK scores, from 3.7 to 3.93. Although there was not a large amount of growth shown, after removing the responses to this first survey question and re-averaging the pre and post scores for the TK category, the average post score is 3.98, bringing this very close to the “agree” response category. In fact, when looking closely at each student’s individual responses, only 2 out of the 9 students had an average score below 3.5 for the TK survey category. Although these specific details shed light on one possible explanation for a lack of growth in these areas, it is likely that students would benefit from additional focus on activities related to their TK development in future courses. There either needed to be additional activities developed to further enhance the development of technological knowledge (TK) in this course or students began this course with adequate knowledge of technology already. Since the average technological knowledge (TK) in the pre-survey was 3.7, this category of knowledge was already adequate among students for them to be able to move forward into integrating the use of this technology with content and pedagogy. The highest category on the survey is 5.0, so students did have room for growth, like they showed in other TPACK related categories.

Although I found that pedagogical knowledge (PK) did not show a significant increase, the average student scores for this category on the pre and post survey were between 4.71 and 5.0, nearly at the top of the scale for responses at the “strongly agree” level. This shows me that students’ perceptions of their pedagogical knowledge were already strong prior to the learning activities and teaching strategies implemented in the course. This could have been because they were well-prepared pedagogically in their previous curriculum course that they completed prior to being cleared to take methods courses. Overall, the survey results support the growth of my students’

TPACK knowledge as a result of the sequence of teaching strategies and learning activities in this science methods course.

Data analysis from the mid-semester reflections and end-of-study TPACK interview provide answers to this research question as well. The responses of participants indicated specific examples of ways that their knowledge of TPACK changed during the course (i.e. C4, Findings 1 and 2). They reported learning how to balance the integration of content, pedagogy, and technology in their lesson plans, how to integrate technology into every subject, that it is best-practice to not just present with technology, but to integrate the technology into the ways that the students interact with and learn the content, and also that there are many different types of technology tools to choose from when selecting the tool that best fits the pedagogical plan for teaching the content.

In addition to the learning that students gained through the semester, they also revealed misconceptions that were corrected during the course (i.e. C4, Finding 3). Their mid-semester reflection responses indicated that they realized that there were different ways to use technology to support content and pedagogy and that “the most important thing is deciding on the best way to implement the task using technology”. They learned to start with the task and then move on to include the technology only if the available technology tools fit the task and support what and how they are teaching.

I found that the pre and post lesson plan artifacts completed by students in the science methods class also showed examples of the changes in TPACK knowledge of the pre-service teachers in the course (i.e. C4, Findings 1 and 2). The increase in NETS*S in the lesson plans was likely in response to the activities related to the introduction of these standards to students and the evaluation activities that students completed using the TPACK integration chart to evaluate the lesson plans of their peers. During the course, as recommended by Schulman, students were given opportunities to build their pedagogical content knowledge through specifically designed course activities (i.e. C2, Table 2-4; Schulman, 1986). The increase in *learning activity types* was likely in response to the guided course activity when students learned about a variety of learning activities for science teaching and applied this learning to designing activities that fit within each category of learning activities as defined by Blanchard (2011). In my view, the increase in technology tools used from the pre to post-TPACK lesson plans was probably in response to the guided exploration of and evaluation of technology tools as well as the use of the TPACK lesson plan format that provided clear expectations and specific guiding questions for including the use of technology to support instruction. I would argue that the increase in the levels of high cognitive demand (Silver, 2009) in the post-TPACK lesson plans can be attributed to the use of the TPACK integration evaluation chart, making students aware of the different levels of cognitive demand being used in their lesson plans and encouraging them to increase the higher levels to provide for higher levels of learning among students. Finally, and most integral to the purposes of this study, the increase in levels of technology integration from the pre to post-TPACK lesson plans are likely related to the growth in TPACK among pre-service teachers that developed throughout the course as they participated in the carefully planned out sequence of learning activities.

Overall, the results of the lesson plan data analysis indicate specific growth areas within the TPACK framework among pre-service teachers as evidenced by their lesson plan attributes.

**Research Question # 2:** What teaching strategies and learning activities will support TPACK development among pre-service teachers in a science methods course? Students reported that the use of the TPACK lesson plan format (i.e. C4, Finding 3), peer and self-revision of lesson plans (i.e. C4, Findings 3 and 4), and viewing of the videos (i.e. C4, Finding 1) were the course activities that provided the most support in their TPACK growth and development. I designed the initial sequencing of course activities following recommendations from Chai and others to focus on the science pedagogy, then exploring technology tools, and then finally on how to integrate these to teach the content (Chai et al., 2010). This sequence can be seen in the activities table (i.e. C2, Table 2-4).

Overall, the mid-semester student reflections and end-of-study interview responses provided concrete evidence to inform the study. These data revealed specific learning activities and teaching strategies that supported the TPACK development of pre-service teachers in the science methods course, as well as the changes in TPACK knowledge that occurred as a result of the carefully planned sequence of activities (i.e. C2, Table 2-4).

Specific teaching strategies and learning activities led to this growth as students became more aware of the importance and relevance of increasing science and technology experiences with students from the viewing of the course video clips and creation of science autobiographies (i.e. C4, Finding 1). The growth in content and pedagogical understanding of the scientific process grew as a result of the student science project proposal activity. Students began thinking more intentionally about technology tools for teaching after completing the activities related to exploration of technology tools and designing learning activities (i.e. C4, Finding 2). A variety of tools were explored including several tools specifically for the special education setting. Graham and others (i.e. C2) recommended exposing students to technology tools for use specifically for science (Graham et al., 2009). As students participated in course activities involving the exploration of technology tools, I directed them to specific resources that could be used in the science classroom. Marino and others (i.e. C2) suggested a need to better prepare pre-service teachers to select technology tools to support students with disabilities (Marino et al., 2009). As students evaluated and explored technology tools for use in the science classroom, they included in their search tools that could be used to support special education learners. They later began implementing the TPACK framework once introduced to the TPACK lesson plan template (i.e. C4, Finding 3).

## Implications

My goal for the study was to strategically design, assess, and make plans for future changes to a series of activities that encourage the development of technological, pedagogical content knowledge of pre-service teachers throughout my science methods course (i.e. abstract, C1, C3, and C5). I was unsure of the best teaching strategies and learning activities to support this change or the amount of direction and scaffolding that students would need to be able to change their thinking about creating lesson. I needed to start with a carefully designed plan of action that I would assess regularly to determine which activities and strategies worked and which did not. Throughout the study, I was able to observe and document student change, growth, and better understanding of how to use the TPACK framework to develop content-based lesson plans with intentional technology integration to support specific learning goals.  My students, teaching, TPACK, classroom, and school are all connected in that the results of this study will inform future instruction.  Students now know how to develop stronger technology-rich lesson plans using the TPACK framework and lesson plan template as shown through their increase in levels of integration throughout their lesson plans. Based on recommendations from the exit interview and my researcher reflection data, my teaching has been informed with regards to the things that I should keep the same (that have worked well) and things that I should change in order to strengthen courses that I will teach in the future.  Lesson plan data show that TPACK integration is happening among my students, a practice that was not evident before this study.  My classroom will continue to show learner engagement and skill development in the area of TPACK.  Finally, based on these findings, programmatic changes including the implementation of up-to-date technology integration practices in all methods classes will impact the entire education program at my university.  The implications of this study fit into three categories, including my teaching, the teacher-education program at my university, and teacher education programs of other universities.

## Implications for My Teaching

As a teacher-researcher new to the post-secondary classroom, this study has taught me that regular, systematic reflection is of upmost importance in guiding my own course development; specifically in providing evidence to help determine how to best respond to the learning needs of my students.

Perhaps the most significant findings, not specific to the research questions of this study, but certainly applicable to all college-level courses, is that my students are impressionable and capable of changing their current practices when provided with high quality, specific resources and careful scaffolding to support their learning. They need lots of modeling to show them examples of behaviors that they are expected to acquire. The idea of modeling for students was suggested by Baran and others (i.e. C2) in their study that included modeling of the expectations that the teachers had for the pre-service teachers (Baran et al., 2011). Adequate modeling did not take place in my class during this study as indicated by the data. Additional modeling has been planned for future courses and is highlighted in the plan for future courses (Table 5-1).

Both the end of study interview data and my researcher reflection journal highlighted suggested improvements to future science methods courses. In the analysis of interview data I found that students recommended introducing TPACK earlier in the course and explaining this concept thoroughly from the beginning, when students write their first lesson plans. Additionally, much more modeling is needed to show students how to build a TPACK lesson. In future science methods courses, I plan to invest significant classroom time modeling the behaviors expected of the pre-service teachers. These include, but are not limited to, the evaluation of and use of a variety of technology tools, the creation of all components of the TPACK lesson plan using the format provided to students, and assessment of lesson plans using the TPACK evaluation chart.

The analysis of my researcher reflection journal showed a positive student response to the videos clips showing both explanations of content and examples of science teaching in the classroom. Additional videos will be included in my future courses to provide students even more of this useful information in a video-based format that allows them to revisit and/or review the content in a convenient way. I will provide additional scaffolding to students, specifically in the use of the TPACK evaluation chart and lesson plan format. In the future, modeling will occur to show students how they are expected to use the TPACK evaluation grid to assess lesson plans and make recommendations for revisions. In addition, I will require that my class work through a guided lesson development from start to finish, with modeling provided by me, before students will be asked to use this lesson plan format on their own. The activities that students responded best to (based on their comments in class and through their reflections, and as evidenced by their growth) were those that included the most scaffolding and specific resources.

Another improvement for my future courses will be for me to provide support for the learning of the science content by moving the required content paper to the first three weeks of the course, while providing support by giving students access to a content expert to collaborate with while writing the paper. More time will be given for the most beneficial activities to allow students adequate practice time with the support of their peers and that of their instructor. I will address student attendance issues in a proactive manner by including greater consequences for absences in the course syllabus, as well as making expectations clear and setting up incentives for those students who attend all class sessions. In addition to these recommendations for improvement to future science methods courses, I will also create a better and more thorough list of web-based technology resources to guide the technology resource list project, a need also indicated by notes in my researcher reflection journal. Finally, additional detailed instructions will be given to students for activities throughout the course. Although students were successful in changing their technology integration behaviors using the TPACK framework followed through the course, implementation of these recommended changes should strengthen this changeand provide clearer perceptions of self-growth among students during future courses. I have developed a revised sequential plan for course activities using the suggestions gathered through data analysis (Table 5-1).

## Implications for My Teacher Education Program

Beyond changes to my own courses, I will suggest changes be made within the broader teacher education program as a result of this study. Students recommended the introduction of the TPACK framework in all methods courses and for the first introduction to occur during the introductory educational technology course that students take prior to beginning methods courses in the teacher education program. As the instructor of both science methods and the educational technology course, I will be able to effect this change in these courses. Additionally, I am scheduled to teach math methods and arts methods during the upcoming calendar year. During the development of each of these course revisions, I will ensure that the TPACK framework is introduced early on in each course, with appropriate modeling and scaffolded learning activities provided. An initial and thorough introduction of the TPACK framework will also be embedded into the introductory educational technology course that students will typically take during their sophomore year.

I will encourage other instructors in the teacher-education department to include the TPACK framework and lesson plan format in their methods courses as well through participation in a series of professional development offerings about the research and benefits supporting the use of this TPACK framework in teacher-education courses. These sessions will provide peer instructors not only the research basis to hopefully motivate them to include this framework in their teaching, but also the skills that they themselves will need as instructors to be able to model and implement this framework successfully as they work to transfer this knowledge to their students.

In addition to these programmatic changes that can be implemented as early as the summer and fall sessions of 2013, I will be proposing the addition of a technology integration methods course to be added into the University catalog for School of Education programs. If accepted, this new course will be able to begin in approximately one calendar year from the date the formal proposal is submitted to the School of Education board. This new course will enable our pre-service teachers to begin learning about technology tools in the introductory technology applications course, learn about pedagogy in their curriculum course, learn how to integrate TPACK in this new technology integration methods course, practice their knowledgeable integration of TPACK in the rest of their methods courses, and put these skills into practice in their clinical classroom settings as they student teach. These planned programmatic changes build on the Brigham Young study (i.e. C1) suggesting that pre-service teachers begin their study of TPACK with a study of technology tools in an introductory educational technology course, continue in each of their methods classes, and complete this in their field experience (Wentworth et al., 2009).

**Implications for Other Teacher Educators**

To my peers in the higher-education setting who are working to prepare pre-service teachers for their own classrooms, I highly encourage the use of this carefully designed framework. There are numerous resources available (see reference list) to support the use of these teaching strategies with students. I would be honored to collaborate and provide support in adopting this framework for the preparation of future teachers to intentionally integrate technology to support teaching methods and learning goals.

As the technology tools that are being used in classrooms rapidly change, teachers will be armed with the knowledge and pedagogical habits needed to select tools to support the method of teaching and learning (and not, as my students have said, "…vice versa"). With this framework, the planning and lesson development of teachers will be minimally affected by the rapidly changing technologies at their disposal. Teachers will be able to continue to use and work to perfect the sound, research-based teaching methods that they know work for their students, and adapt to whatever new tools are available at any given time throughout their teaching careers, using the appropriate tools to support their instruction.

Empowering future teachers to knowledgably integrate technology, content, and pedagogy will set their future students up for a dynamic learning experience, full of research-based, effective pedagogy that is supported by the tools of the day.

**Improvements for Future Research**

For future research, I have noted a few improvements that I believe are necessary. First, prior to administering the pre-TPACK survey, I believe additional information needs to be gathered from students to provide me with a better "feel" for the types of technology integration that has been modeled and expected of students previously. Second, I believe an explanation of the terminology throughout the survey would be beneficial in ensuring that students self-report their perceptions accurately.

During the course, students could record reflections after each class session to provide timely feedback about what the students feel they are getting out of the instruction and learning activities.  This would allow time the instructor to implement changes within the context of the course in a more timely manner than is possible withmid-semester reflections and post-study interviews.

At the end of the study, it may be beneficial to give students an opportunity to discuss with their peers the ways that their technology integration skills have changed before giving them the post-TPACK survey and/or interviews.  I believe that doing so may help to better prepare them to give accurate answers by providing them with a structured opportunity to reflect on their course experiences with the social learning benefits that they get when discussing with their peers.

Although this study adds to the current research that is available in the educational field, additional support is needed through research in a variety of settings from the elementary to the post-secondary level of instruction.  In-service classroom teachers working directly with students, K-12 students in the classrooms of these teachers, pre-service teachers learning in teacher-education programs, and instructors in the higher education settings that are working to prepare future teachers, are each likely to have slightly different perspectives on their experiences with technology in the teaching and learning setting.  The more research that we have to lean on, the more informed our decisions can be about how to best design instruction supported by technology for our students.

## Conclusions

This study of TPACK development among pre-service teachers is timely and critical as our country's education system progresses further into the 21st century.  Even in many of our nation’s poorest schools, the availability of technology tools is rapidly rising.  Effective courses must be in place in our teacher training programs to provide effective instruction to prepare our future teachers to teach effectively with technology. As the tools being used in classrooms will continue along a trend of rapid change, I believe that properly prepared educators will be able to embrace this change and continue to reach learners through research-based instruction that balances sound pedagogy, teaching of standards-based content, and thoughtful selection of appropriate technology tools that will support the planned instruction.

The results of this study provide practical answers for teacher educators by following a similar, research-based, sequence of course activities related to the development of this TPACK knowledge.   This course of activities, along with recommended teaching strategies, will prepare pre-service teachers to be able to apply TPACK in their lesson plans.  The application of this study can be transferred to a variety of educational settings included, but not limited to, K-12 classrooms, professional development of teachers at all levels, post-secondary teacher education programs, and graduate schools for educators.

Teacher education course instructors can use the implications of this study to refine courses to meet the changing needs of future teachers.  K-12 classroom teachers can adapt their current lesson plan framework to use technology more effectively to support instruction.  In addition, education leaders providing professional development can shift the standard for technology integration in their schools by arming teachers with the TPACK lesson plan, or a similar format that provides guiding questions to provide scaffolded support as teachers begin to implement this approach to lesson planning with technology.  Finally, post-secondary education programs at all levels can incorporate the TPACK framework into their teacher-education courses to prepare practicing and pre-service teachers to improve their instruction from technology-based to technology-supported.

In my view, the development of technology tools for use in the classroom is not likely to stall.  As the availability of technology tools in education settings continues to rise, so does the need for teachers to be knowledgeable of ways to use this technology, while holding on to strong pedagogical teaching methodologies.  This study advocates for the revision of the old ways of teaching with technology in all areas of education preparation and professional development.  Additional research studies in these teaching settings are needed to develop effective sequences of instructional techniques and activities that will result in the empowering of teachers to better plan for technology integration, thus ultimately enabling today's 21st century students to learn through the meaningful support of technology.

Table 5-1. Plan for future courses, with changes from the original course activity plan highlighted.

| Time Frame | TPACK Component(s) Being Built | Teaching Activities Planned to Develop TPACK | Associated Student Learning Tasks |
|---|---|---|---|
| Day 1 | Content Knowledge | -Introduce content knowledge | -Create a "science autobiography", reflecting upon the development of science knowledge using Glogster |
| Days 2-4 *attendance reminder | | | -Create overall concept maps of each K-5 goal (life, physical, and Earth science) |
| Days 2-4 | Content Knowledge | -Review content within each theme to build and refresh pre-service teacher content knowledge | -Student-centered science labs for each theme<br>-Science collaborative journal of reflective learning (blog) with instructor modeling of expectations |
| Days 2-4 | Content Knowledge | -Introduce content paper with expert collaborators | -Students begin planning and writing their content paper with collaboration with content expert from science department |
| Day5 | Content Knowledge Pedagogical Knowledge | -Introduce the notion of content and pedagogy combining to create the methods for teaching science | -Complete online learning module about the history of science education |
| Days 6-7 | Pedagogical Knowledge | -Introduce pedagogical knowledge<br>Model examples of constructivist teaching methods | -Explore, describe and provide examples of constructivist teaching methods (Piaget, Vygotsky, and active, inquiry-based learning) |
| Days 6-7 | Pedagogical Knowledge | Explore demonstrations vs. experiments and model both | -Research current trends in science education (focusing on methods)<br>-Assign science fair projects |
| Days 8-9 | Pedagogical Knowledge | -Introduce *learning activity types,* focusing on the three types of knowledge building activities | -Explore *learning activity types*<br>-Categorize learning related to each content-based theme within the three types of knowledge building activities (model first) |
| Days 8-9 | Pedagogical Knowledge | -Model choosing *learning activity types* based on determining types of knowledge needed to be built among learners | -Guided practice in small groups to select *learning activities* to match the needs for knowledge building (model first)<br>-Individual practice selecting *learning activities* to match the needs for knowledge building |

Table 5-1. Continued

| Time Frame | TPACK Component(s) Being Built | Teaching Activities Planned to Develop TPACK | Associated Student Learning Tasks |
|---|---|---|---|
| Day 10 *attendance reminder | Pedagogical Knowledge Content Knowledge | -Model combining content and pedagogical knowledge using *learning activity types* | -Use *learning activity types* to develop plans for teaching science content (model first) |
| Day 11 | TPACK Concept | -Introduce the TPACK concept | -Introduce the TPACK idea generally to give a purpose for our study of technology tools and provide a scope for upcoming course activities |
| Day 12 | Technological Knowledge | -Introduce technological knowledge | -Define technological knowledge |
| Days 13-14 | Technological Knowledge | -Introduce technology tools to support science teaching and learning | -Explore technology tools with science (give more web-resources to scaffold this) and encourage students to troubleshoot technical problems collaboratively<br>-Evaluate usefulness of a variety of technological tools for science teaching and learning (no emphasis on pedagogy) (model first) |
| Days 15-16 | Technological Knowledge Content Knowledge | -Provide opportunities for exploration with different technology tools in building pre-service teacher content knowledge | -Science labs using technology to continue building content knowledge of pre-service teachers<br>-Science collaborative journal of reflective learning continued (blog) |
| Day 17-18 *attendance reminder | Technological Knowledge Content Knowledge | -Model combining technological knowledge with content knowledge | -Develop lesson plan to teach science content with technology (no emphasis on pedagogy) (model first) |
| Day 19 | Technological Knowledge Content Knowledge Pedagogical Knowledge | -Model using *learning activity types* to choose technology tools to go along with selected learning activities | -Model for students the selection of technology tools to support learning activities |
| Day 20 | Technological Knowledge Content | --Use *learning activity types* document (Appendix C) to choose technology tools to go along with selected learning activities | -Scaffolded practice selecting technology tools to support science learning using *learning activity types* document in small groups |
| Day 21 | Knowledge Pedagogical Knowledge | | -Individual practice selecting technology tools to support science learning (provide adequate details for clear student expectations) |

Table 5-1. Continued

| Time Frame | TPACK Component(s) Being Built | Teaching Activities Planned to Develop TPACK | Associated Student Learning Tasks |
|---|---|---|---|
| Day 22 | | Model use of TPACK lesson plan format to create lesson plan integrating TP and CK | -Model use of the TPACK lesson plan format and evaluation using *Evaluating Technology Tools To Support Content and Pedagogy Chart* |
| Day 23 | | Students create TPACK lesson plan using TPACK plan format | -Using the TPACK lesson plan format, create TPACK lesson plan (draft) to be evaluated by self and peers using the *Evaluating Technology Tools To Support Content and Pedagogy Chart* (give adequate details to make expectations clear) |
| Day 24 | TPACK evaluation | -Provide opportunities for pre-service teachers to evaluate the usefulness of the tools that they select to support teaching and learning and model this type of evaluation | -Using the *Evaluating Technology Tools To Support Content and Pedagogy Chart*, evaluate the usefulness of the technology tools intended to support teaching and learning from peers' lesson plans |
| Day 25 | TPACK revision | -Model revision of lesson plan based on self and peer evaluations using the *Evaluating Technology Tools To Support Content and Pedagogy Chart* | -Model revision of lesson plan<br>-Students revise their lesson plan based on peer feedback (give adequate details to make expectations clear) |
| Days 26-30+ | Tying it all together in practice | Unit Plan Development<br>Engaged Learning Project in Local School | -students work in groups to develop unit plans around a central science theme<br>-students visit a local school to lead science experiments and demonstrations |

*In addition to course activities listed in this chart, the instructor will lead guided inquiry mini-lessons using the scientific method weekly. Students will also participate in two book studies focusing on methods and issues of science education.

APPENDIX A
QUESTIONNAIRE

*Thank you for taking time to complete this questionnaire. Please answer each question to the best of your knowledge. Your thoughtfulness and candid responses will be greatly appreciated. Your individual name or identification number will not at any time be associated with your responses. Your responses will be kept completely confidential and will not influence your course grade.*

**DEMOGRAPHIC INFORMATION**

1. Your Student ID Number

2. Gender
   a. Female
   b. Male

3. Age range
   a. 18-22
   b. 23-26
   c. 27-32
   d. 32+

4. Major
   a. Special Education
   b. Elementary Education
   c. Secondary Education
   d. Health and P.E.
   e. Other

5. Area of Specialization

6. Year in College
   a. Freshman
   b. Sophomore
   c. Junior
   d. Senior

7. Are you currently enrolled or have you completed a practicum experience in a classroom?
   a. Yes
   b. No

*Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"*

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| **TK (Technology Knowledge)** | | | | | |
| 1. I know how to solve my own technical problems. | | | | | |
| 2. I can learn technology easily. | | | | | |
| 3. I keep up with important new technologies. | | | | | |
| 4. I frequently play around the technology. | | | | | |
| 5. I know about a lot of different technologies. | | | | | |
| 6. I have the technical skills I need to use technology. | | | | | |
| **CK (Content Knowledge)** | | | | | |
| **Mathematics** | | | | | |
| 7. I have sufficient knowledge about mathematics. | | | | | |
| 8. I can use a mathematical way of thinking. | | | | | |
| 9. I have various ways and strategies of developing my understanding of mathematics. | | | | | |
| **Social Studies** | | | | | |
| 10. I have sufficient knowledge about social studies. | | | | | |
| 11. I can use a historical way of thinking. | | | | | |
| 12. I have various ways and strategies of developing my understanding of social studies. | | | | | |
| **Science** | | | | | |
| 13. I have sufficient knowledge about science. | | | | | |
| 14. I can use a scientific way of thinking. | | | | | |
| 15. I have various ways and strategies of developing my understanding of science. | | | | | |
| **Literacy** | | | | | |
| 16. I have sufficient knowledge about literacy. | | | | | |
| 17. I can use a literary way of thinking. | | | | | |
| 18. I have various ways and strategies of developing my understanding of literacy. | | | | | |

| PK (Pedagogical Knowledge) | | | | | |
|---|---|---|---|---|---|
| 19. I know how to assess student performance in a classroom. | | | | | |
| 20. I can adapt my teaching based-upon what students currently understand or do not understand. | | | | | |
| 21. I can adapt my teaching style to different learners. | | | | | |
| 22. I can assess student learning in multiple ways. | | | | | |
| 23. I can use a wide range of teaching approaches in a classroom setting. | | | | | |
| 24. I am familiar with common student understandings and misconceptions. | | | | | |
| 25. I know how to organize and maintain classroom management. | | | | | |

| PCK (Pedagogical Content Knowledge) | | | | | |
|---|---|---|---|---|---|
| 26. I can select effective teaching approaches to guide student thinking and learning in mathematics. | | | | | |
| 27. I can select effective teaching approaches to guide student thinking and learning in literacy. | | | | | |
| 28. I can select effective teaching approaches to guide student thinking and learning in science. | | | | | |
| 29. I can select effective teaching approaches to guide student thinking and learning in social studies. | | | | | |
| **TCK (Technological Content Knowledge)** | | | | | |
| 30. I know about technologies that I can use for understanding and doing mathematics. | | | | | |
| 31. I know about technologies that I can use for understanding and doing literacy. | | | | | |
| 32. I know about technologies that I can use for understanding and doing science. | | | | | |
| 33. I know about technologies that I can use for understanding and doing social studies. | | | | | |

| TPK (Technological Pedagogical Knowledge) | | | | | |
|---|---|---|---|---|---|
| 34. I can choose technologies that enhance the teaching approaches for a lesson. | | | | | |
| 35. I can choose technologies that enhance students' learning for a lesson. | | | | | |
| 36. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom. | | | | | |
| 37. I am thinking critically about how to use technology in my classroom. | | | | | |
| 38. I can adapt the use of the technologies that I am learning about to different teaching activities. | | | | | |
| 39. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn. | | | | | |
| 40. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom. | | | | | |
| 41. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district. | | | | | |
| 42. I can choose technologies that enhance the content for a lesson. | | | | | |

| TPACK (Technology, Pedagogy, and Content Knowledge) | | | | | |
|---|---|---|---|---|---|
| 43. I can teach lessons that appropriately combine mathematics, technologies and teaching approaches. | | | | | |
| 44. I can teach lessons that appropriately combine literacy, technologies and teaching approaches. | | | | | |
| 45. I can teach lessons that appropriately combine science, technologies and teaching approaches. | | | | | |
| 46. I can teach lessons that appropriately combine social studies, technologies and teaching approaches. | | | | | |

| MODELS of TPACK (Faculty, PreK-6 Teachers) | | | | | |
|---|---|---|---|---|---|
| 47. My mathematics education professors appropriately model combining content, technologies and teaching approaches in their teaching. | | | | | |
| 48. My literacy education professors appropriately model combining content, technologies and teaching approaches in their teaching. | | | | | |
| 49. My science education professors appropriately model combining content, technologies and teaching approaches in their teaching. | | | | | |
| 50. My social studies education professors appropriately model combining content, technologies and teaching approaches in their teaching. | | | | | |
| 51. My instructional technology professors appropriately model combining content, technologies and teaching approaches in their teaching. | | | | | |
| 52. My educational foundation professors appropriately model combining content, technologies and teaching approaches in their teaching. | | | | | |
| 53. My professors outside of education appropriately model combining content, technologies and teaching approaches in their teaching. | | | | | |
| 54. My PreK-6 cooperating teachers appropriately model combining content, technologies and teaching approaches in their teaching. | | | | | |

| | *25% or less* | *26% - 50%* | *51% - 75%* | *76%-100%* |
|---|---|---|---|---|
| **MODELS of TPCK** | | | | |
| 55. In general, approximately what percentage of your teacher education professors have provided an effective model of combining content, technologies and teaching approaches in their teaching? | | | | |
| 56. In general, approximately what percentage of your professors outside of teacher education have provided an effective model of combining content, technologies and teaching approaches in their teaching? | | | | |
| 57. In general, approximately what percentage of the PreK-6 cooperating teachers have provided an effective model of combining content, technologies and teaching approaches in their teaching? | | | | |

***Please complete this section by writing your responses in the boxes.***

73. Describe a specific episode where a Pfeiffer University professor or instructor effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content was being taught, what technology was used, and what teaching approach(es) was implemented.

74. Describe a specific episode where one of your cooperating teachers effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content was being taught, what technology was used, and what teaching approach(es) was implemented. If you have not observed a teacher modeling this, please indicate that you have not.

75. Describe a specific episode where you effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content you taught, what technology you used, and what teaching approach(es) you implemented. If you have not had the opportunity to teach a lesson, please indicate that you have not.

APPENDIX B
CODING CRITERIA FOR LESSON PLANS AND TECHNOLOGY INTEGRATION EVALUATION CHART

**Science Content** (NC Essential Science Standards, 2012)

| Physical Science | Earth Science | Life Science |
|---|---|---|
| Forces and Motion | Earth Systems, Structures, and Processes | Structures and Functions of Living Organisms |
| Matter, Properties, and Change | Earth In the Universe | Ecosystems |
| Energy:  Conservation and Transfer | Earth History | Molecular Biology |
| | | Evolution and Genetics |

**National Education Technology Standards** (ISTE, 2007)

| Creativity and Innovation | Collaboration | Research and Information | Critical Thinking | Digital Citizenship | Technology Operations |
|---|---|---|---|---|---|
| Apply existing knowledge to generate new ideas, Products, or processes | Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media | Plan strategies to guide inquiry | Identify and define authentic problems and significant questions for investigation | Advocate and practice safe, legal, and responsible use of information and technology | Understand and use technology systems |
| Create original works as a means of personal or group expression | Communicate information and ideas effectively to multiple audiences using a variety of media and formats | Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media | Plan and manage activities to develop a solution or complete a project | Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity | Select and use applications effectively and productively |

| | | | | | |
|---|---|---|---|---|---|
| Use models and simulations to explore complex systems and issues | Develop cultural understanding and global awareness by engaging with learners of other cultures | Evaluate and select information sources and digital tools based on the appropriateness to specific tasks | Collect and analyze data to identify solutions and/or make informed decisions | Demonstrate personal responsibility for lifelong learning | Troubleshoot systems and applications |
| Identify trends and forecast possibilities | Contribute to project teams to produce original works or solve problems | Process data and report results | Use multiple processes and diverse perspectives to explore alternative solutions | Exhibit leadership for digital citizenship | Transfer current knowledge to learning of new technologies |

| | | |
|---|---|---|
| ***Learning activity types*** *(*Blanchard, et al., 2011) | | |
| Conceptual Knowledge<br>Read Text | Procedural Knowledge<br>Participate in a Simulation | Knowledge Expression<br>Learn and Practice Safety Procedures |
| Attend to Presentation/Demonstration | Explore a Topic/Conduct Background Research | Measure |
| Take Notes | Study | Practice |
| View Images/Objects | Observe Phenomena | Prepare/Clean Up |
| Discuss | Distinguish Observations from Inferences | Carry Out Procedures |
| | Develop Predictions, Hypotheses, Questions, Variables | Observe |
| | Select Procedures | Record Data |
| | Organize/Classify Data | Generate Data |
| | Analyze Data | Collect Data |
| | Compare Findings with Predictions/Hypotheses | Collect Samples |
| | Make Connections Between Findings and Science Concepts/Knowledge | Compute |
| **Technology Tools** (Blanchard et al., 2011) | | |
| Conceptual Knowledge<br>Websites | Procedural Knowledge<br>Web-based Simulations | Knowledge Expression<br>Content-Specific Interactive Tools |

| | | |
|---|---|---|
| Video | Web Search Engines | Web-based Software |
| Presentation Software | Wikis | Simulation |
| Wiki | Websites | Web Cams |
| Concept Mapping Software | Presentation Software | Digital Video Cameras |
| Digital Camera | Video Clips | Web-based Data Sets |
| Blog | Simulation | Glogster |
| Interactive Whiteboard | Database | Video Creation Software |
| Other | Spreadsheet | Other |
| | Word Processing | |
| | Concept Mapping | |
| | Other | |

| **Assessment** (Morrison et al., 2008) |
|---|
| Rubrics |
| Teacher Observation |
| Group Assessment |
| Peer Assessment |
| Student Self-Assessment |
| Performance –Based Assessment |
| Short Response Test |
| Extended Response Test |
| No Assessment Specified |

| **Levels of Demand** (Silver et al., 2009) | |
|---|---|
| <u>Low demand</u> | <u>High demand</u> |
| Recall | Justify |
| Define | Compare |
| Remember | Assess |
| Implement | Analyze |
| Apply Facts | Evaluate Facts |

| **Levels of Integration** (Sandholtz et al., 1997) | | | | |
|---|---|---|---|---|
| Entry | Adoption | Adaptation | Infusion | Transformation |
| Teacher uses technology to present to students | Students use single technology tool | Students choose technology tool to create a digital product | Technology is an integral in supporting learning and student engagement | Technology is an essential tool in carrying out the lesson-lesson would not be possible without the technology tool being used |

APPENDIX C
LEARNING ACTIVITY TYPES

| ***Learning activity types*** | | |
|---|---|---|
| Conceptual Knowledge<br>Read Text | Procedural Knowledge<br>Participate in a Simulation | Knowledge Expression<br>Learn and Practice Safety Procedures |
| Attend to Presentation/Demonstration | Explore a Topic/Conduct Background Research | Measure |
| Take Notes | Study | Practice |
| View Images/Objects | Observe Phenomena | Prepare/Clean Up |
| Discuss | Distinguish Observations from Inferences | Carry Out Procedures |
| | Develop Predictions, Hypotheses, Questions, Variables | Observe |
| | Select Procedures | Record Data |
| | Organize/Classify Data | Generate Data |
| | Analyze Data | Collect Data |
| | Compare Findings with Predictions/Hypotheses | Collect Samples |
| | Make Connections Between Findings and Science Concepts/Knowledge | Compute |

(Blanchard, et al., 2011)

## APPENDIX D
## GUIDING QUESTIONS FOR REFLECTIVE PRACTITIONER JOURNAL

What activities/strategies worked and why?

What activities/strategies did not work and why?

How did the students respond?

What (if any) misconceptions emerged through this activity/strategy?

How can I facilitate correction of student's misconceptions?

What evidence of growth (if any) emerged through this activity/strategy?

How could I improve this activity/strategy for later on during this course?

How could I improve this activity/strategy for next semester?

Other Thoughts of Reflection

APPENDIX E
GUIDING QUESTIONS TO ANALYZE COMPLETE DATA SET (DERIVED FROM DANA and YENDOL-HOPPEY, 2009).

| | | |
|---|---|---|
| Describe | What did I see during the inquiry process? | |
| | What happened? | |
| | What are my initial insights? | |
| Organize | What am I noticing in the data? | |
| | What is happening? | |
| | How might the different pieces of data fit together? | |
| | Which data pieces stand out from the rest? | |
| Interpret the Meaning | What did I initially wonder? | |
| | How do these themes inform my wonderings? | |
| | What is happening within and across each theme? | |
| | How is what is happening connecting to:<br>-my students?<br>-my teaching?<br>-TPACK?<br>-my classroom?<br>-my school? | |
| Develop Implications | "What have I learned about myself as a teacher?" | |
| | What have I learned about my students? | |
| | What have I learned about the larger context of teacher-education at my university? | |
| | "What are the implications of what I have learned on my teaching?" | |
| | "What changes might I make in my practice?" (Dana and Yendol-Hoppey, p. 122, 2009). | |
| | What questions do I now have? | |

APPENDIX F
TPACK LESSON PLAN TEMPLATE

<table>
<tr><td colspan="2">Name and Grade Level: Type your name and grade level for the lesson.</td></tr>
<tr><td colspan="2">Title: Give a title to your lesson. Your title can be an essential question.</td></tr>
<tr><td colspan="2">Summary: Write one or two sentences to tell the main idea of your lesson.</td></tr>
<tr><td colspan="2">NC Essential Standard for Science:<br>State which standard and objective(s) from NC Essential Standards your lesson will address. You should copy and paste this word-for-word and include the standard and objective letters/numbers.</td></tr>
<tr><td>Materials:<ul><li>List all of the materials that the teacher and/or students will need to successfully complete the lesson.</li></ul></td><td>Teacher Technology Tools:<ul><li>List the technology that the teacher will use to present and guide the lesson.</li></ul>Learner Technology Tools:<ul><li>List the technology that the students will be actively using. Remember to keep them actively engaged with the learning at all times. Giving them direct access to technology tools encourages this active engagement.</li></ul></td></tr>
<tr><td>Resources:<ul><li>List all resources used here.</li></ul></td><td>Formative Assessment:<ul><li>How will you evaluate student progress DURING the lesson? How will you record this formative assessment data?</li></ul></td></tr>
<tr><td colspan="2">Learning Outcomes:<ul><li>What do you want students to know as a result of this lesson?</li><li>What will students be able to do as a result of this lesson?</li></ul></td></tr>
<tr><td colspan="2">Teacher Activities:<br>Describe in great detail what the teacher will be doing throughout the lesson.<br>Introduction:<br>Guided Activity:<br>Group/Independent Activity:<br>Closure:</td></tr>
<tr><td colspan="2">Student Activities: (correlate to learning activity types)<br>Describe in great detail what the students will be doing throughout the lesson.<br>Introduction:<br>Guided Activity:<br>Group/Independent Activity:<br>Closure: Students need to actively summarize their learning. This summary can be verbal, written, with a peer, etc.</td></tr>
</table>

| |
|---|
| **Summative Assessment:**<br>How will you evaluate student achievement of the learning outcomes?<br>What evidence will you collect to show this? |
| **TPACK Components:**<br>Describe how you've intentionally considered and planned for the following instructional design components in your lesson plan.<br><br>Content-<br>Pedagogy-<br>Technology- |
| **TPACK Lesson Plan Self-Evaluation**<br>Use the "Integration Assessment Rubric" to self-evaluate your lesson plan for integration of technological, pedagogical, content knowledge.<br>Attach your completed rubric to this lesson plan. Write a paragraph about how you could improve this lesson plan based upon the results of your self-evaluation. |

APPENDIX G

EXIT INTERVIEW OF PRE-SERVICE TEACHERS

| |
|---|
| Overall, describe what you learn from the TPACK activities? |
| What TPACK activity (or activities) helped you the most to strengthen your technology integration skills? |
| Were there any TPACK activities that you do not think were important to help you strengthen your technology integration skills? |
| How do you feel about the TPACK lesson plan format? Give details. |
| Do you feel like including the TPACK activities in future science methods courses is a good idea? Explain your reasoning. |
| Is there another course that you think should teach the TPACK framework? Why or why not? |
| Describe what you have gotten out of the course so far in terms of technology integration. |
| How could this course be made better to provide further support for technology integration? |

# APPENDIX H
# TRAINING DOCUMENT FOR INTERVIEWER

Post TPACK Interview Guide Sheet

Dear <u>xxxxxxxxxx</u>,

Thank you so very much for supporting my doctoral dissertation work by administering this interview!

I appreciate your help greatly!

Please use the instructions below to administer the interview questions to each group of students.

Instructions for Interviewer:

1. Please call in a group of not more than 4 students to participate in the group interview.
2. Please <u>SAY</u> the following to students: **"Professor XXXXXXXX greatly appreciates your participation in this interview. The questions that you answer will help to strengthen future courses in our program. Although the information that you share will be given to Professor Lowder, she will not be given any identifying information. Also, nothing shared in the interview will affect your grade in the course. Thank you for your feedback."**
3. Please begin recording the interview using the camera on the iPad. No students should be viewed on the recording so, please just leave the iPad flat on the table during the interview.
4. Ask each interview question, <u>asking follow-up questions as needed to obtain additional information and/or details for each question</u>. **(Why? Can you explain that answer a little bit more? Can you give me a specific example? etc.)**
5. Students may respond as a group, chiming in as they wish. It is not a big deal if not all students answer every question. It is okay if some wish to "listen".
6. At the conclusion of the interview <u>SAY</u>, **"This concludes the interview questions. Thank you again for your participation. Professor XXXXXX and I wish you a wonderful winter break!"**
7. Turn off the camera.

Thank you!!!!

XXXXX ☺

APPENDIX I
SAMPLE OF THE INTERVIEW TRANSCRIPTION

Post TPACK Interview Transcription

Question # 1: “Overall, describe what you've learned from the TPACK activities?”

“How to integrate technology into science.” (Student 1)

“Technology, pedagogy, and content….and how to balance it.” (Student 2, Student 3)

Question # 2: “What TPACK activity (or activities) helped you the most to strengthen your technology integration skills?”

“Doing the TPACK lesson plan and revising our previous lesson plan into that lesson plan format.” (Student 4)

Interviewer: Why do you think that helped you strengthen it?

“Because you could see where your technology strengths are and how you could integrate technology in your lesson.” (Student 4)

“I like watching the videos. It hands-on shows what we were supposed to do.” (Student 5)

Question # 3: “Were there any TPACK activities that you do not think were important to help you strengthen your technology integration skills?”

“The poster, because when we had to do our papers the videos pretty much all had that drawing so it was just …” (Student 6)

Interviewer: “Anything else?” “No”

Question # 4: “How do you feel about the TPACK lesson plan format? Give details.”

“I liked it because it really segmented it and it allowed you to really focus on one thing at a time instead of feeling overwhelmed, you could work piece-by-piece to plan your lesson and make sure that you had all the parts that you need.” (Student 7)

Interviewer: “How does anyone else feel about the lesson plan format?”

“It’s organized and it has like specific areas where you need to put the specific technology that you use into.” (Student 6)

Question # 5: “Do you feel like including the TPACK activities in future science methods courses are a good idea? Explain your reasoning.”

“Yes, but I would introduce it earlier on in the semester so we could have the whole time to perfect it.” (Student 3)

Interviewer: “Why?”

“Because if it is just thrown at you at once you don’t really know the specifics that are needed for it and if you start out with it at the beginning you can work on making it better.” *(*Student 3*)*

“I think that you should start out with it at the beginning because it lays the foundation that you can build on and your students get used to the way you teach with technology.” (Student 7, Student 1)

Question # 6: “Is there another course that you think should teach the TPACK framework? Why or why not?”

“I think all of ‘um.” (other student) “Yea” (Student 3)

“I think it can be integrated into all.” (Student 5)

“Yea, you need to integrate technology into every subject so, it should be taught in all of them so that we know what technology there is to use for reading and math, etc.” (Student 5)

“…and it would be thorough and more in depth in all the content areas.” (Student 7)

“They could introduce it in ed. Tech. since you take that before your methods classes, so that way you know what it is, it’s not all new.”(Student 3)

Question # 7: “Describe what you have gotten out of the course so far in terms of technology integration.”

“You can integrate technology into every subject.” (Student 3)

“There are many different tools and you need to use the tool that best fits the plan instead of using the plan to fit the tool.” (Student 7)

“…and you shouldn’t just present it with technology, you should integrate the technology into the students’ content so that they are using the technology as well.” (Student 8, Student 4)

Question # 8: “How could this course be made better to provide further support for technology integration?”

“I think they should explain what TPACK is to start with because when we first started it I was like, ‘what is TPACK and why are we learning about this.” (Student 5) “and maybe kind of introduce it in another course …” (Student 8)

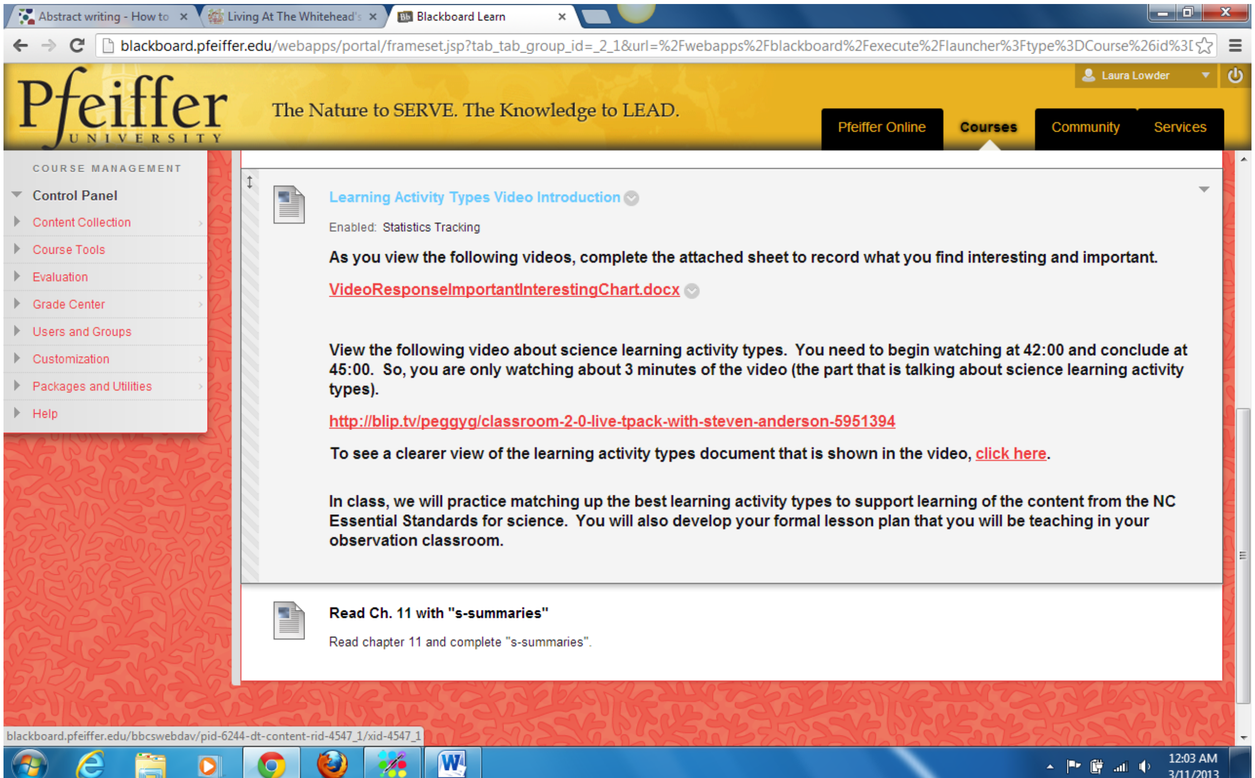
“like she said, ed. Tech.” (Student 5)

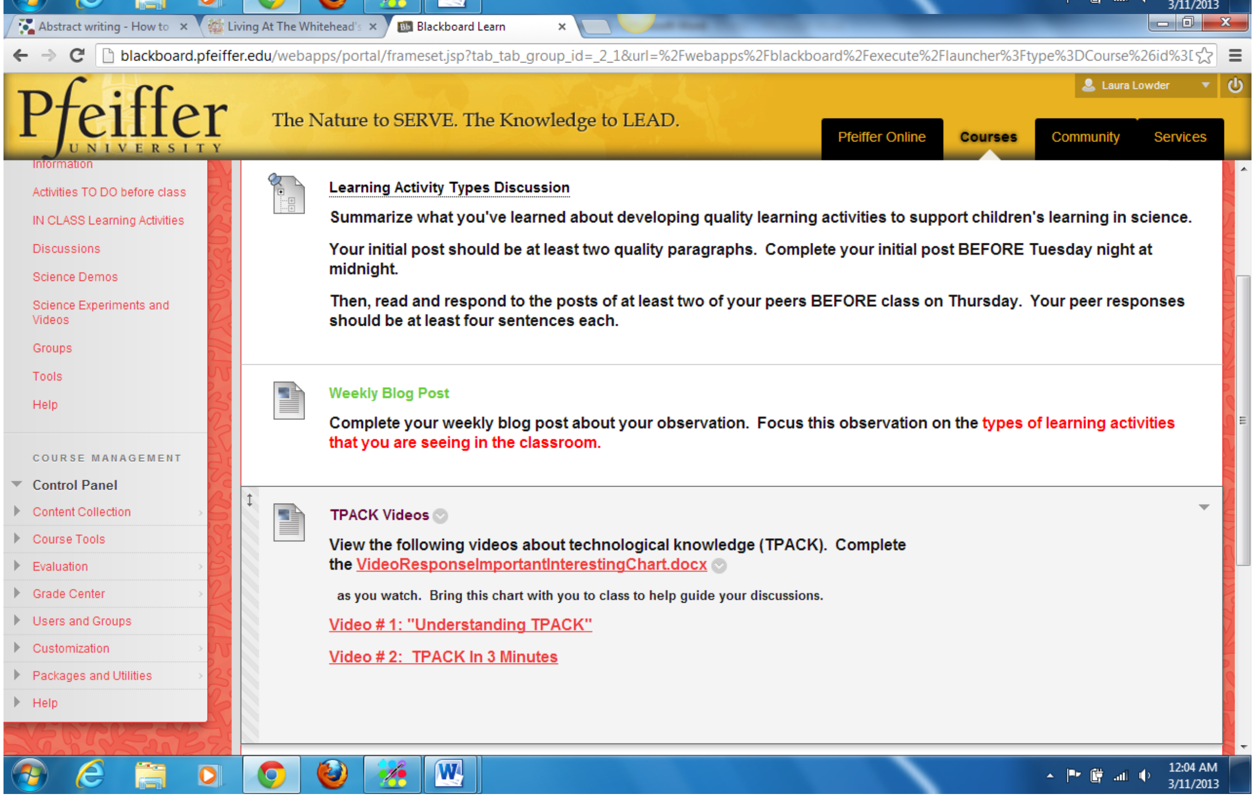
“If the instructor modeled how to build a TPACK lesson that would be really good, like in depth modeling to kind of create all the components.” (Student 7)

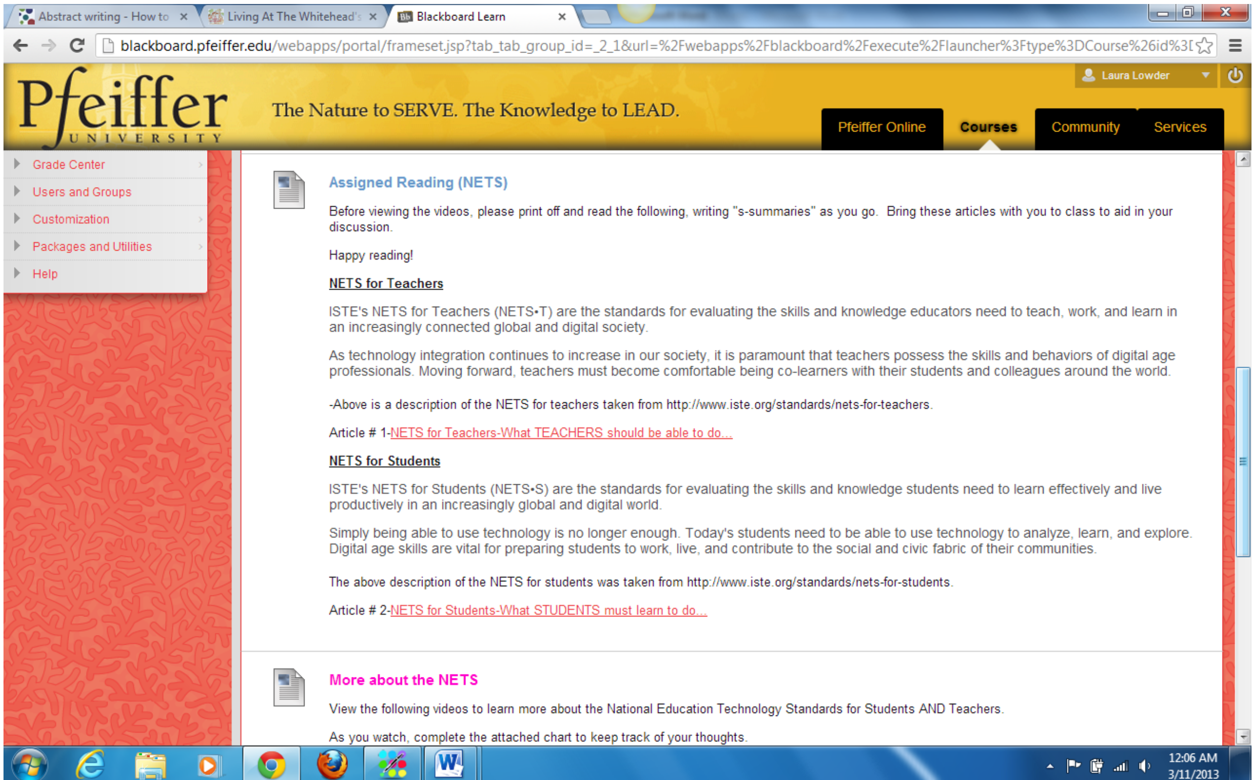
“I think it would be a good idea, would be to let the students create a lesson plan that’s for science, that way you have that one activity and then you see it done with technology integrated into it and see how different it is, how much you think it’s better or worse.” (Student 1)

Interviewer: “Thank you, …”

# APPENDIX J
# SCREENSHOTS FROM BLACKBOARD COURSE





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- Help

**Assigned Reading (NETS)**

Before viewing the videos, please print off and read the following, writing "s-summaries" as you go. Bring these articles with you to class to aid in your discussion.

Happy reading!

**NETS for Teachers**

ISTE's NETS for Teachers (NETS•T) are the standards for evaluating the skills and knowledge educators need to teach, work, and learn in an increasingly connected global and digital society.

As technology integration continues to increase in our society, it is paramount that teachers possess the skills and behaviors of digital age professionals. Moving forward, teachers must become comfortable being co-learners with their students and colleagues around the world.

-Above is a description of the NETS for teachers taken from http://www.iste.org/standards/nets-for-teachers.

Article # 1-NETS for Teachers-What TEACHERS should be able to do...

**NETS for Students**

ISTE's NETS for Students (NETS•S) are the standards for evaluating the skills and knowledge students need to learn effectively and live productively in an increasingly global and digital world.

Simply being able to use technology is no longer enough. Today's students need to be able to use technology to analyze, learn, and explore. Digital age skills are vital for preparing students to work, live, and contribute to the social and civic fabric of their communities.

The above description of the NETS for students was taken from http://www.iste.org/standards/nets-for-students.

Article # 2-NETS for Students-What STUDENTS must learn to do...

**More about the NETS**

View the following videos to learn more about the National Education Technology Standards for Students AND Teachers.

As you watch, complete the attached chart to keep track of your thoughts.

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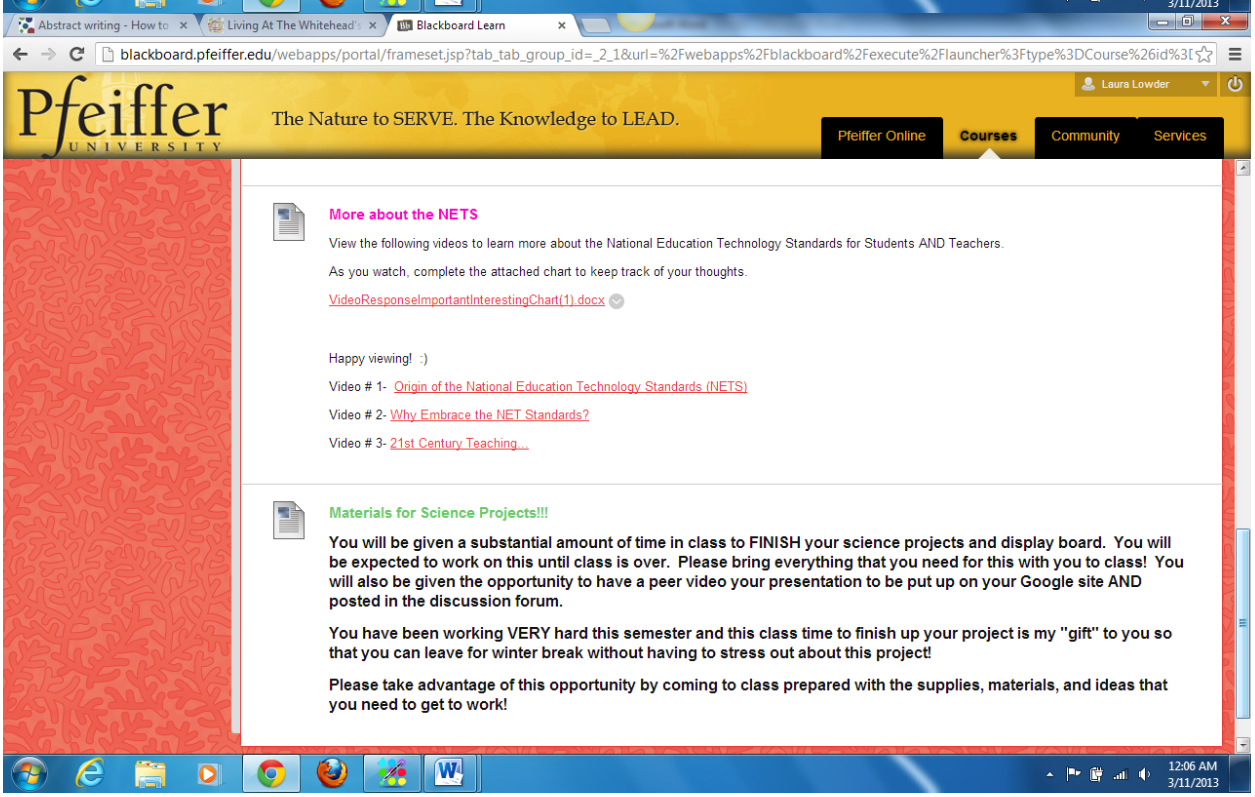

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**More about the NETS**

View the following videos to learn more about the National Education Technology Standards for Students AND Teachers.

As you watch, complete the attached chart to keep track of your thoughts.

VideoResponseImportantInterestingChart(1).docx

Happy viewing! :)

Video # 1- Origin of the National Education Technology Standards (NETS)

Video # 2- Why Embrace the NET Standards?

Video # 3- 21st Century Teaching...

**Materials for Science Projects!!!**

**You will be given a substantial amount of time in class to FINISH your science projects and display board. You will be expected to work on this until class is over. Please bring everything that you need for this with you to class! You will also be given the opportunity to have a peer video your presentation to be put up on your Google site AND posted in the discussion forum.**

**You have been working VERY hard this semester and this class time to finish up your project is my "gift" to you so that you can leave for winter break without having to stress out about this project!**

**Please take advantage of this opportunity by coming to class prepared with the supplies, materials, and ideas that you need to get to work!**

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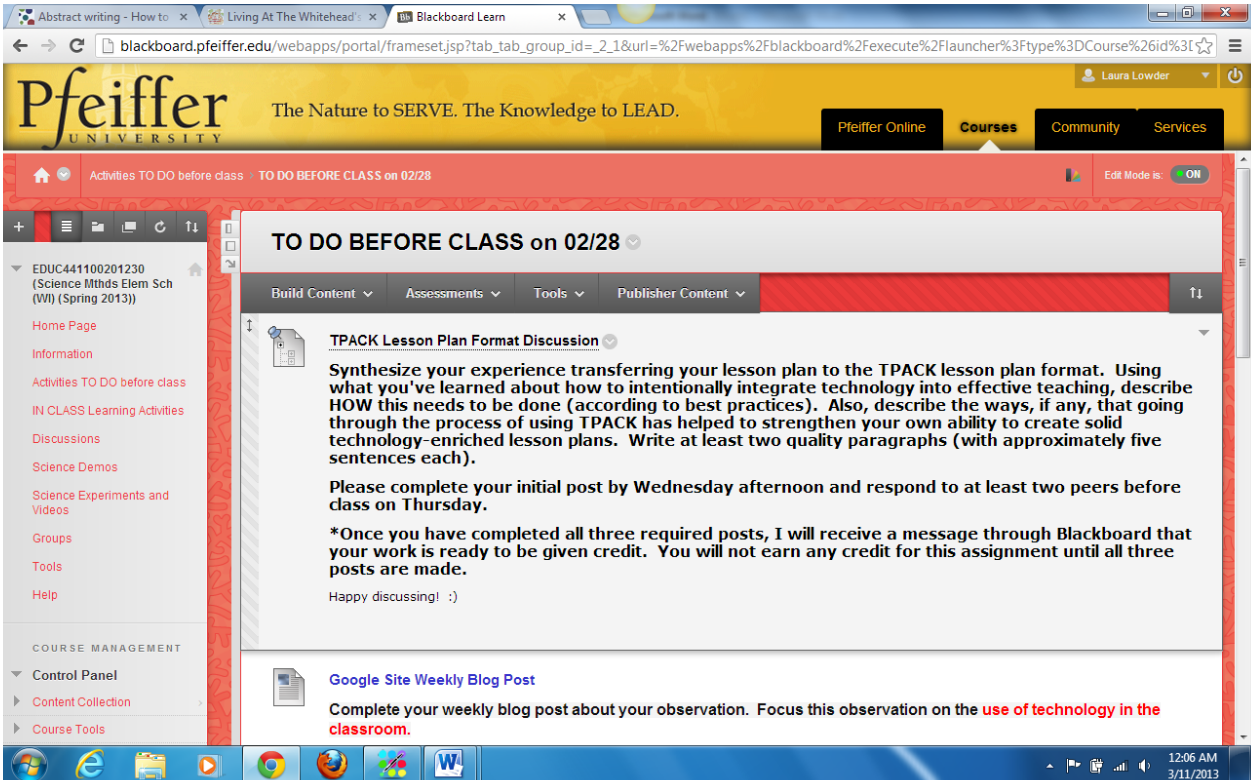
Abstract writing - How to
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Activities TO DO before class
TO DO BEFORE CLASS on 02/28
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Home Page
Information
Activities TO DO before class
IN CLASS Learning Activities
Discussions
Science Demos
Science Experiments and Videos
Groups
Tools
Help
COURSE MANAGEMENT
Control Panel
Content Collection
Course Tools
TO DO BEFORE CLASS on 02/28
Build Content
Assessments
Tools
Publisher Content
TPACK Lesson Plan Format Discussion
Synthesize your experience transferring your lesson plan to the TPACK lesson plan format. Using what you've learned about how to intentionally integrate technology into effective teaching, describe HOW this needs to be done (according to best practices). Also, describe the ways, if any, that going through the process of using TPACK has helped to strengthen your own ability to create solid technology-enriched lesson plans. Write at least two quality paragraphs (with approximately five sentences each).
Please complete your initial post by Wednesday afternoon and respond to at least two peers before class on Thursday.
*Once you have completed all three required posts, I will receive a message through Blackboard that your work is ready to be given credit. You will not earn any credit for this assignment until all three posts are made.
Happy discussing! :)
Google Site Weekly Blog Post
Complete your weekly blog post about your observation. Focus this observation on the use of technology in the classroom.
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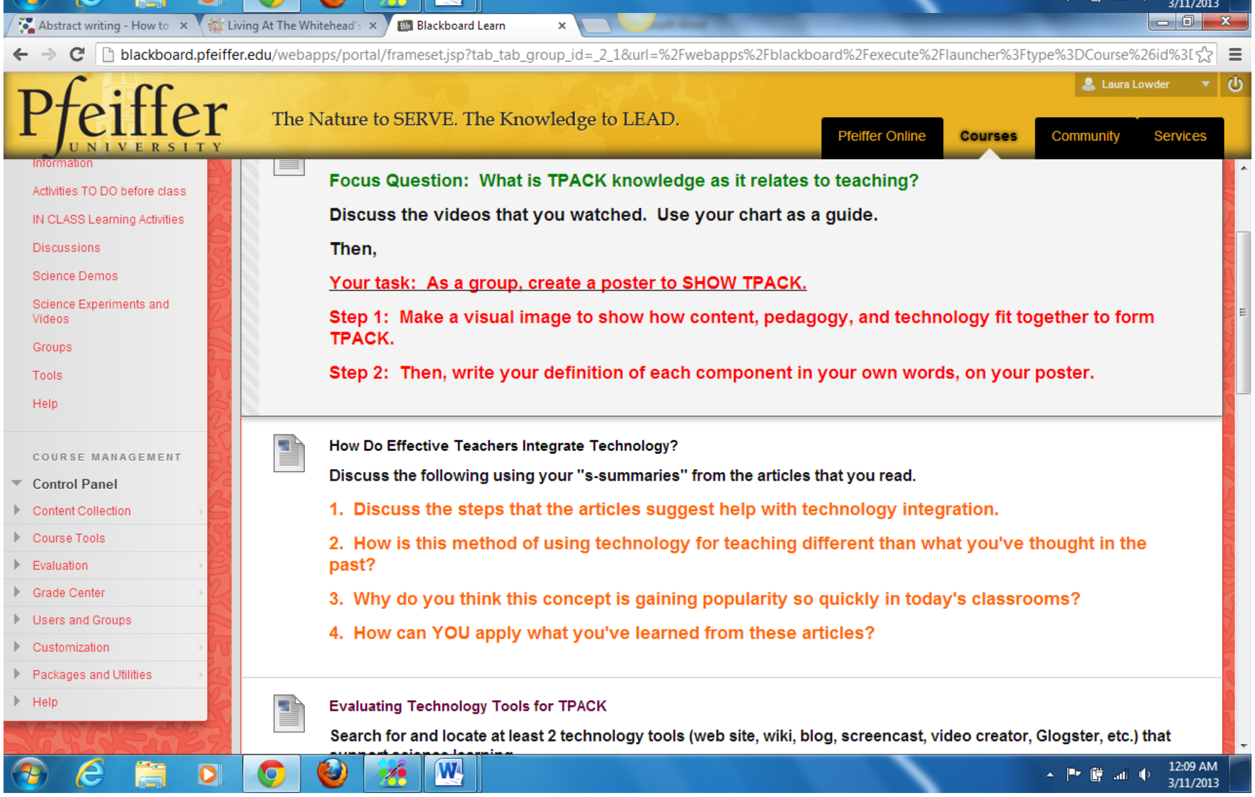
Abstract writing - How to
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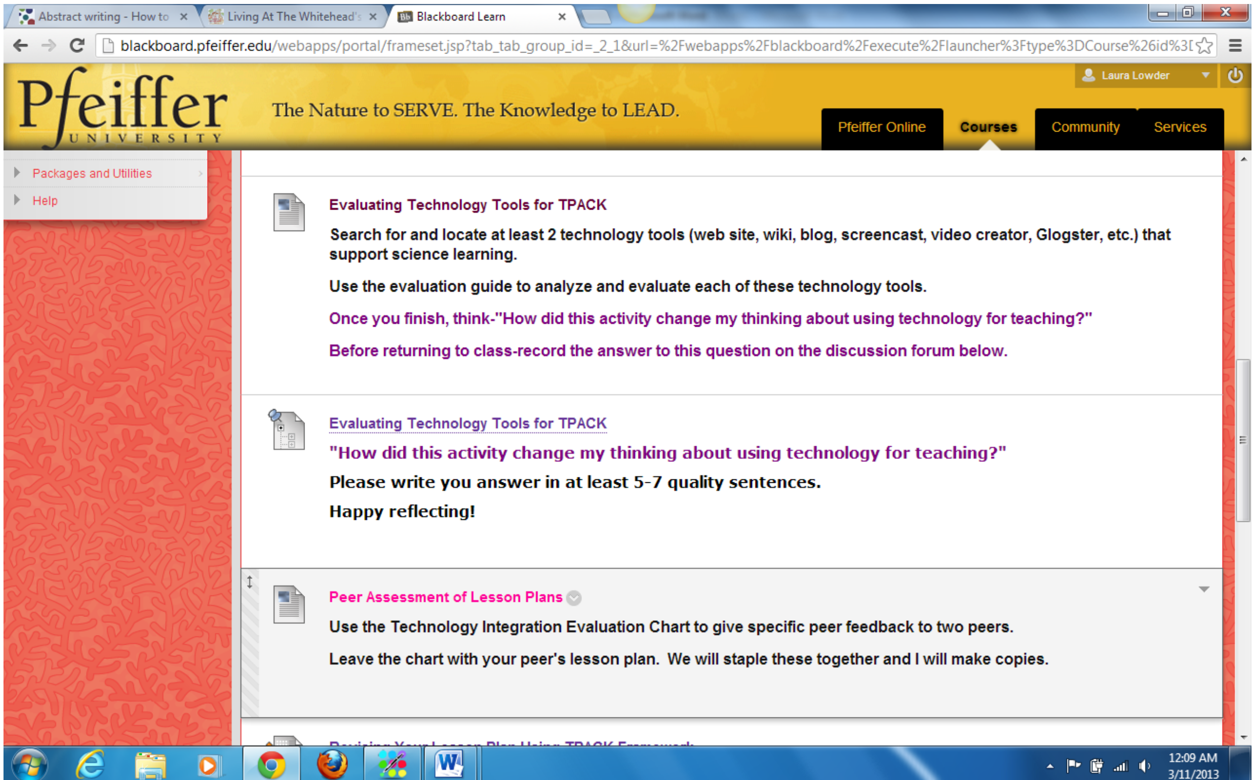
IN CLASS Learning Activities
Discussions
Science Demos
Science Experiments and Videos
Groups
Tools
Help
COURSE MANAGEMENT
Control Panel
Content Collection
Course Tools
Evaluation
Grade Center
Users and Groups
Customization
Packages and Utilities
Help
Focus Question: What is TPACK knowledge as it relates to teaching?
Discuss the videos that you watched. Use your chart as a guide.
Then,
Your task: As a group, create a poster to SHOW TPACK.
Step 1: Make a visual image to show how content, pedagogy, and technology fit together to form TPACK.
Step 2: Then, write your definition of each component in your own words, on your poster.
How Do Effective Teachers Integrate Technology?
Discuss the following using your "s-summaries" from the articles that you read.
1. Discuss the steps that the articles suggest help with technology integration.
2. How is this method of using technology for teaching different than what you've thought in the past?
3. Why do you think this concept is gaining popularity so quickly in today's classrooms?
4. How can YOU apply what you've learned from these articles?
Evaluating Technology Tools for TPACK
Search for and locate at least 2 technology tools (web site, wiki, blog, screencast, video creator, Glogster, etc.) that
12:09 AM
3/11/2013



Abstract writing - How to | Living At The Whitehead's | Blackboard Learn

blackboard.pfeiffer.edu/webapps/portal/frameset.jsp?tab_tab_group_id=_2_1&url=%2Fwebapps%2Fblackboard%2Fexecute%2Flauncher%3Ftype%3DCourse%26id%3I

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Packages and Utilities

Help

**Evaluating Technology Tools for TPACK**

Search for and locate at least 2 technology tools (web site, wiki, blog, screencast, video creator, Glogster, etc.) that support science learning.

Use the evaluation guide to analyze and evaluate each of these technology tools.

Once you finish, think-"How did this activity change my thinking about using technology for teaching?"

Before returning to class-record the answer to this question on the discussion forum below.

**Evaluating Technology Tools for TPACK**

"How did this activity change my thinking about using technology for teaching?"

Please write you answer in at least 5-7 quality sentences.

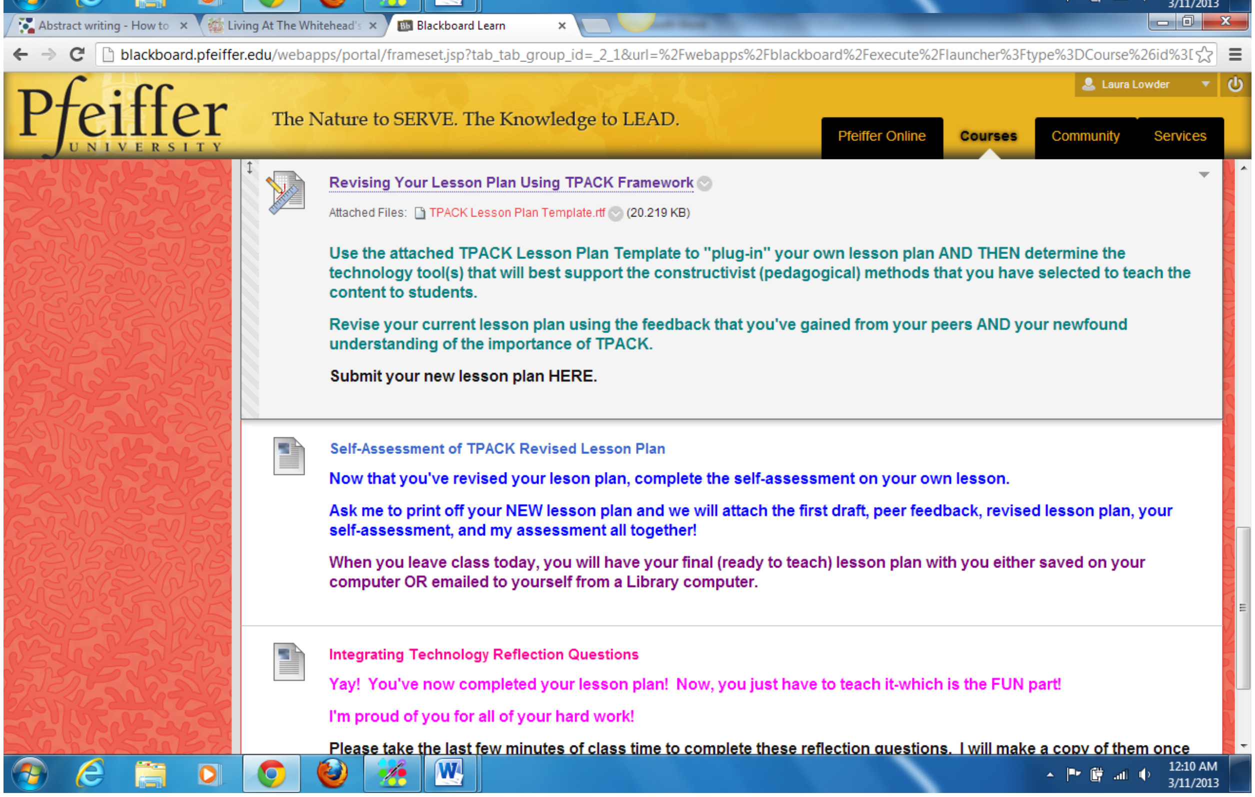
Happy reflecting!

**Peer Assessment of Lesson Plans**

Use the Technology Integration Evaluation Chart to give specific peer feedback to two peers.

Leave the chart with your peer's lesson plan. We will staple these together and I will make copies.

12:09 AM
3/11/2013



Abstract writing - How to | Living At The Whitehead's | Blackboard Learn

blackboard.pfeiffer.edu/webapps/portal/frameset.jsp?tab_tab_group_id=_2_1&url=%2Fwebapps%2Fblackboard%2Fexecute%2Flauncher%3Ftype%3DCourse%26id%3I

Pfeiffer UNIVERSITY

The Nature to SERVE. The Knowledge to LEAD.

Laura Lowder

Pfeiffer Online | Courses | Community | Services

**Revising Your Lesson Plan Using TPACK Framework**

Attached Files: TPACK Lesson Plan Template.rtf (20.219 KB)

Use the attached TPACK Lesson Plan Template to "plug-in" your own lesson plan AND THEN determine the technology tool(s) that will best support the constructivist (pedagogical) methods that you have selected to teach the content to students.

Revise your current lesson plan using the feedback that you've gained from your peers AND your newfound understanding of the importance of TPACK.

Submit your new lesson plan HERE.

**Self-Assessment of TPACK Revised Lesson Plan**

Now that you've revised your leson plan, complete the self-assessment on your own lesson.

Ask me to print off your NEW lesson plan and we will attach the first draft, peer feedback, revised lesson plan, your self-assessment, and my assessment all together!

When you leave class today, you will have your final (ready to teach) lesson plan with you either saved on your computer OR emailed to yourself from a Library computer.

**Integrating Technology Reflection Questions**

Yay! You've now completed your lesson plan! Now, you just have to teach it-which is the FUN part!

I'm proud of you for all of your hard work!

Please take the last few minutes of class time to complete these reflection questions. I will make a copy of them once

12:10 AM
3/11/2013

APPENDIX K
SAMPLE PRE AND POST STUDENT LESSON PLANS

**Student Sample Pre-Lesson Plan Artifact # 1**
***Use of technology to present a video to students (entry).**

How many layers are there in the Rainforest?

Candidate's Name 7 Content Area Science /LA Grade First

Date Monday Duration of Lesson 35 minutes Grouping Groups of five

## I. Lesson Objectives:

### A. *Essential Standards/Common Core*

- L.2.1 Summarize the basic needs of a variety of different plants(Including air, water, nutrients, and light) for energy and growth.
- L.2.2 Summarize the basic needs of a variety of different animals (Including air, water, and food) for energy and growth.
- CC LIT.1 Ask and answer questions about key details in a text.

### *B.* Content Objectives(s):

- Students will recognize and label the four layers of the rainforest and the animals that live there.

### *C.* Skill Objective(s):

- Reflection
- Writing using correct capitalization and punctuation
- Knowledge of The three layers of the Rainforest.

## II. *Key Vocabulary:*

- **Forest Floor:** This is the first layer of the Rainforest; it is the darkest and dampest part of the forest. It has little sunlight, low amount of plants growing. The ground is covered with leaves.
- **Understory:** The second layer of the Rainforest it is a dark place where many snakes, lizards and monkeys live.
- **Canopy:** The third layer of the Rainforest, this is bright and colorful. The canopy is the name given to the upper parts of the trees (about 65 to 130 feet or 20 to 40 m tall).

- **Emergent Layer:** The emergent consist of the tops of the tallest trees, which are much higher than the average canopy height (ranging up to 270 feet or 81 m).

- **Epiphytes:** Plants that grow on trees.

- **Lianas**: Thick Woody Vines.

- **Strata:** Another name for Layers of the Rainforest

III. ***Materials/Technology/Preparation;***

Guide to layers of the rainforest Attachment 1
Layers of the rainforest worksheet
Computer or smart board.
Pencils and coloring tools
Episode 108 the Rain Game by Cat in the Hat.
http://movies.netflix.com/WiPlayer?movieid=70148661&trkid=3325854

III. **Instructional Process:**

A. **Lesson Introduction** **Est. Time: 5 minutes**

1. Have all students go sit in rows of six in the meeting place of the classroom.
2. Read the Layers of the Rainforest Fact sheet.
3. Ask students what animals live in the rainforest.

B. **Lesson Development:** **Est. Time: 10 minutes**

- Have students go back to their table.
- Then play video on the rainforest by The Cat in the Hat it will be shown on the smart board.
- Tell the students that "We will now be going into groups by table to discuss the animals and

layers of the rainforest."

- Give each table a different layer of the rainforest, (examples) understory, canopy, emergent.
- Go to the board and write down one example of each layer and an animal or plant that lives there.

**Forest Floor – Leaf Cutter Ants**
**Understory – Snakes**
**Canopy – Epiphytes**

**Emergent Layer – Harpy Eagle**

C. **Closure/Conclusion:** **Est. Time: 15 minutes**

- Have students go back to their seat and discuss with each other the layers and one animal or characteristic of the layer they are given.
- Pass out worksheet with four layers and then tell each that they are to write the words Forest Floor, Canopy, and Understory on the correct lines. Then have students write down examples of animals and characteristics of the rainforest layers and place them into the correct section. Some of the layers may have some of the same animals and characteristics listed more than once. This is OK!

A. **Extension Activity:** **Est. Time: 5 minutes**

- Select groups to share similarities then select groups to share differences have students write a short sentence individually on what similarity or difference they chose.

V. **Accommodations/Modifications for Individual Differences, Abilities, Styles:**

- Audio/Visual Learner: Student can learn the layers of the rainforest through watching the video.
- Spatial Learner -Students can draw a picture of the Rainforest Animal or layer of the rainforest instead of discussing in group.
- Bodily Kinesthetic Learner – student can sit on floor or stand to complete their work.

VI. **Method of Assessment** **Est. Time 15 minutes**

- Students are able to participate in class discussion after watching the video and hearing the information.
- Students are able to write down an example of two animals or characteristics in each part of the circles on the Venn diagram.

VII. Reflection

As the teacher of this lesson, I will reflect on the pedagogy, results, and student learning outcomes. I will adjust and modify as needed for this lesson in order to make sure that my children learn the objectives set forth.

**Student Sample Post-Lesson Plan Artifact # 2**

***Technology is used to present a video to students (entry), students use Glogster to record their observations, graph their observations on the Smart Board or Mimeo (infusion), and choose their own technology tool to use in completing their final reflection (adaptation and transformation).**

Name and Grade Level: Student # 7 ~ First Grade

Title: Healthy Teeth

Summary: Through this lesson students will explore ways to keep our teeth healthy through good choices in our daily habits.

NC Essential Standard for Science:

1. L.2.2 Summarize the basic needs of a variety of different animals (including air, water, and food) for energy and growth.

| |
|---|
| Healthful Living<br><br>1 1.PCH.2 Understand wellness, disease prevention, and recognition of symptoms. |
| Materials:<br><br>• 4 eggs<br>• Small, plastic cups<br>• Water, milk, grape juice and cola<br>• Toothbrushes and toothpaste<br>• Science journals (or blank paper), pencils and crayons<br>• http://www.youtube.com/watch?v=oeA3IAVULZc<br>• Video on what happens if you drink cola. |
| Resources:<br>http://www.snack-girl.com/snack/dental-health-experiment-egg-soda/ |

| | |
|---|---|
| Learning Outcomes:<br>Learner will be able to discuss and share why making good choices is important to the longevity of our teeth. They will also recognize the effects that various types of drink and food can have on our teeth. | Teacher Technology Tools:<br>The teacher will use the smart board or mimeo to allow students to view the video on teeth and the effects of soda.<br><br>Learner Technology Tools:<br>The student will use glogster to record their observations.<br>Students will view the video and respond to it.<br>Students can write their responses on the mimeo or smart board or graph their observations on the chart. |
| Teacher Activities:<br>Describe in great detail what the teacher will be doing throughout the lesson.<br><br>Introduction: Teacher will hold up an egg that is unstained and have the students look at it for one to two minutes, and then ask students to share some of the characteristics of the "clean" egg. Ask them to think about their teeth and what foods they eat, then ask them the question "What kinds of things do you think will stain our teeth?"<br><br>Let them answer and then tell them "Today we are going to see how the things that we drink can affect and stain our teeth." Have them move to their assigned stations and get ready to observe.<br><br>Guided Activity: Next have the students draw the experiment in their journals under their predictions. They can draw the eggs in the cups and label each cup with the liquid it holds. The students will be observing the eggs that we had previously placed in liquids and left overnight.<br><br>After the students have recorded their observations and written down their predictions they will then observe the egg as it is taken out of the liquid and will write down their new observations. Talk about what happened and which eggs were stained.<br><br>Ask the students" What you think will remove the stains from the egg. What do they think will happen if they brush the eggs using toothpaste and toothbrushes?" Have students shared their thoughts and they will record their observations on their chart.<br><br>Place a small amount of toothpaste on a toothbrush and let students take turns brushing the eggs. Discuss what | Formative Assessment:<br>• Through observation during the activity and reviewing the student's predictions to make sure that they are on task.<br>• Students will record this prediction in their science journal which I will take up after the experiment has been set up and then review them after class so that they will be available for student use the next day. |

<table>
<tr><td>happened,<br><br>Group/Independent Activity:<br><br>In their journals, have them write and draw what happened to the eggs after soaking in the liquids and after being brushed. Then have them write about what they learned from the experiment, record if this was similar or different from the prediction that you made.<br><br>Closure:<br>After this the students will go to their seats and the teacher will put the video on the smart board. After watching ask the students if they saw any connection between the video and what we experimented with. Then discuss as a whole group, ask them what would happen if the egg was in the liquid longer or shorter.<br><br>Students will then take this knowledge and connect it with their own teeth and the ways that they can keep their teeth clean and healthy. They will record this information in their science journal with three sentences and an illustration.</td><td></td></tr>
<tr><td colspan="2">Student Activities: (correlate to learning activity types)<br>Describe in great detail what the students will be doing throughout the lesson.<br>Introduction: During this activity the students will be in the meeting area observing and listening as the teacher introduces the lesson. students will be reflecting and connecting to their prior knowledge.<br><br>Guided Activity: During this activity the students will be making predictions and assisting with the experiment by placing the hardboiled egg into the cup on their table and then recording what they have observed and their predictions in their science journal.<br><br>Group/Independent Activity:<br>The student will go back to the egg the next day and write again what they observe and also their prediction whether the same or new in their science journal. Then they will take the egg out of the liquid and write down what it looks like and also what they think caused the egg to change or stay the same.<br><br>Closure:<br>After this the students will go to their seats and the teacher will put the video on the smart board. After watching ask the students if they saw any connection between the video and what we experimented with. Then discuss as a whole group, ask them what would happen if the egg was in the liquid longer or shorter.<br><br>Students will then take this knowledge and connect it with their own teeth and the ways that they can keep their teeth clean and healthy. They will record this information in their science journal with three sentences and an illustration.</td></tr>
<tr><td colspan="2">Summative Assessment:<br>Students will chose their tool to use in recording their data through a blog, reflection notebook, poster, or data sheet to record their observations each day on what happened to the egg what will happen to the egg. Then they will turn this in at the end of the experiment and the last reflection is to show what happened and draw an illustration or make a chart graphing the data.</td></tr>
<tr><td colspan="2">TPACK Components:<br>Describe how you've intentionally considered and planned for the following instructional design components in your lesson plan.<br><br>Content- The topic of the lesson is incorporated through a hands on activity and also relates to the experiment and assessments, the observations, glogs and reflection tools.<br><br>Pedagogy- I am relating the new content to what the students already know about health, just presenting it in a new way for the learners.<br><br>Technology- Technology has been offered to students as a tool for reflection through glogging and also as a connective tool during the extension/conclusion, they will be relating what they have done in the experiment to a video on the effects of soda on teeth.</td></tr>
<tr><td colspan="2">TPACK Lesson Plan Self-Evaluation<br>Use the "Integration Assessment Rubric" to self-evaluate your lesson plan for integration of technological, pedagogical, content knowledge. Attach your completed rubric to this lesson plan. Write a paragraph about how you could improve this lesson plan based upon the results of your self-evaluation.<br><br>~</td></tr>
</table>

According to the evaluation I would integrate more technology into the lesson and use a way to create an assessment using a glog that could span several days, the students could use the glog as a tool to carry out their predictions and observation through the whole unit. I think that the lesson is a hands on lesson but if I had more time I could create extensions to allow for more technology, videos, blogs, and video of the observations each day but extend for a couple of weeks.

**Student Sample Pre-Lesson Plan Artifact #3**

***Although the materials list includes a computer with Internet access, no suggestions for use of this technology are evident in the lesson plan.**

## HOW ARE HURRICANES CATEGORIZED?

didate's Name 6 Content Area Science/ Information Technology

Grade 5 Date week 1 day 1 Duration of Lesson 90-120 minutes Grouping whole class & partners

I. Lesson Objectives:

A. Essential Standards **5.RP.1.1 Implement a research process by collaborating effectively with other students.**

B. Essential Standards: **5.E.1.2 Predict upcoming weather events from weather data collected through observation and measurements.**

C. Content Objectives(s): Given the outlines of what to research students will be able to distinguish the difference between hurricane categories and their damages at 80% efficiency.

D. Skill Objective(s): The skill objectives in this lesson are: writing, thinking, listening, speaking, and viewing

*II.* *Key Vocabulary:*

- Hurricane- a violent, tropical, cyclonic storm of the western North Atlantic, having wind speeds of or in excess of 72 mph
- Expedition- an excursion, journey, or voyage made for some specific purpose, as of war or exploration
- Advancing- to move or bring forward
- Sustained- to support, hold, or bear up from below; bear the weight of, as a structure
- Evacuate- to remove persons from a city, town, area, ect. for reasons of safety

*III.* *Materials/Technology/Preparation;*

- Hurricane by: David Weisner
- 

I survived Hurricane Katrina by: Lauren Tarshis


- computers with internet access
- board map of the US

IV. Instructional Process:

A. Lesson Introduction — Est. Time: 10 minutes

- Say "Who has ever imagined what it is like inside a hurricane?"

I will ask the students these questions:

- Who knows what a hurricane is?
- Have you ever been in a hurricane?
- Do you know how many different categories there are of hurricanes?

Today we are going to learn about the different categories of hurricanes and discuss how they are categorized.

B. Lesson Development: — Est. Time: 30 minutes

- I will read the book Hurricane just to introduce the topic
- I will show the students on a map of the US where hurricane Isaac is expected to hit, because it is a hurricane that is active at this time.
- I will show the students a chart of the different hurricane categories and explain each of the categories to the students.

C. Closure/Conclusion: — Est. Time: 5 minutes

- I will say to the students: "Today we learned about the different categories of hurricanes, and tomorrow we are going to start reading I survived Hurricane Katrina.

A. Extension Activity: — Est. Time:45-60 minutes

Imagine that you lived in the path of an oncoming hurricane, like the one that is bearing down on the southern coast of the US. Research with your partner the different categories of hurricanes, the damage that each category causes, and how to prepare for a hurricane. How would the technology of today help you prepare for the storm? Together create a poster with all of the information displayed. You will then teach the class what you have learned.

ommodations/Modifications for Individual Differences, Abilities, Styles:

1. If a students would like to do the project alone they may if they aren't comfortable working in partners (intrapersonal)
2. The students can draw out topics on their projects (visual/spatial)
3. The students can make a sequence of how a hurricane progresses (logical/mathematical)

VI. Method of Assessment — Est. Time: minutes

I will assess the students with the check sheet attached and their grade will come from that.

VII. Reflection

As a teacher of this lesson, I will reflect on the pedagogy, results, and student learning outcomes. I will adjust and modify as needed for this lesson in order to make sure that my students learn the objectives set forth

**Student Sample Post-Lesson Plan Artifact # 4**

***Technology is used to present a video to students (entry) and for students to use when doing research (adoption and infusion).**

<table>
<tr><td colspan="2">Name and Grade Level: Student # 6 – 2nd grade</td></tr>
<tr><td colspan="2">Title: How Do Animals Survive off of each other and Plants?</td></tr>
<tr><td colspan="2">Summary: Students will learn about food webs for animals and plants. They will be able to distinguish between the predators and the prey.</td></tr>
<tr><td colspan="2">NC Essential Standard for Science:<br>2.L.1.2 Compare life cycles of different animals such as, but not limited to, mealworms, ladybugs, crickets, guppies or frogs.</td></tr>
<tr><td>Materials:<br>Index cards<br>Markers<br>Yellow circles<br>Green circles<br>Orange circles<br>Brown circles</td><td>Teacher Technology Tools:<br>PowerPoint<br>Video on food webs<br><br>Learner Technology Tools:<br>Computer</td></tr>
<tr><td>Resources:<br>Computer<br>YouTube (food web video)</td><td>Formative Assessment:<br>How will you evaluate student progress DURING the lesson?<br>I will watch that they are doing what I asked them to do, and making sure they understand why they are matching the cards together<br>How will you record this formative assessment data?<br>I will have a checklist with the options that they were following directions, or weren't following directions.</td></tr>
<tr><td colspan="2">Learning Outcomes:<br>What do you want students to know as a result of this lesson?<br>Students will know which animals are the prey and which are the predators and how the food web works.<br>What will students be able to do as a result of this lesson?<br>Students will be able to make their food web from the information they learned in the lesson.</td></tr>
<tr><td colspan="2">Teacher Activities:<br>Describe in great detail what the teacher will be doing throughout the lesson.<br>Introduction:<br>• I will introduce the topic by showing the students a video about a food web/ food chain.<br>• I will show the students the PowerPoint with all of the vocabulary terms on it.<br>Guided Activity:<br>Group/Independent Activity:<br>• I will hand out the index cards with the different plants and animals on it. They will match the cards with either what it would eat or be eaten by.<br>• We will discuss why they matched each card to the one they did. I will correct any misconceptions they have made through matching.<br>Closure:<br>• I will review what we learned about the food web</td></tr>
</table>

Student Activities: (correlate to *learning activity types*)

Describe in great detail what the students will be doing throughout the lesson.

Introduction:

- Students will watch the video about a food web and then they will be given different index card with different animals and plants on them.

Guided Activity:

- The students will match their card to the card that it either eat or is eaten by. If they have a plane they find what would eat them, if they are an animal they find what they would eat.

Group/Independent Activity:

- Students will research what animal or plant they have on their index card on the internet. They will have a short presentation on their animal to present to the class.

Closure: Students need to actively summarize their learning. This summary can be verbal, written, with a peer, etc.

- Students will answer questions on a worksheet that shows what they have learned throughout the lesson.

Summative Assessment:

How will you evaluate student achievement of the learning outcomes?

- I will look at their worksheet and how they matched their cards with each other.

What evidence will you collect to show this?

- I will collect the worksheets and have a checklist to show they matched their cards.

TPACK Components:

Describe how you've intentionally considered and planned for the following instructional design components in your lesson plan.

Content- The content is covered through the introduction video and the PowerPoint with the vocabulary terms discussed on it. It comes from the 2nd grade essential standards.

Pedagogy- I will teach this lesson through hands-on experiences and group discussions about what we have learned.

Technology- Technology will be used through the video and PowerPoint as well as when the students research their animal or plant they received.

TPACK Lesson Plan Self-Evaluation

Use the "Integration Assessment Rubric" to self-evaluate your lesson plan for integration of technological, pedagogical, content knowledge.

Attach your completed rubric to this lesson plan. Write a paragraph about how you could improve this lesson plan based upon the results of your self-evaluation.

- I think that I could learn to integrate technology more into my lessons. I want to learn new ways to integrate technology besides just a PowerPoint or video off of the internet. Learning about TPACK helped me start to think about different ways to integrate technology with pedagogy and context but I feel like I still need more practice. I want to try to find a fun game to use with this lesson that could be used to reinforce what was being taught. I think students would enjoy this and it would help them learn more about the subject.

**[redacted]**
**Under the Sea**
**Week 1 Day 3**
**Lesson Plan 12**
**Science**
**First grade**
**One hour**
**Individual**

I. <u>Lesson Objectives:</u>

A. <u>NC Standard Course of Study</u>:

- 1.L.1.1 Recognize that plants and animals need air, water, light (plants only), space, food and shelter and that these may be found in their environment.

-1.L.1.2 Give examples of how the needs of different plants and animals can be met by their environments in North Carolina or different places throughout the world.

-1.L.1.3 Summarize ways that humans protect their environment and/or improve conditions for the growth of the plants and animals that live there. (e.g., reuse

B. Content Objectives(s): The students will be given 2 worksheets and have 20-30 minutes to complete them. Once the worksheets are completed, the students will have a basic understanding of the food chain, and common terms associated with the food chain.

C. Skill Objective(s): during this time students will think, reorganize, choose, point out, match, and arrange.

II. <u>Key Vocabulary:</u>

Food Chain- a chain of a food source to the ultimate consumer

III. Materials/Technology/Preparation; students will use:

Worksheet
Pencil/eraser

IV. Instructional Process:

A. Lesson Introduction
(5 minutes)

-Students will be handed out a worksheet that defines the vocabulary words for them, and the teacher will review the words with them. The teacher will ask if anyone has any questions. Once they have reviewed, the will continue on with the lesson.

- Who can give me an example of what a bird would eat?
- Who can give me an example of a carnivore?

B. Lesson Development:
(30 minutes)

- Students will be given the worksheet with pictures and vocabulary words on it, and will be asked to match the picture to the correct term.

-Then students will be given the "scales"

-Given 20-30 minutes. The students will work independently to complete their worksheet, and ask the teacher if they have any questions.

- After the students complete their worksheets and time is up, we will go over the correct answers in class.

Closure/Conclusion:

(20 minutes)

-When all students have completed their worksheets they will put them on the corner of the teachers desk.

-They will then sit and read quietly or do any extra work that they may have

-After all the students have competed their worksheets and all the materials are put away the teacher will mix up the worksheets and pass them back out

-Students will go over the worksheets as a class, grading another student's paper in the class

Extension Activity:

(10 minutes)

-If the students have all of their materials cleaned up and they are given permission to, they may go to the reading corner and read quietly or they may continue sharing with the other students.

V. Accommodations/Modifications for Individual Differences, Abilities, Styles:

- If students are having difficulty the teacher or other student can help them out if they are willing.

VI. Method of Assessment:

The worksheet is the method of assessment.

VII. Reflection

"As a teacher of this lesson, I will reflect on the pedagogy, results, and student learning outcomes. I will adjust and modify as needed for this lesson in order to make sure that my students learn the objectives set forth."

**Student Sample Post-Lesson Plan Artifact # 6**

***Technology is used to present a video to students (entry), to give students an opportunity to play learning games (adoption), and to give students a choice of tool(s) to use in creating a digital product (adaptation, infusion, and transformation).**

| | |
|---|---|
| Name and Grade Level: Student # 5 Grade 5 | |
| Title: Understanding adaptations we need to survive in our environment | |
| Summary: In this lesson students will use manipulatives to alter their own adaptations to understand why we need them. They will do this to understand adaptive characteristics. | |
| NC Essential Standard for Science:<br>5.L.1 Understand how structures and systems of organisms (to include the human body) perform functions necessary for life.<br>5.L.2 Understand the interdependence of plants and animals with their ecosystems.<br>5.L.3 Understand why orgasms differ from or are similar to their parents based on the characteristic of the organism. | |

| | |
|---|---|
| Materials:<br>bird pictures, toothpicks, craft sticks, tape, flexible straws, sunflower seeds (and two others), gummy worms, and flat corn chips. | Teacher Technology Tools:<br>• A video will be shown at the beginning to show the different types of bird beaks and why they have those kinds of characteristics, and one will be shown at the end if there is time to show one specific kind of bird just for fun.<br>• -they can also play the interactive game online about animal adaptations<br>• -they will choose at the end what they want to use to make a short project on animal adaptations<br><br>Learner Technology Tools:<br>• http://www.ecokids.ca/pub/eco_info/topics/climate/adaptations/index.cfm |
| Resources:<br>• Rice University site<br>• http://blackboard.pfeiffer.edu/webapps/portal/frameset.jsp?tab_tab_group_id=_2_1andurl=%2Fwebapps%2Fblackboard%2Fexecute%2Flauncher%3Ftype%3DCourse%26id%3D_144_1%26url%3D<br>• http://video.nationalgeographic.com/video/kids/animals-pets-kids/birds-kids/stork-shoebill-kids/<br>• https://www.youtube.com/watch?v=XzHQ5-lYvrk<br>• http://www.ecokids.ca/pub/eco_info/topics/climate/adaptations/index.cfm | Formative Assessment:<br>• The students will be assessed on how well they participate and engage themselves in the lesson and their projects will be graded with a rubric. |
| Learning Outcomes:<br>• Students will know that certain animals have specific characteristics or adaptations that they need to survive.<br>• The students will be able to identify certain characteristics animals have that help them survive in their particular environment. | |
| Teacher Activities:<br>Describe in great detail what the teacher will be doing throughout the lesson.<br>Introduction: The teacher will show the video of the rid with the different beaks and have questions up during the video to help them think about why they have these adaptations and characteristics.<br>Guided Activity:The teacher will be demonstrating and explaining what the students will be doing. When they are sorting the seeds they will show the students how they are to tape their thumbs and walk around if any students are struggling. they will also be walking around asking the class questions to get them to think about what they are doing and why.<br>Group/Independent Activity: while the students are playing games the teacher will be walking around making sure they are on task. when they are creating their short project thy will be doing the same (since it is online)<br>Closure: The teacher will ask questions as a review. | |
| Student Activities: (correlate to *learning activity types*)<br>Describe in great detail what the students will be doing throughout the lesson.<br>Introduction: the students will watch a video on birds that explains the different kinds of beaks they have for which foods they eat<br>Guided Activity: They will have a pile of three different types of seeds. they will have to sort them into the three types however they want. They will then have to tape their thumb down to their palms and do it again, which will get them to realize that their thumbs are an adaptive trait they need in order to survive in their environment. Then they will do a similar activity taping toothpicks and craft sticks to their thumb and index finger to represent a birds beak. this will help them understand why different birds eat different things.<br>Group/Independent Activity: the students will play an online game and then do a short project choosing a form of technology | |

| | |
|---|---|
| to use (glogster, powerpoint, etc)<br>Closure:  Students will use their projects or write down what they learned, then they will discuss it with a partner and then have a class discussion on it. | |
| Summative Assessment:<br>during the lesson the teacher will be walking around to make sure they are staying on task, but the projects will be graded with a rubric. | |
| TPACK Components:<br>Describe how you’ve intentionally considered and planned for the following instructional design components in your lesson plan.<br><br>Content- they are learning about animals and their adaptive characteristics<br>Pedagogy- they are organized so they are working in partners or individually<br>Technology- they are watching online videos, playing online games, and using a form of technology resource to create a short project | |
| TPACK Lesson Plan Self-Evaluation<br>Use the “Integration Assessment Rubric” to self-evaluate your lesson plan for integration of technological, pedagogical, content knowledge.<br>Attach your completed rubric to this lesson plan.  Write a paragraph about how you could improve this lesson plan based upon the results of your self-evaluation.<br><br>I could improve this lesson by making it safer for them to be in the computers. Under Digital Citizenship I only covered one of the boxes so i could try to include more of that. Also I didn't really include the scientific method and have them create a hypotheses to test or a conclusion, i just had them watch the video and share what they learned so I could have them write down what they think they will find during the little experiments. | |

APPENDIX L
COURSE SYLLABUS

SCIENCE METHODS IN THE ELEMENTARY SCHOOL

EDUCATION 441  Section 100
Spring 2013
xxxxxxxxxxx

**Office:** 307C Library

**Phone:** 463-3155 (Voice Mail)
xxxxxxx@fsmail.xxxxx.edu

| | | | | |
|---|---|---|---|---|
| Office Hours: | M | 11:00 A.M.-1:00 P.M. | T | 10:30 A.M.-12:30 P.M. |
| | W | 6:30-7:30 P.M. | Th | 9:15-9:45 P.M. |

Or by appointment.

SCHEDULE: Th 9:30-12:15
TEXTS:
<u>What's Your Evidence: Engaging K-5 students in constructing explanations in science</u>
ISBN: 978-0-13-211726-5
and
<u>Launching Learners In Science, Pre-K-5</u>
ISBN: 9781412937030

North Carolina Essential Standards

Goals: xxxxx Mission Statement

The xxxxx student will develop skills in translating learning and teaching theories into pedagogically sound and effective science instruction. The student will develop skills in oral communication, learning-to-learn, reasoning, decision-making, and problem solving.

**CONCEPTUAL FRAMEWORK OF THE XXXXX TEACHER EDUCATION PROGRAM**

**DEVELOPING SERVANT LEADERS FOR PROFESSIONAL PRACTICE**

Since 1999, the primary focus of the xxxxx Teacher Education Program has been articulated as **"Developing Servant Leaders."** Consistent with the vision and mission of Pfeiffer University, this concept remains in place as the goal toward which our program strives. **Teachers as servant leaders** help to set high standards for the learning communities in which they serve. Through daily interaction, teachers encourage academic and civic excellence among their students. Moreover, because of their unique position in the community and society, teachers who are both servants and leaders have the ongoing opportunity through their collaborative relationships with school colleagues, parents, and community agency personnel to model advocacy and high standards of ethics on behalf of the students they serve.

The leading phrase of the conceptual framework also recognizes the work of **the teacher as professional**. The teacher is not a technician, but rather has extensive preparation that equips the teacher to be informed about the discipline, the nature of the learner, and learning. The teacher must make innumerable independent decisions daily for the benefit of students' affective, cognitive and physical development.

The conceptual framework of the xxxxx Teacher Education Program embodies **four domains** that specify the areas of a teacher's responsibility. These domains are based on the work of Charlotte Danielson (Enhancing Professional Practice: A Framework for Teaching (2nd Edition), 2007) and are consistent with the North Carolina Professional Teaching Standards.

Under each domain are **curriculum standards** and **professional dispositions,** which candidates for teacher licensure are expected to demonstrate.

## Domain 1. Planning and Preparation

The teacher as servant leader approaches the teaching function with a fund of knowledge about the discipline, the learner, and learning that must be continually renewed and elaborated. This fund of knowledge is buttressed by continued engagement in professional development opportunities and reflection. The teacher's knowledge provides the bases for informed planning.

### Dispositions

1. The candidate is intellectually curious about the discipline(s) that s/he teaches.
2. The candidate values balanced treatment of controversial issues and problems.
3. The candidate regards the scientific method as valid for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge.

### Curriculum Standards

1. The candidate uses accurate and extensive content knowledge to plan for instruction.
2. The candidate uses knowledge of content pedagogy to plan for instruction.
3. The candidate plans for and makes cross-curricular connections.
4. The candidate integrates 21st Century content and skills in instructional plans.
5. The candidate uses knowledge of how children learn and develop to plan effective lessons.
6. The candidate selects instructional goals and objectives based on students' interests and needs, and on State and local curricular goals.
7. The candidate uses knowledge of instructional resources to enhance lesson design.
8. The candidate develops a coherent plan for instruction utilizing units, lessons, and activities that are aligned with instructional goals and objectives.
9. The candidate uses diagnostic, formative, and summative assessment that informs instruction.

## Domain 2. Establishing a Respectful Environment

The teacher provides leadership for establishing and maintaining respectful learning environments in which each child has a positive, nurturing relationship with caring adults. In the classroom the teacher is that adult along with teacher assistant and volunteers.

### Dispositions

1. The candidate embraces diversity in the school community.
2. The candidate is respectful of others' opinions.
3. The candidate is committed to the development of others.
4. The candidate demonstrates caring for the well being of others.

### Curriculum Standards

1. The candidate creates and maintains a positive and nurturing learning environment.

2. The candidate identifies differences in approaches to learning and performance, including different learning styles, learning challenges, and multiple intelligences, and uses students’ strengths as a basis for growth.
3. The candidate uses knowledge about the process of second language acquisition and strategies to support the learning of students whose first language is not English to provide nurturing environment.
4. The candidate works collaboratively with families and other adults in the school community for engagement in the instructional program.
5. The candidate uses a variety of classroom strategies for instructional grouping, transitions, and use of volunteers and paraprofessionals.
6. The candidate creates high expectations for student behavior, and monitors and responds appropriately to student behavior.
7. The candidate makes effective use of classroom space for safety and instruction.

## Domain 3. Instructing Effectively

Instructional effectiveness lies at the heart of the role of the professional teachers. The teacher as servant leader facilitates student development based upon knowledge of content, the structure of the discipline, students, teaching methods, the community, and curriculum goals.

Dispositions

1. The candidate is enthusiastic about the teaching function.
2. The candidate values the role of research-verified evidence in informing teaching practice.

Curriculum Standards

1. The candidate communicates clearly and accurately.
2. The candidate uses a variety of instructional strategies to encourage high achievement of all students.
3. The candidate uses questions and assignments that encourage critical and creative thinking.
4. The candidate provides for a high level of student engagement.
5. The candidate integrates literacy instruction across all subjects.
6. The candidate monitors student performance.
7. The candidate provides feedback to students that is accurate, substantive, constructive, timely, and specific.
8. The candidate uses and integrates technology in instruction.

## Domain 4. Professional Responsibilities

**The teacher is responsible, not only to the students, but also to the entire learning community and to the teaching profession. Therefore, the teacher as servant leader models excellence in support of the school and the profession. Moreover, the teacher has an advocacy role to help assure that settings outside the classroom in which the student participates also promote healthy development.**

Dispositions

1. The candidate values the dispositions and behaviors of the servant leader including: listening, empathy, conceptualizing, heightened awareness, persuasiveness through action, using foresight, exercising stewardship, healing, commitment to the group, and building community.
2. The candidate models behavior appropriate to a professional setting including: consistent attendance, a strong work ethic, consistent preparation, punctuality, respect for colleagues, and appropriate dress.

Curriculum Standards

1. The candidate reflects on teaching for instructional improvement.
2. The candidate maintains accurate records.
3. The candidate assists in identifying needs and implementing plans for school improvement.
4. The candidate communicates with families and professional colleagues to provide services to students.
5. The candidate engages in professional development for personal and professional improvement.

6. The candidate uses personal professional ethics in decision-making and interactions with students, peers, parents, and the community.
7. The candidate advocates for students and schools.
8. The candidate engages in service for benefiting students and improving schools.
9. The candidate perceives and evaluates self as a servant leader.

**Course Objectives:**

1. Understand the constructivist philosophy of teaching/learning and its relationship to the teaching of elementary school science.
2. Understand the developmental process of the child in the learning of science concepts.
3. Examine and compare uses of published instructional materials.
4. Develop and implement lesson plans for appropriate grade levels in science using the North Carolina Essential Standards and teacher handbooks as guides.
5. Examine the need for the integration of other skill areas into the K-6 science instruction.
6. List and discuss the goals of science education.
7. Describe and discuss the advantages and disadvantages of lecture, discussion, free discovery, and guided discovery as instructional strategies.
8. Given a specific set of objectives, select one of the above strategies and give a rationale for that selection.
9. Identify characteristics of a classroom environment that focuses on activity-based experiences.
10. Discuss motivational strategies in science instruction, with particular emphasis on females, minorities, and at-risk students.
11. Describe appropriate uses of technology for teaching science.

1. Attendance is REQUIRED. Points will be subtracted from a student's overall point accumulation if the student misses class sessions. One point will be deducted for each class past the first that is missed. Please inform the instructor if you know you will be absent from class. If students are involved in a xxxxx University activity (sports, etc.) which require that they miss a class, they must provide the instructor with written notification that has been signed by the university official who serves as sponsor for the activity. If students miss class on the day that a test is given, they must take the test within one week of the scheduled test date or receive zero points for the test.

2. Please be on time for class. When a student misses any portion of a class session, the student is not participating in that particular portion of the session and looses out on important learning opportunities.

3. All assigned learning activities must be submitted on or before the designated class session in which the assignment is due. Points will be subtracted from overall point accumulation for any assignment that is late. Activities and projects are eligible for "full" credit only when presented on time. Missing class does not give students permission to submit assignments late. Students must make arrangements to hand in assignments if they are absent from class. All members of groups must participate in all assignments. Group members will complete self and peer

evaluations for group work and this will be included in the determination of your grade for group assignments.

4. Active participation in classroom discussions will be evaluated and included in your participation grade for the course. Active participation requires students to be looking and listening to the instructor and peers, as well as contributing to discussions with thoughtful ideas.

5. The instructor does realize that emergency situations arise (e.g., death in the family). Students who experience unforeseen emergencies must arrange to meet with the instructor to discuss alternative arrangements for any missed class time, incomplete activities, and/or assignments. In the case of illness, a doctor's note will be required.

6. All **written assignments must be typed and double-spaced**. When typing on a computer, please use a size 12 font. Content, neatness, spelling, grammar, punctuation, and sentence structure will be evaluated.

7. When working in cooperative groups for presentations, if there is a problem regarding workload in the assigned group, students must notify the instructor as soon as it arises. Students must NOT wait until the day before a presentation to notify the instructor of an inequitable workload.

8. In accordance with college policy, a student with special needs, who wishes to receive instructional accommodations because of a documented disability, should meet with the instructor within the first week of class to discuss those accommodations.

9. xxxxx University Honor Code will be applicable for all assignments associated with this course. Please refer to the Pfeiffer Student Handbook.

***The instructor reserves the right to change the syllabus as may be needed during the semester.

Evaluation Criteria:
10% Weekly Discussion Forums on Blackboard
10% Active and Thoughtful Discussions
10% Google Site (with technology project and weekly classroom reflections)
10% Group Presentations
10% Lesson Plans
10% Science Fair Project
10% Service Learning Project
10% Final Exam
20% Research Paper (including literature review)

Grade Determination:

| | | |
|---|---|---|
| A 93 –100 | A- 90 – 92 | |
| B+ 87 – 89 | B 83 – 86 | B- 80 – 82 |
| C+ 77 – 79 | C 73 – 76 | C- 70 – 72 |
| D 60 – 69 | | |
| F Below 60 | | |

Honor Code: Students will be asked to sign the xxxxx University Honor Code Statement accompanying tests and exams.

**Course Learning Activities**

1. Classroom Observation Hours: Students will complete 15 hours of science instruction observations in the elementary classroom. Reflections will be completed weekly on student blog (Google site). Throughout the course, specific material from the course will be the focus of these observations and reflections (ex: developmental level of children, motivation, equity, content, learning theories in practice, integration, assessment, technology, etc.). Refer to "Reflections on my experience in science classrooms" expectations.
2. Weekly Discussion Forums within the course Blackboard: Students will complete weekly discussion forum postings with ongoing responses with at least two peers. Discussion prompts will relate to in-class learning and will be organized according to topic (ex: content, learning theories, child development, resources, integration across the curriculum, standards, equity, motivation, technology, assessment, pedagogy, …)
3. Google Site Portfolio: Students will keep a portfolio of their course work on individual websites through Google sites.
4. Active and Thoughtful Reading Discussion Groups: Students will be assigned weekly reading and will be required to keep notes within their textbooks. Small group discussions will take place to help students to synthesize and summarize the material.
5. Service Learning Project: Students will participate in a service learning project geared towards elementary science instruction in a local Title I school. On-site visits with guided inquiry mini-lessons will be provided by students and will occur on multiple days in place of part of our class time.
6. Elementary Science Methods Group Activity Presentations: Students will be assigned a particular topic and expected to research and present appropriate activities for the content area including integration with at least one other curriculum area. Refer to Learning Activity Directions.
7. Classroom Assignments: Students will be given opportunities to build knowledge and applications related to the course objectives through classroom assignments. Assignments not completed during class time will be completed as homework.
8. Individual Lesson Plans: During the observation hours that students spend in elementary classroom(s), at least one whole-group, inquiry-based, science lesson will be taught. A full lesson plan will be developed for the whole-class lesson, with opportunities for peer and instructor feedback given before implementation with children. Both formative and summative assessments will be used to plan instruction and determine impact. Reflections will be completed following each lesson.
9. TPACK Pre/Post Lessons: Students will develop lessons that integrate technology into science instruction using the TPACK framework. Peer and instructor feedback will be given followed by opportunities for revision.
10. Technology Project: Students will utilize the Internet to research useful websites for supporting the teaching of elementary science. This activity will be included in the Google Site Portfolio grade. Refer to Learning Activity

Directions.

11. Literature Review: Students will complete a literature review on their assigned science topic. This literature will consist of information from the current state of knowledge on the topic from at least 7 resources. This will be organized into themes and will be written as an informal annotated bibliography.
12. Final Examination: Students will show evidence of their culminating knowledge of science methods for elementary students through a final examination.
13. Science Experiment: Students will develop a science experiment/science fair project to present to the rest of the class and will design a plan of action for gaining participation of students in an optional science fair.
14. Content-based Research Paper: The purpose of this assignment is for you to demonstrate in-depth knowledge of a concept in science. Research a topic from one of the areas of science and write a synthesis of the current state of knowledge of that topic. The paper must be between 12 and 15 pages and must use at least 5 references. It should be written in APA style. You will prepare a brief presentation of your topic for your peers.
15. Other activities as may be needed to meet the course objectives.

## Learning Activity Directions

**Group Activities Presentation:**
The purpose of this assignment is to expose the class to techniques and activities to teach children various concepts as dictated by the NC Goals and Competencies for science. Groups will research and present three guided inquiry mini-lessons about their topic, including tools developed by the group to guide formative and summative assessment of student learning.

Group 1 – Physical Science (one mini-lesson from each subtopic)
Group 2 – Earth Science (one mini-lesson from each subtopic)
Group 3 – Life Science (one mini-lesson from each subtopic)

Groups should:
1. Choose 3 different activities, one to represent each aspect of the assigned topic. The activities should directly parallel the NC Goals and Competencies. Please choose activities that would apply to different grade levels (e.g., don't use all kindergarten activities). The activities must support guided discovery. The group can borrow, make, buy, etc. any materials needed for the activities.

2. A list of group contributions should be submitted to the instructor on the day of the presentation. Please list group member names and their role in the activity. If this is not submitted the group will lose 5 points from the total presentation grade.

3. Groups will use a minimum of 3 sources, including at least one from the Internet. A reference list developed according to APA style should be turned in the day of the presentation.

4. Groups should prepare a brief summary of each activity including, the NC Goal/Competency the activity addresses, which grade level(s) the activity is appropriate for, materials needed for the activity, and the group's critique of the activities.

5. Groups should create a class handout that outlines each activity. Correct composition skills should be used in the development of the handout.

6. Presentations should last 30 minutes (approximately 10 minutes for each mini-lesson). All group members should be present on the day of the presentation and should have an active speaking part. Any member not present or who does not take an active role in the presentation will receive a zero for this assignment.

7. Students must use appropriate oral communication skills during the presentation. Students must dress appropriately for the presentation (no shorts, jeans, caps, etc.).

**Classroom Observation Reflections:**
Reflective writing is way to dialogue about your feelings concerning science learning

and instruction.  Through this activity students will explore ideas, clarify thinking, pose questions, express concerns and interests, and work towards synthesis of the classroom material and real-world application of learning.

Throughout the semester, students will be given ideas to focus on during their time spent in the elementary science classroom.  Reflections will be posted in a blog on student Google sites each week.  It is best if these reflections be posted immediately following the classroom visits.  These are due before each class period, at the latest.  A copy of these reflections should be emailed to the professor at xxxxxx@fsmail.....edu.

In addition to the required entry, feel free to pose any questions or address any concerns that you may have about the class or other assignments you're working on.

**Blackboard Discussion Forums:**
Collaborative discussions offer a mechanism for knowledge-building.  According to Bandura, learning occurs through social interactions.  By putting into words our ideas about the content that is related to the course, will be strengthen the collective understanding and support one another in knowledge acquisition.

The instructor will post a discussion prompt following each class.  Students will be expected to participate in the discussion forum by submitting a post in response to the prompt AND by participating in an ONGOING discussion with at least two peers.  Initial prompt responses should be posted by Friday night at midnight and should be at least 2 paragraphs long (with at least five sentences in each paragraph).  Support from the textbook and/or other resources should be included for full credit.  Responses to peers should be posted by Tuesday night at midnight and should consist of a thoughtful, meaningful, back-and-forth dialogue related to the peer's initial response.  The purpose of these discussions is to clarify thinking, ask questions, and strengthen understanding.

**Individual Lesson Plan:**
Select a specific grade level and describe a hypothetical class to include 25 students. The length of the lesson should be for a 20-minute block of time. Select one or more of the NC Competencies for the focus of the lesson. After completion, post this assignment on your Google Site Portfolio.

<u>Lesson Planning</u>
*Use the provided lesson plan format

*Objectives:
Write 2 - 3 cognitive objectives for the lesson to meet the NC Competencies for Science. Each of the cognitive objectives must address a different level of Bloom's Taxonomy. At the end of each of the cognitive objectives, label the level of Bloom's that the objective addresses.

*Class composition
Develop a computer generated student chart to indicate the student composition of the hypothetical class relative to gender, socio-economic status, abilities according to multiple intelligences, and the five areas of students with learning challenges: physical/sensory challenges, communication disorders, emotional/behavioral disorders, hyperactivity/attention disorder, and learning disabilities. Each of the learning challenges must be represented in the hypothetical class and modifications for the students with learning challenges must be indicated on the plan.

Type a brief narrative, on a separate piece of paper and attach it to the lesson plan, to explain how the lesson is appropriate for the age levels and composition of the class.

Content must be age appropriate, information accurate, and learning activities must meet the objectives.

<u>Assessment Tool</u>
Develop an assessment tool for the lesson. Develop either a test, checklist, rating scale, etc. Attach the instrument to the back of the lesson plan and submit it on the day of the lesson.

<u>Peer Feedback</u>
Include suggestions made by peers for improving your lesson plan.

<u>Reflection</u>
After teaching this lesson to students in your practicum location, write a paragraph or two to reflect on your experience. What went well? What would you like to change if you teach this lesson again? What surprised you? Etc.

**Technology Project:**
Technology should be an important part of your educational preparation for several reasons. First, NC DPI requires that all newly licensed teachers be computer literate. For this project you will:
1. Compile a list of 10 Internet sites that pertain to elementary science.
2. For each site listed, include a brief description of the site: who is the site designed for, how you could use it in teaching mathematics.
You will post this project on your Google Site Portfolio AND email a link to the instructor at xxxxx@fsmail.xxxxx.edu.

**Service Learning Project:**
You will receive detailed expectations for this project during the course.

**Teaching Methods Used in This Course:**

| | | |
|---|---|---|
| **Lecture** | **Clinical Experience** | **Independent Research** |
| **Discussion** | **Cooperative Learning** | **Micro Lessons** |
| **Reports** | | |

**Accommodations for Disabilities**:
If modifications are to be made in instructional processes, students with documented disabilities must contact the Director of Academic Support Services. He will inform the instructor of approved accommodations. Students with a documented disability and approved instructional accommodations are asked to notify the instructor before the end of the last add day.

**Honor Code**:
All provisions of the xxxxx University Student Honor Code are applicable for **<u>all</u>** assignments. Cheating and plagiarism are prohibited under the Honor Code and carry consequences. The first offense of plagiarism during enrollment in the University carries a penalty of a grade of 0 on the assignment or F in the course. Subsequent offenses must be adjudicated by the Honor Board. Ideas for lesson plans and other resources from the Internet or elsewhere may be consulted for ideas. **However, all work must be the original work of the teacher candidate.**

**Safety:**
xxxxx University is committed to protecting all community members from any and all threats. You can help the university to protect all persons by reporting any threats that you receive (or hear about) to your professor, to police, or to any university official. The university is diligent in providing a proactive approach to protect anyone who has reason to believe that he/she is in danger. Do not hesitate to report any suspicious activities to university officials. Please visit the Police web site to learn more about campus safety:

**Assistance**:
The instructor is available to assist students during office hours and at other times by appointment. Please see the instructor if you need additional explanations, further clarifications, or help with any other matter related to this course. Tutorial assistance is available in the Wick Sharpe Learning Center (located in the Library).

**Note: The instructor reserves the right to change the syllabus to meet students' needs in accomplishing the course objectives.**

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**Journal of Research in Science Teaching**

*The Science Teacher*

*Science and Children*

*Ranger Rick*

## APPENDIX M
## 8 STEPS TO INCREASING TPACK AMONG YOUR STUDENTS

1. Provide students with multiple opportunities to build content knowledge focusing on the teaching standards that they will be using in the classroom. Include collaboration between students and experts in the content field via a collaborative blog to strengthen this learning. (Content Knowledge)

2. Model constructivist teaching methods in class. Provide multiple opportunities for students to explore, describe, and design learning activities based on these pedagogical approaches. (Pedagogical Knowledge)

3. Model using the revised Bloom's Taxonomy to teach content knowledge. Provide multiple opportunities for students to explore, describe, and design learning activities and/or lesson plans to teach the content using activities from different levels of Bloom's. Scaffold these experiences; moving from teacher-led, to peer collaboration, and finally independent work. (Pedagogical Content Knowledge)

4. Model the use of technology tools to support content knowledge learning of students. Provide multiple opportunities for exploration of a variety of technology tools in building content knowledge of your students (if teaching pre-service teachers, these activities should be used to build their content knowledge, not the children who they will be teaching). (Technological Content Knowledge)

5. Provide multiple opportunities for students to explore a variety of technology tools for teaching and learning. Direct students to at least eight-ten specific technology tools used for the content area in focus. Using Figure 4-11, "Evaluating Technology Tools to Support Content and Pedagogy", scaffold students' evaluation of technology tools. Model first, then use peer collaboration, and finally independent use of the chart. Encourage students to troubleshoot any technology problems that come up collaboratively with their peers. (TPACK)

6. Model the selection of appropriate technology tools to support the content that is being taught and the constructivist pedagogy that has been designed (using the "Evaluating Tech. Tools…" chart). After modeling and giving clear expectations to students, provide opportunities to select appropriate technology tools to support learning activities with peers and then independently to scaffold this process for students.

7. Introduce the TPACK Lesson Plan Format (APPENDIX F). Model the development of a lesson plan that integrates TPACK using this

lesson plan format. Provide support as students develop their own lesson plan using these guidelines.

8. Using APPENDIX B (revised to include the teaching standards that your students will be teaching in the children's classroom), model the evaluation of lesson plans. Assign students to complete evaluations of peers' lesson plans, including specific suggestions for improvement. Also, assign students self-evaluations of their own lesson plans using this chart. Following these self and peer evaluations, model the revision of a lesson plan and then provide opportunities for student' revision.

   *Throughout this sequence of steps, provide students with opportunities to reflect both independently and collaboratively on their thinking about the integration of technology into teaching and learning. Focus on the big ideas that arise in their thoughts as well as any misconceptions that are noticed and/or clarified.

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