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Promoting Creative Thinking and Expression of Science Concepts Among Elementary Teacher Candidates Through Science Content Movie Creation and Showcasing

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Abstract

This article reports the phases of design and use of video editing technology as a medium for creatively expressing science content knowledge in an elementary science methods course. Teacher candidates communicated their understanding of standards-based core science concepts through the creation of original digital movies. The movies were assigned as a component of an elementary science methods course to help teacher candidates frame their understandings of science ideas and science content through the medium of movie-making technology. A mixed method analysis of the movie-making process was conducted through open-ended questionnaires and interviews. Results revealed that the project was valuable, as it provided an opportunity for students to think about science concepts from a new and deeper perspective. Further, the movie-making experience included the learning and utilization of iMovie technology, increasing candidate comfort and confidence in using the technology, which candidates reported will carry over to their own classrooms. This study has implications within science methods courses for the relationship between creative expression and core science concepts.

Although considerable literature describes the science content knowledge of preservice teachers, less is written on how such information is expressed through creative thinking, development, and construction. The National Research Council (Duschl, Schweingruber, & Shouse, 2007) has recently proposed that K-8 students study core science concepts through a cycle of learning progressions where they are expected to experience the value of communicating and representing their understandings of science ideas. In addition, technology supported experiences for elementary students that promote creativity, communication, and collaboration continue to reflect standards of best practices in schools (International Society for Technology in Education [ISTE], 2007). However, elementary teacher candidates are typically characterized as having had negative experiences in science and low science content knowledge, and they do not regard themselves as science teachers but rather language arts teachers (Appleton, 2003). This attitude poses difficulties for science methods course instructors when attempting to create science educational experiences that are meaningful and positive for the teacher candidates.

Recently, researchers have reported the benefits of using digital video editing technology to enhance thinking and communication skills among elementary students in science (Yerrick, Ross & Molebash, 2003) as well as a powerful tool to promote teacher reflection (Yerrick, Ross & Molebash, 2005). Potter (2006) found that digital video editing software supported teacher candidates' ability to create meaning from multimodal resources in creative and expressive ways. This study is a partial extension of Potter's work, which examined the use of video editing technology as a tool to support candidates' conceptual understanding and expression of science content knowledge, as well as the potential to support creative thinking.

Theoretical Framework

Three theoretical constructs guided the flow of this study. First, the study was framed in a constructivist approach to teaching and learning science, which recognizes the importance of the social aspect of constructing knowledge by the learner (McRobbie & Tobin, 1995; Roth, 1995). The instructional environment of the study contained the following three elements (recommended by Brooks & Brooks, 1999): (a) respect for the learner's prior knowledge; (b) meaning constructed through interactions with others and various media and materials; and (c) understanding constructed around core concepts.

Second, the Creative Learning Model (Treffinger, 1980) was used to conceptualize creative thinking as a relevant component in science learning. Within Treffinger's model, both cognitive and affective dimensions are emphasized and embedded in any creative act of learning. Finally, multimodality (Kress, 2003; Kress & Van Leeuwen, 1996) and new media expression (Potter, 2006) offered a context for recognizing how communication involves a multiplicity of forms, including language and visual sign systems. In this case, teacher candidates were given technology tools that enabled them to generate and represent science knowledge in a creative context.

The student project described here was designed from a foundation of digital storytelling. This form of new literacy does not focus solely on the story itself, but rather the crafting and developing of the story through a digital medium. The inclusion of video clips, voice-over narration, music, and still shot images all work to engage the audience on many levels (Ohler, 2008). Video technology (O'Brien, 2001), like the one utilized in this project, is a form of new literacy that aims to provide new mediums for information transmission and communication (Leu, Kinzer, Coiro, & Cammack, 2004).

Alvermann (2004) purported that the use of new technologies is drastically and irreversibly affecting the ways information is communicated in schools. As the technology becomes more ubiquitous in schools, teacher educators should expose preservice teachers to some of the possibilities of integrating the technology into their teaching and learning. This project was designed with this objective in mind.

A primary goal of our science methods course was to provide elementary teacher candidates with experiences that directly support best practice in their future teaching of science (Bleicher & Lindgren, 2005; Carter & Sottile, 2002; Hoban, 2007; Kelly, 2000). Consistent with the recommendations of Duschl et al. (2007) and ISTE (2007), we also wanted teacher candidates to engage in creative ways of communicating science conceptual understanding. Given the reported benefits among elementary teacher candidates as well as elementary students, we decided to explore the potential for digital video editing as a tool for supporting creative thinking and expression of science concepts. Essentially, candidates working alone or in pairs used the iMovie software to creatively compose and authentically express their science conceptual understanding of a specific core science concept of their choice. This paper is intended to report the specific nature and reported value of developing a science concept movie.

Participant and Project Details

Elementary teacher candidates in both sections of an elementary science methods course (n = 121) participated in this 2-year study. This methods course ran in the penultimate semester before graduation. The course was a constructivist, inquiry-based 15-week course with once-a-week, 3-hour-long sessions. Each class integrated hands-on activities, exercises, discussions, experiments, and inquiries that related and demonstrated the fusion of core science concepts with key pedagogical concepts. Technology supported field-work and in-class work were emphasized, as they are seen as critical to best practice teaching. The following is a description of one class project.

The methods course project entitled Science Concept Movie was an assignment for preservice teachers to illustrate and express a science concept using digital video editing software through a 3- to 5-minute movie. The purpose of the assignment was to provide the opportunity for candidates to select a core science concept of their choice from the list of State Science Content Standard (North Dakota Department of Public Instruction, 2009) and express it to the class in a creative way through the creation of the movie. The finished movie reflected a personal understanding and meaning of the science concept. Showcased science concepts were mostly scientifically accurate, yet manifested and presented in a noticeably more personal way than the textbooks had relayed the same information. Through this distinction the assignment has implications for teaching and learning science for both the preservice and in-service aspects of teacher education.

After 3 hours of orientation to the iMovie software, which is identified later as Phase 1, candidates had 6 weeks to complete the project. Once the movies were created and burned onto DVDs, candidates showcased their movies in front of their classmates on the last day of the class as a celebration of our course and the completion of the required coursework aspect of their program of study. A total of 76 movies were created in the following topic areas: life science (26 movies), physical science (22 movies), Earth science (20 movies) and environmental science (eight movies).

Science Concept Movie Guiding Dimensions

Teacher candidates expressed their understanding of core science concepts by creating iMovies, which were guided on two dimensions: depth of conceptual understanding and expression of understanding. Depth of conceptual understanding reflected the scientific accuracy of the concept presented and the depth to which it was expressed. Expression of understanding encapsulated three subareas; creativity, digital enhancement, and story flow. Both dimensions are further explained in the tables 1 and 2.

Table 1
Descriptive Aspects of Depth of Conceptual Understanding Dimension

Depth of Conceptual Understanding	Notable Aspects
Incomplete Level (Major pieces of information missing or misunderstood)	• Facts and information wrong or misunderstood, or fragmented understanding
Surface Level (Basic information present)	• Definition level of understanding • No examples provided • Presented in haphazard manner
Intellectual Level (Topic information understood)	• Important elements indentified • Examples provided • Information organized into a flowing pattern
Dynamical Level (Exemplary understanding)	• Important elements identified • Examples provided • Information organized into a generalized content pattern • Interrelationships between key elements provided • Pieces and the whole are connected

These tables comprise the basis of the project's grading rubric, which can be found in the appendix. A high score was attained within the depth of understanding dimension if a clear identification of interrelationships and significant aspects of the scientific concept were demonstrated. A project titled *Rainbows* claimed to explain how rainbows form. Rather than explain the basics of refraction of sunlight, the project creators described the nature of making new colors of the visible spectrum using different color pigments of paint that were mixed together. The discord between their proposed explanation and what they described resulted in a low score for this dimension. Conversely, the project titled *Can It Be Done?* accurately described, demonstrated, and gave examples of the effects of changes of air pressure and subsequently attained a high score within this dimension. (See Video 1 for a film clip.) Each of the subcategories in the expression of understanding dimension was included as a notable aspect of each level as can be seen in the rubric.

Creativity

The project titled *Hurricanes* was poorly constructed. The project creators simply filmed a computer monitor streaming the explanation of hurricanes found on the website "Brain Pop" (http://www.brainpop.com/science/weather/hurricanes/), thus demonstrating an absence of creative or original expression. Conversely, the project titled *Tsunamis* reflected high creativity in terms of expression using unique and original methods. The project creators used claymation to express how tsunamis are created. (See Video 2 for a film clip.)

Table 2
Descriptive Aspects of Expression of Understanding Dimension

Expression of Understanding	Notable Aspects
Poor Expression	• Transitions were not timed properly • Font was too small to read • Text scrolled too quickly to read • Music was inappropriate, there was now connection of music and topic • Scenes did not flow into each other but were abrupt • The editors did not infuse any of their own video into their work, but rather streamed it from the Internet
Good Expression	• Transitions were mostly timed well • The font was readable, but font type or color made it hard to read • Text scrolled too slow and thus made the project drag • The music was too loud or soft, but was connected to the topic • Scenes sometimes did flow into the next • The editors did some original video capture and presentation
Excellent Expression	• Transitions were all timed well • The font was readable, without distraction of color or type • Text scrolled at a reasonable pace being consistent with movie flow • The music was well chosen and presented in terms of connection to concept and sound level • All scenes flowed into the next ones smoothly • The editors included all original video capture and presentation

Digital Enhancement

The project titled, *Bridge Building* faired poorly in the subcategory Digital Enhancement, as it had no soundtrack, no transitions between scenes, nor any tools that iMovie provided to cut and edit the lengthy footage students recorded. The project titled *Oh, Gravity* attained high regard, as it integrated music in the same cadence as the scene changes, transitions between scenes and visual effects. (See Video 3 for a film clip.)

Story Flow

Constellations, a project with much potential, had difficulty. The final product was edited in choppy, segmented parts that had little flow and minimal continuity, and viewers were unable to follow the project's expression and purpose. The project titled *Tornado* was an emotional 8-minute creation describing the nature of tornados and the subsequent destructive, devastating, and fatal effects of a tornado touching down in a small town, like Northwood, North Dakota. The project creator was from Northwood, which made this project even more meaningful and authentic. This project flowed with a smooth pace, which included engaging footage, audio and video effects, and well-timed transitions. Unlike *Constellations*, *Tornado* engaged viewers and told a coherent story while describing the scientific concept.

With these guidelines for movie creation set, it was now time to teach students pragmatically how to think of, create, and express their science concept movie. This process included five phases.

Results and Discussion

The results of this study are presented through two distinct areas. The first section, Phases of Teaching Science Concept Movie Creation, presents findings, descriptions, and discussion about each of the phases of the activity, beginning with a project description and introduction to the digital video editing software and finishing with the showcase of finished movies on the last day of class. This section is punctuated with student narrative responses from interviews and questionnaires. The second section, Overall Perceptions, provides a quantitative summary and brief discussion of student responses according to the four guiding questions asked in the questionnaires and interviews, namely,

- What is your perceived value of this project in terms of learning a science concept?
- What is your perceived value in terms of learning to use video capture and creation software?
- Describe the most valuable aspect of this experience.
- Describe the least valuable aspect of this experience.

Phases of Teaching Science Concept Movie Creation

Five main procedural stages were used to create the movies. These phases are applicable to university-aged preservice teachers as well as to school-aged children. The phases have been developed and honed over time, as we continue to use this project in our methods course. A description of each of the phases is presented, as well as excerpts from student comments that reflected typical responses of the participant group. All of the student names are pseudonyms.

Phase 1: Preparation and Practice. The day this project was assigned in the elementary science methods course, preservice teachers participated in an in-class, 3-hour training session that explored capturing digital video, transferring it to the computers, and using the iMovie software. The session began with showcasing exemplar past projects to pique student interest. After explaining the nature and dynamics of the project, including a brief best-of and not-exactly-the best-of session, students were provided with digital camcorders. Students were given time to venture out on campus and capture video of any sort or theme they chose. Upon return, students were provided appropriate USB firewire cables to connect to the laptops in order to upload the recently captured video in its raw form. In an effort to ease this process, especially the transfer of the raw video from the camcorder into iMovie, a sheet was provided to the students, and a step-by-step tutorial was given by the instructor.

Once the raw video was uploaded into the iMovie software, students were provided a general overview of the program's features and tips on how to access and utilize them. At this point, students were encouraged to explore the program and develop a primitive movie that incorporated a title, a music track, scene transitions, and one or two basic special effects. At the end of the session, each of the newly created movies was shown to the class. In watching all the movies, students were provided an opportunity to see the multifaceted capabilities of the iMovie software.

As only a small portion of students had taken a technology in education course, the practice of making movies in this fashion was a critical starting point for the project. Bill, at the completion of his project commented, "Learning to use the software in the practice session was very beneficial to me. I was very unfamiliar with it before, and am more confident with it now to start my own project." This sentiment is addressed further in the discussion section.

Although several other movie making programs are available on both Mac and PC platforms, iMovie was chosen because all public elementary schools in the state use Macs, and students are becoming more and more well versed in that domain. This project is useful for teacher candidates but has implications for use once they become teachers, as they can then develop similar movies with elementary-level students. Using the same equipment and technology teacher candidates will see in the field was, therefore, an important choice.

Phase 2: Planning and Research. The first choice made in this phase was whether students would work alone or with a partner. This choice was not always easy to make, as some work-related partnerships do not end well despite the best intentions and personalities of the students. As Deanna commented after a disappointing conclusion to her project, "I was really frustrated with my partner and felt as if I were the one left to do everything." Working in partnerships is not always negative, as Ana remarked about valuable aspects of this experience, "Through working with a partner to create a fun and informative video about a science topic, I got to know the person and software more!"

Some considered the social dynamics of this project to be part of the most valuable aspect of the entire experience.

> The most valuable aspect of this experience was getting to know how to use the technology. I think something else that was important was working with someone else and that kind of relationship you form dealing with problems of software, but working together to solve them. (Rene)

Once the practical choice of working dynamics was made, the content-oriented selection needed to be made. Teacher candidates were asked to choose a core science concept from those applicable to elementary level science. Although students seemed naturally to gravitate toward topics or concepts they felt most comfortable with, course instructors encouraged them to select and pursue a concept they were less familiar or efficacious with, as this opportunity would enable them to explore the concept to a deeper level and from a different perspective.

Students began the planning process by researching their chosen science concept. When asked about how the research aspect influenced the project as a whole, Ilana said: "The research helped me to break down a concept and see it in a way that only reading about it in a textbook wouldn't let me see." The research component also provided the genesis of the storyboarding, as it was mostly through the research phase that the personal connections and meaning with the material were made. The research phase developed the initial big picture ideas, and the next phase of direction and capture deconstructed the big picture into smaller sequences used in the storyboarding process.

When asked about how the research phase affected her project, Laura responded, “I knew very little about my topic before this project, but I learned so much through the research I did. I needed to have a strong understanding to be able to present it in the end.” Partners Erika and Carter captured the essence of this phase in one fell swoop:

> In order to make the movie interesting, we had to learn a lot about our topic. After we had a plethora of information, we determined importance. My knowledge was deepened and I made connections between knowledge I already had and knowledge gained. (Erika)

> From my own video we had to research information to make sure we said things properly and explained things accurately. (Carter)

Phase 3: Direction and Capture. This third phase has two distinct layers. Direction is the process by which students mapped out in a storyboard manner the proposed direction the movie would take. Included in this subphase is the determination of the scenes that need to be captured and in what order, the props and music needed, the locations needed for sets, and time allocation and dates needed for the pieces to be gathered and then put together toward the final product. Further, students need to assess, analyze, and determine the science concept aspects from their research in Phase 2 they wished to express. The storyboarding process, especially for the science related aspects, prompted Signy to remark about the creativity needed within this process: “There was great value in this phase, as I needed to figure out a creative and interesting way to demonstrate the scientific principle.”

The capture aspect of this phase is the specific act of using the digital camcorder to capture the video as designed and planned in the direction phase. Although most people now have digital video capabilities in their cell phones, the picture, clarity, and memory requirements are often better served by using a camcorder. As such, students were provided access to communal digital and video tape camcorders through the departmental computer center that could be checked out by request. Videotapes or discs for the camcorders were the responsibility of the students, as this allowed them to keep the raw footage after the project was completed. Appropriate cables to connect to the laptops for the transfer of raw video were provided within the camcorder case.

The time necessary for this phase is mostly contingent on the capture stage. Despite the best planning and direction in previous phases, the scenes and images often require more than one take to get the shot or sequence the directors had in mind. Multiple takes may be required due to staged and unstaged bloopers, dialog errors, malfunctioning equipment or props, unaccounted-for intrusions, or simply a shaky hand if a tripod was unavailable. As the bloopers or reasons for delay were often funny by nature, students sometimes included the best one or two of them at the conclusion of the movie, usually as the credits or, in this case, the resource list are rolling.

This phase also takes time because, sometimes, once students begin shooting scenes, new ideas emerge for a better way to show or say the same idea. Natalie, in her postmovie questionnaire wrote, “We got better ideas when we starting videotaping.” In the follow-up interview, Natalie was asked to elaborate on this statement: “When we started shooting the second scene, we realized that what we were trying to show didn't make sense. So we sat down and came up with a new plan, and then shot that."

Few students and professors would argue that the time allotment for this project was intense. Students were given 6 weeks for the project. However, despite the encouragement and warning and weekly updates provided by students in class, some students underestimated the time required for this phase of the project: "I just felt I did not have enough time to do as good a job as I had wanted. I shouldn't have left it all to the last week" (Erin).

Fiona, a student who often looked for greater meaning and ideas in and out of pedagogy, described her experience in this phase: "In the beginning, my idea of my topic started with the big picture (tornadoes, hurricanes...etc), but once we started planning, we pulled ideas from everyday life to help demonstrate cause and effect, which third graders could relate to."

The direction and capture phase comprised moments where the project went from theoretical to practical, as raw footage had been captured and the vision the directors had in mind for the final product began to take shape. Although the video had been taken, the process by which that video was transformed to a finished product began in phase 4.

Phase 4: Editing and Enhancement. Once all the video and still pictures had been taken, the raw footage needed to be uploaded to the laptops and imported into iMovie for movie making and project production. This process, which was practiced in Phase 1, included the connection of the camcorder or camera to the computer through a USB firewire cable. Once imported into iMovie, students then used the program to edit the footage. The editing and enhancement process involved splicing and sequencing footage into the storyboard proposed order of scenes from the direction aspect of Phase 3, adding visual and audio features to enhance the scenes and transitions, and developing a title screen and credit sequence. This phase was mostly dependent on the use of the software as a tool for creating the final product. Having practiced iMovie use in Phase 1, and having opportunities outside of class to hone their skills, students were not new to the software. It must be noted here that some students more quickly developed a software fluency and efficiency than others, which caused some distress amongst students. In this phase creativity manifested differently than in the direction stage of Phase 3.

In Phase 3, students organized their plans via storyboarding and footage capturing in a creative manner. There, creativity meant determining what sequence, what shots, and what specific concepts or ideas directors wanted the audience to see in their finished product. In Phase 4, the creativity existed in what the software can do to enhance the video and turn the raw footage into a final product. Patrick described his perceived value in learning the software:

> I learned a lot about iMovie. I learned how fun and creative these movies can be. I also learned how to use effects, transitions, ass music, and add titles to movies. I also learned how to create a sequence in the movie....Each one of them enhanced the movie in ways I could not previously imagine. They made my movie so much better.

Although a few students felt that adding as many bells and whistles as iMovie would afford was the way to make the final product more engaging, most students realized that that was not the way to go:

Kim:	At first I thought that the more special effects I used, the cooler it would be. But after watching it, it looked stupid. So I simplified the effects and made them more as an enhancement.
Interviewer:	Can you elaborate on what you mean by that?
Kim:	The explosion thing is cool, but I had placed one in each scene. This made the movie look kind of dumb. So instead, I selected more appropriate effects for each scene and used those. My movie rocked in the end because of it!

There was a steep learning curve for students to use the software at a level they were comfortable with. The computer lab was open for student use everyday. This availability helped students become more familiar with the software. In addition, students needed to use the same computer for all their editing and enhancing as they uploaded their footage and still shots only to one computer. Lauren, on her postmovie questionnaire commented about the value of this experience as a whole:

It gave me an idea on how complex this whole process is. It made me aware of the fact that if I ever wanted to make an iMovie with my students I have to plan ahead that each minute of the movie will need at least an hour of work.

Once the science concept movie had been edited and enhanced, the final step of this phase was to burn it onto a DVD for submission and showcasing. With DVD burners in the computers, this step was easily accomplished. Six weeks after Phase 1 had been initiated, the burned video was brought to the final class of the semester to be presented in a showcase event.

Phase 5: Delivery and Showcasing. The showcase event was both a celebration of the course and science concept movie completion, but also the last bit of coursework before launching in to the student teaching semester prior to graduation. This event has two layers from which the day proceeded.

The first step was the delivery of the burned DVD to the professor. The delivery, which occurs in front of the class, was accompanied by a brief introduction by the student creators as to the title or theme of their film and the designer's names. Any and all explanations about the specific movie content were optional and were frequently omitted from the verbal introduction. Andrea, in her introduction of her film, *Tornado*, said nothing more than, "This movie is about my hometown."

One by one, on a volunteer basis, each science concept movie was delivered and then shown via the ceiling-mounted digital projector to the large screen for maximum effect. Students often brought movie-style snacks like popcorn, candy, and soda.

The showcase event was perceived by students as more than simply a day to kick back, relax, and eat high fructose containing foods. Ariane, in her postshowcasing event commentary noted, "I learned more from watching people's movies than in lectures about the topics." Marcelo commented that his most valuable aspect of the project-making experience was "watching everyone's movie and seeing how they did it."

Overall Perceptions

The data in tables 3-6 were ascertained from surveys given to the students after the project was completed. From the 121 students in the courses, 103 surveys were completed. The greater themes of the quantitative data reported in these tables are the basis from which the following discussion emanates.

Table 3
Responses to Perceived Value in Terms of Learning of a Science Topic

Theme	Number of Responses	Percentage of Total Responses (*N* = 103)
Better understanding/look deeper into topic	47	45.6%
Research the topics/ experimenting with science	20	19.4%
Creatively showing what was learned	8	7.8%
Did not help	7	6.8%
Reinforced current understanding of topic	6	5.8%
Watching other movies to learn concepts	5	4.9%
Looked outside the box into science in real world	3	2.9%
Future use	2	1.9%
Blank/no answer	2	1.9%
Helped with technology	2	1.9%
Strong misconceptions	1	1%

Table 4
Responses to Perceived Value in Terms of Learning to Use Video editing Software.

Theme	Number of Responses	Percentage of Total Responses (*N* = 103)
Learning to use software	58	56.3%
Increased comfort/confidence	17	16.5%
Frustrating stressful process	12	11.6%
Figuring out how to use the software	8	7.8%
Use with students	8	7.8%

The purpose of the science movie assignment was to provide elementary teacher candidates with an opportunity to express their understanding of a science topic of their choice using video editing software as a tool to develop the finished product. Students completed pre- and postmovie open-ended questionnaires, and interviews were held with a sample of students regarding the five phases of developing the science concept movies as a whole. From the student commentary and perspective, two overt themes emerged that are relevant to preservice elementary science teacher education and preparation.

Table 5
Perceived Most Valuable Aspect of the Experience

Theme	Number of Responses	Percentage of Total Responses (*N* = 103)
Learning to use the software	49	47.6%
Expressing the Science	17	16.5%
Viewing movies with peers	11	10.7%
Creative Process	7	6.8%
Future Use with students	6	5.8%
Confidence	5	4.9%
Miscellaneous	8	7.7%

Table 6
Perceived Least Valuable Aspect of the Experience

Theme	Number of Responses	Percentage of Total Responses (*N* = 103)
No answer/left blank	56	54.4%
Technology issues	18	17.5%
Time commitment	16	15.5%
Timeline in course	5	4.9%
Expectancies	3	2.9%
Partner problems	2	1.9%
Didn't learn anything	2	1.9%
Explain more science	1	1%

Science Concept Movies as a Means to Think About Science. Addressing teacher candidates' alternate conceptions of science concepts is not new to the literature (Abell, George, & Martini, 2002; Stein, Larrabee, & Barman, 2008; Trundle, Atwood & Christopher, 2006). Although identifying and modifying such conceptions are not primary purposes of elementary science methods courses, they are clearly part of them, as science content is inherent to the courses. The student reflective statements about participating in this project described having the opportunity to think about the science concepts in a different and unusual manner as a result of progressing through the second and third phases of the project.

Caitlin, a quiet and reserved student who was cautious when discussing science content questions and concepts in class was emphatic in her response about how her understanding of the science concept changed throughout the development of her movie: "Now I can actually articulate what surface tension is! Before I knew, but probably couldn't explain it very well. Plus, I know now a few ways to show examples of surface tension!" Heather thought about the greater picture of the process and nature of science as she created her movie: "This experience showed me how science can be demonstrated in a creative way. Although research was done, the action of doing the science experiment, and the explaining let me learn the materials." In the follow-up interview, Heather elaborated on her response:

Heather:	I had to think through the science at a level where all the pieces fit together in my brain. During Phase 2, I realized that I really didn't know how electricity worked.
Interviewer:	What happened in Phase 2?
Heather:	After researching the transfer of electrons and how electricity flows, I realized that I had no idea what really happened. I thought positive charges turned lights on, and somehow negative charges cancelled them off to turn it off.

Heather was not alone in having a conceptual paradigm shift in terms of the science concept. Sandra, an enthusiastic learner commented on her postmovie review: "I understood the concept to some degree with the natural and simple understanding of buoyancy. But understood it way more after! I saw different examples and learned more about what actually keeps thing afloat or causes them to sink." Her choice of "natural and simple understanding" evoked a need for a follow-up conversation:

Interviewer:	On your post-movie sheet you wrote that you had a natural and simple understanding of buoyancy. What did you mean by that?
Sandra:	[Pause.] I meant that I had based my understanding on what I remembered from school.
Interviewer:	And what was that?
Sandra:	[Sheepishly.] That heavy objects sank, and light objects float. I really had not considered how ocean liners floated or how density was involved.

Not all the thinking about science related to modifying misconceptions. Some, like Tyler, made a connection to scientific literacy:

> I learned quite a bit about the science topic I had chosen. I had some background knowledge but have learned a lot more. Now when I watch the weather I actually know what the meteorologist is saying, and it makes sense.

Students, for the most part, spoke and wrote about how their understandings of the science concepts were modified in some way through the journey of making the movie. Although some students reported no change in their understandings, they were in the minority. This theme is valuable to acknowledge here, as it may provide a further rationale for other teacher educators to use in an effort to work with student conceptions and misconceptions of core science concepts in a creative and authentic way in their science methods courses.

Using the Technology in the Science Methods Classroom. The inclusion of technology in the science methods classroom is also not new to the literature (Bodzin, 2005; Hoban, 2007; Valinides & Angeli, 2006). Many teacher candidates in this study reported that learning to use the software had distinct advantages that included increasing their confidence in using the software and having to figure out how the software could support their ideas. We reminded students that the technology and software were merely tools that made expression of the science concept possible and that, within all the phases of developing the final project, learning was taking place.

Max, who initially shunned the idea of using iMovie because he was a PC user and feared switching platforms, commented on his postmovie questionnaire about the value of learning to use the iMovie software: "I did something I thought I could never do. So it was extremely valuable for me to realize that I could do such a complicated thing as making a movie." After coding student responses, the notion of this project affecting student confidence was a theme that overtly emerged from student responses:

> "It gave me more confidence in myself that I could do it – gave me a lot of hands-on experience." (Drake)
>
> "I feel very comfortable using iMovie now and would enjoy using it in the future." (Chapin)
>
> "[This project] was amazing. I really hope I have more opportunities to create more. It made me now comfortable to use iMovie, and also confident to learn how to use other technology." (Shael)
>
> "This was a great experience for hands-on learning. I have never done anything like this before so it was neat to learn something new and see a finished product. I can do this." (Josh)

With many students reflecting a perceived sense of confidence and comfort in using the technology themselves, some students connected this new efficacy to their personal use and their future classrooms:

> It was a great experience learning how to use iMovie because it is very important to use technology in the classroom, and now I know how to use it. There are so many ways it could be used in the classroom and now I know that I can use it. (Amy)
>
> We learned a lot. I had never actually made a whole movie before, but doing this process, I learned the entire process through the phases like editing and adding effects to the movie. The most valuable aspect of this experience was learning to make the video from start to finish in iMovie so that I can use it my future classroom. (Kate)

While connecting the newly found sense of achievement and ability using the software, Marcy went one step further than a hypothetical future classroom:

> It opened doors to what I can do with my students. Being able to use a creative way to express knowledge to students has great value. I didn't know how to make a movie until this, now I have made 3-4 movies for personal use!

Cheryl, a student who frequently looked for connections between theory and practice, wrote the following passage on her questionnaire: "This would be valuable to do with children in a classroom as another form of guided practice." In terms of overall perceptions of this activity, Rhonda and Harry, partners in a video titled *Water Cycle*, expressed their thoughts in the postcourse interview.

> I learned so much about how to make an iMovie production from start to finish. I am very proud of my partner and I. Using a brand new model of iMovie forced us

> to figure out everything by ourselves. I will definitely use this in my classroom. (Rhonda)
>
> I feel as though I will use this software in the near future in my classroom. What a great way to learn to do things. Working together, working with new technology, having fun! (Harry)

Frank and Sue, although they made independent films, shared the same sentiment about how this project encouraged them to think about science:

> “It made me think outside the box to find science in our world.” (Frank)
>
> “This experience enabled me to think about science in the real world.” (Sue)

As Tamara suggested, the journey of picking a topic and following through with the entire project was the valuable aspect: "Deciding what to make the movie about was challenging. Then, figuring out how to put it all together made the whole experience valuable for me.” With the overwhelming positive responses to participating in this project, we have continued to incorporate this project into our methods courses.

Conclusion

In light of the reported findings from four semesters, we are encouraged to continue implementing this innovation in future methods courses. The candidates found that the process gave them an opportunity to explore, assemble, and communicate a story of their concept in a creative and engaging way that was meaningful for them. Many of the candidates also realized how video editing could be a powerful tool for creativity and communication with their own future students in science with the potential, as Potter (2006) suggested, to “re-engineer the curriculum” in meaningful ways.

This article is intended to share the nature of the assigned Science Concept Movie project from beginning to end. In establishing multiple phases, we have attempted to promote creative thinking and expression through the movie-making process. The process of reconceptualizing and redeveloping this project has evolved over time.

We found, in some cases, that the integrity of the movie-making process was compromised, as some groups added copyrighted video into a substantial amount of their finished products, thus undermining the purpose of the project. This problem has been minimized with the development of the rubric in the appendix and a clear verbal discussion about plagiarism and using unauthorized video. Further, students noted that, although 6 weeks is theoretically plenty of time, a stronger presence in the video progress would help them avoid becoming complacent and procrastinating. From that set of comments, we introduced weekly reporting of the project in an attempt to keep students on task. Further, with some concern about availability of equipment required for this project, we arranged for preservice teachers to sign out the necessary video and computer equipment for use in their practicum classrooms.

Future research emanating from this project includes a longitudinal study of how these movies, or new ones created, were used in actual classrooms. This research will provide an opportunity for preservice teachers to reflect on the integration of this project within a greater lesson and unit plan and the pragmatic use of this movie making experience in real time.

As instructors in science teacher education and aspiring to meet our goals consistent with the recommendations by both the Duschl et al. (2007) and ISTE (2007), the project was worthwhile in terms of instructional time, teacher candidate perceived value, and the movie products supporting creative expressions of science conceptual understanding. For many candidates, the project was valuable because it was not an easy task.

The process of this project is seldom linear or straightforward. The content presented in the final showcased movie is edited, recaptured, further enhanced, and constructed and deconstructed several times from Phase 1 through Phase 5. Although sometimes difficult to see when the project is in motion, preservice teachers, as we do, saw great value in the multifaceted nature of this project and recommend that science teacher educators create or use similar projects in their science methods classrooms.

References

Abell, S., George, M., & Martini, M. (2002). The moon investigations: Instructional strategies for elementary science methods. *Journal of Science Teacher Education*, *13*, 85-100.

Alvermann, D. E. (Ed.). (2004). *Adolescents and literacies in a digital world*. New York, NY: Peter Lang.

Appleton, K. (2003). How do beginning primary school teachers cope with science? Toward an understanding of science teaching practice. *Research in Science Education 33*(1), 1-25.

Bleicher, R. E., & Lindgren, J. (2005). Success in learning science and preservice science teaching self-efficacy. *Journal of Science Teacher Education, 16*, 205-225.

Bodzin, A. M. (2005). Implementing web-based scientific inquiry in preservice science methods
courses. *Contemporary Issues in Technology and Teacher Education* [Online serial], *5*(1). Retrieved from http://www.citejournal.org/vol5/iss1/general/article1.cfm

Brooks, J. G., & Brooks, M. G. (1999). *In search of understanding: The case for constructivist classroom*. Alexandria, VA: Association for Supervision and Curriculum Development.

Carter, W., & Sottile, J. M. (2002). *Changing the "ecosystem" of preservice math and science methods classes to enhance students' social, cognitive, and emotional development*. Paper presented at the annual meeting of the Eastern Educational Research Association, Sarasota, FL.

Duschl, R.A., Schweingruber, H.A., & Shouse, A.W. (Eds.). (2007). *Taking science to school: Learning and teaching science in grades K-8*. Washington, DC: The National Academy Press.

Hoban, G.F. (2007). Using slowmation to engage preservice elementary teachers in understanding science content knowledge. *Contemporary Issues in Technology and*

Teacher Education, 7(2), Retrieved from http://www.citejournal.org/vol7/iss2/general/article2.cfm

International Society for Technology in Education. (2007). *National educational technology standards for students*. Retrieved from http://www.iste.org/NETS

Kelly, J. (2000). Rethinking the science methods course: A case for content, pedagogy, and informal science education. *International Journal of Science Education, 22,* 755-777.

Kress, G. (2003). *Literacy in the new media age.* London, England: Routledge.

Kress, G., & Van Leeuwen, T. (1996). *Reading images. The grammar of visual design*. London, England: Routledge.

Leu, D. J., Jr., Kinzer, C. K., Coiro, J. L., & Cammack, D. W. (2004). Toward a theory of new literacies emerging from the Internet and other information and communication technologies. In R. B. Ruddell & N. Unrau (Eds.), *Theoretical models and processes of reading* (5th ed., pp. 1570-1613). Retrieved from the International Reading Association website: http:// www.readingonline.org/newliteracies/lit_index.asp?HREF=leu/

McRobbie, C. J., & Tobin, K. (1995). Restraints to reform: The congruence of teacher and student actions in a chemistry classroom. *Journal of Research in Science Teaching, 32*, 373–385.

North Dakota Department of Public Instruction. (2009). *Science state standards*. Retrieved from http://www.dpi.state.nd.us/standard/content/science/index.shtm

O'Brien, D. (2001, June). "At-risk" adolescents: Redefining competence through the multiliteracies of intermediality, visual arts, and representation. *Reading Online*, *4*(11). Retrieved from http://www.readingonline.org/newliteracies/lit_index.asp?HREF=/newliteracies/obrien

Ohler, J. (2008). *Digital storytelling in the classroom: New media pathways to literacy, learning, and creativity*. Thousand Oaks, CA: Corwin Press.

Potter, J. (2006). Carnival visions: Digital creativity in teacher education. *Learning, Media and Technology, 31*(1), 51-66.

Roth, W. M. (1995). Knowing and interacting: A study of culture, practices, and resources in a grade 8 open-inquiry science classroom guided by a cognitive apprenticeship metaphor. *Cognition and Instruction*, *13*, 73-128.

Stein, M., Larrabee, T.G., & Barman, C.R. (2008). A study of common beliefs and misconceptions in physical science. *Journal of Elementary Science Education*, *20*(2), 1-11.

Treffinger, D. (1980). *Encouraging creative learning for gifted and talented.* Ventura, CA: Ventura County Schools, LTI Publications.

Trundle, K.C., Atwood, R.K., & Christopher, J.E. (2006). Preservice elementary teachers' knowledge of observable moon phases and pattern of change in phases. *Journal of Science Teacher Education*, *17*(2), 87-101.

Valanides, N., & Angeli, C. (2006). Preparing preservice elementary teachers to teach science through computer models. *Contemporary Issues in Technology and Teacher Education*, *6*(1). Retrieved from http://citejournal.org/vol6/iss1/science/article1.cfm

Yerrick, R. Ross, D., & Molebash, P. (2003). Promoting equity with digital video. Technology can demonstrate varying scientific strategies, which can be extremely successful in making science accessible to a diverse population of students. *Learning & Leading with Technology*, *31*(4), 16-20.

Yerrick, R., Ross, D., & Molebash, P. (2005). Too close for comfort: Real-time science teaching reflections via digital video editing. *Journal of Science Teacher Education*, *16*, 351-375.

Author Notes:

Student video examples are also available as follows:

Video 1: http://home.cc.umanitoba.ca/~hechter/U_of_M/Can_it_be_done.html

Video 2: http://home.cc.umanitoba.ca/~hechter/U_of_M/Tsunami.html

Video 3: http://home.cc.umanitoba.ca/~hechter/U_of_M/Oh_Gravity.html

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Appendix
Project Rubric for the Science Concept Movie
Dimension 1: Depth of Conceptual Understanding

Score	Criteria	Student Score
0	• Topic was not addressed	
1 – 3	• Major pieces of information missing • Facts/information wrong or misunderstood • Fragmented understanding	
4 – 6	• Basic information present (surface level) • Definition level of understanding	

	• No examples provided • Presented in haphazard manner • Some understanding/assumptions flawed	
7 – 9	• Topic information understood (Intellectual) • Important elements indentified • Examples provided • Information organized into a flowing pattern	
10 – 12	• Exemplary understanding (Dynamical) • Important elements identified • Examples provided • Information organized into a generalized content pattern • Interrelationships between key elements provided • Pieces and the whole are connected	

Dimension 2: Expression of Understanding

Score	Criteria	Student Score
0	The project was not completed	
1 – 3	The project was expressed poorly • Transitions were not timed properly • Font was too small to read • Text scrolled too quickly to read • Music was inappropriate, there was now connection of music and topic • Scenes did not flow into each other but were abrupt • The editors did not infuse any of their own video into their work, but rather streamed it from the internet	
4 – 6	The project was expressed well • Transitions were mostly timed well • The font was readable, but font type or color made it hard to read • Text scrolled too slow and thus made the project drag • The music was too loud or soft, but was connected to the topic	

	• Scenes sometimes did flow into the next • The editors did some original video capture and presentation	
7 – 9	The project was expressed excellently • Transitions were all timed well • The font was readable, without distraction of color or type • Text scrolled at a reasonable pace being consistent with movie flow • The music was well chosen and presented in terms of connection to concept and sound level • All scenes flowed in to the next ones smoothly • The editors included all original video capture and presentation	