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# Improving Preservice Teachers' Science Knowledge by Creating, Reviewing and Publishing Slowmations to TeacherTube

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**Abstract:** "Slowmation" (abbreviated from "Slow Motion Animation") is a simplified form of stop-motion animation that enables learners to create their own animations of science concepts. This paper presents a study of preservice elementary teachers in two science method classes (17 in 2007 and 12 in 2008) to research if they improved their science knowledge when they used a three phase framework to create, review and publish slowmations to a web site (TeacherTube). Qualitative data (three interviews, two concept maps and the animations) collected from each preservice teacher showed that nearly all increased their science content knowledge as a result of creating the animations. Uploading the slowmations to TeacherTube was challenging but enabled the preservice teachers to view other animations for reviewing. Creating slowmations is a new way for preservice teachers to learn science content which can be uploaded and shared on the internet.

## Introduction

Many elementary teachers lack confidence to teach science such that it is one of the least taught subjects in the elementary curriculum in Australia (except for Languages other than English) averaging 41 minutes or 2.7% of teaching time each week (Angus et al., 2004). One of the causes of this alarming trend is the inadequate science content knowledge of preservice elementary teachers. This problem, however, is not unique to Australia. Preservice elementary teachers' lack of science content knowledge has been reported in the USA (Davis, Petish, & Smithey, 2006), the United Kingdom (Goldsworthy, 1997), Canada (Opwood & Souque, 1985), Italy, (Borghi, Hendrich, & Vosniadou, 1991), and Israel (Trumper, 2001).

Using technology is one way to motivate preservice teachers to learn science content, especially when using a popular medium such as digital animation. Well funded National Science Foundation projects in the USA such as the Technology-Enhanced Learning in Science Center and the Concord Consortium have produced many computer animations to promote science education (Viadero, 2007). In Australia, The Learning Federation, which is an \$80 million initiative of the state, territory and federal governments of Australia and New Zealand, has produced many animations about science as learning objects that are freely available on a web site or CD. However, even though many expert-generated animations of science concepts exist (most are constructed using the computer program Macromedia Flash), research has shown that their value for enhancing student learning has been limited (ChanLin, 1998; Rieber & Hannafin, 1998; Weerawandhana, Ferry, & Brown, 2005).

Tvetsky, Morrison, and Betrancourt, (2002) recommended that the educational value of animations could be improved if they were slower and annotated with explanations to highlight the content to be learned. Moreover, some researchers argue that the educational impact of animations has also been limited because they are mostly made by experts for learners to use as consumers of technology, whereas animations would have more value if the learners themselves became the designers and creators of animations (Chan & Black, 2005). A new way for preservice teachers to learn science content is to encourage them to create their own animations to represent their

understandings. According to Bransford, Brown, and Cocking (2000) technology is a powerful tool for learning especially as “learners might develop a deeper understanding of phenomena in the physical and social worlds if they could build and manipulate models of these phenomena” (p. 215).

Empowering learners to make their own animations of science concepts is consistent with the theoretical framework of “constructionism” promoted by Seymour Papert (Papert, 1980, 1991). He contended that students engage in deep learning when they have to research, design and construct an artifact or model with technology to represent their knowledge. Constructionism draws on both the Piagetian notion of constructivism, whereby learning occurs when individuals construct models or artifacts to represent their own understandings of concepts, and Vygotskian social influences when the artifacts are shared with a wider audience. Hence, one way for learners to possibly understand a concept is to conduct their own research and then to create an animation that represents their knowledge because the “quickest way to learn about subject matter is to have to teach (design) it” (Jonassen, Myers, & McKillop, 1996, p. 96).

### Background to Slowmation

“Slowmation” (abbreviated from “Slow Motion Animation”) is a new form of stop-motion animation that greatly simplifies the usually complex process of making animations so that they can be created by learners (Hoban, 2005, 2007, 2008). Slowmation involves the manual manipulation of materials with a digital still photo taken at each change in position of the materials. The digital photos are then uploaded into a computer program that plays the photos in a sequence to create an illusion of movement and is seen by the human eye as moving by itself because of a phenomena called “persistence of vision”. This process involves students researching information, scripting, storyboarding, making models, photographing digital still images of small manual movements of the models and using a computer program such as Apple’s QuickTime Pro, SAM animation or Window’s Movie Maker to create the animation. Slowmation is a similar process to clay animation, however, it is different in six key ways as shown in Table 1. These differences mean that slowmation is a simpler and less time consuming process than clay animation.

Feature	Claymation	Slowmation
<i>Purpose</i>	To tell a narrative or story	To explain a science concept
<i>Content</i>	English	Science
<i>Orientation</i>	Models are made in 3-D to stand up vertically and are moved incrementally as they are photographed with a digital still camera mounted on a tripod looking across at the models.	Most models are made in 2-D flat on the floor or table and moved in the horizontal plane as they are photographed with a digital camera mounted on a tripod looking down at them (this is not always the case, however, as existing 3-D plastic models can be photographed in the usual way).
<i>Materials</i>	Models are made from clay or plasticine	Models are made from a wide variety of materials such as soft play dough, plasticine, 2-D pictures, drawings, clip art, existing 3D models, leaves, rocks, paper, fruit, felt, cardboard cut outs and many everyday classroom materials.
<i>Learning Prompts</i>	The art of telling the story explains the experience	Prompts are included to help explain a scientific concept such as narration, real life photos, diagrams, labels and static images.
<i>Frame Speed</i>	20-24 frames/second to simulate real movement	2 frames/second to explain a science concept in slow motion hence the name “Slow Motion Animation” which is abbreviated to “Slowmation.”

**Table 1:** Comparative Features of Slowmation and Claymation

Most slowmations are short 1-3 minute videos explaining a science concept. Because slowmations are played 10 times slower (2 frames/second) and are much easier to make than traditional clay animations (played at 20

frames/second), learners can represent their own understandings of science concepts in comprehensive ways. Over the last two years over 400 slowmations have been made by preservice elementary teachers demonstrating many science concepts such as day and night, seasons, lunar cycles, life cycles of various animals, particle motion, magnets, fungi life cycle, plant reproduction, weather, movement of the planets, water cycle, simple machines, mitosis, meiosis and phagocytosis. Features called learning prompts are added such as narration, labels, music and diagrams to help explain the science content.

A possible problem with learner-created animations, however, is that the learners may not fully understand or represent a science concept correctly. This is especially the case with elementary preservice teachers who may not have a good understanding of science in the first place. For this reason, a three phase framework was designed to encourage preservice teachers to create an animation about a science concept and upload them to a web site (TeacherTube) to enable them being displayed and reviewed. The purpose of this study, therefore, was to ascertain whether the three phase framework of creating, reviewing and publishing slowmations to a web site (TeacherTube) changed the preservice teachers' science content knowledge?

## **Methodology**

The preservice teachers were enrolled in a 13 week science method course in the first year of a four year Bachelor of Education degree at a university in Australia. This study involved two cohorts in a science method course with 24 students in each course. The forty eight students were invited to be in the research project and 17 elementary preservice teachers (15 females and two males) volunteered in 2007 and 9 preservice elementary teachers (6 females and 3 males) volunteered in 2008. One of the three assignments in the course involved the preservice teachers making a slowmation of a science topic that they had been allocated. The preservice teachers received a two hour workshop to explain how they could create a slowmation. The instructions and examples can be seen in the Teaching Resources at [www.slowmation.com.au](http://www.slowmation.com.au).

This study involved three phases of data collection to correspond to the three phases of the framework. Data gathering methods to monitor each student's science learning included three semi-structured interviews, sketching and reviewing concept maps completed during the interviews (White & Gunstone, 1992) and the animations themselves as knowledge artifacts. The three phases of the framework with further details on the methodology are now described.

### **The Three Phase Framework**

#### ***Phase 1: Creation***

At the first class of the course, the preservice teachers were each allocated different topics from the kindergarten to grade 6 Science curriculum of the state of New South Wales in Australia. On the same day they were allocated their topic, the preservice teachers were interviewed by a research assistant to ascertain their prior knowledge. The interview included the students drawing a concept map of the topic, identifying the words they knew about the topic and noting the relationships amongst them (White & Gunstone, 1992). The drawing of the concept map was in conjunction with semi-structured interview questions to ascertain what preservice teachers understood about the topic. Typical questions in the interview were "What are the main concepts in this science topic?", "Tell me what you know about the topic?", "What do these terms mean on the concept map?," "What is the relationship amongst these terms?", "How are you going to find information about the topic?" and "How confident are you with your scientific content knowledge in this topic?". The preservice teachers then had two weeks to create their slowmation which involved planning and researching the topic. Some students voluntarily created storyboards which allowed them to reflect upon their understandings of a science concept and break it down or analyse it into episodes or a sequence of steps that could be digitally photographed for making the animation.

#### ***Phase 2: Reviewing***

A special group site was created on the web site Teacher Tube so that the preservice teachers could upload their slowmations to be displayed to the whole group in order to facilitate the review process. The slowmations were first marked by the course instructor for assessment purposes. The purpose of this initial review was to provide feedback on the scientific accuracy of the content and the use of technology. To facilitate the process the slowmations were uploaded to a specific part of the web site that was only accessible by the members of the class and the instructors. A

rubric was provided to the preservice teachers that had been specially designed to facilitate this feedback from other preservice teachers and the instructor. Each slowmation video was also reviewed by two other preservice teachers in the class. After the review process the preservice teachers were interviewed a second time to ascertain if their science knowledge had changed as a result of creating their slowmation and receiving feedback from the three reviews.

**Phase 3: Publishing**

After the preservice teachers received their feedback from the review process, if necessary, the preservice teachers modified their animations and resubmitted them to the web site for sharing with the whole community of preservice teachers. The preservice teachers were interviewed a third time after they had uploaded their slowmation to “Teacher Tube” and received their review from other class members. The preservice teachers also examined their concept map sketched during the first interview and if necessary modified it to represent any changes in understanding about the concept.

Data were analysed according to the preservice teachers’ understandings of the topic that they were allocated at the beginning of the course and any subsequent change in understanding. Data were analysed from the interviews, concept maps as well as their slowmations collected as knowledge artifacts. Change in science knowledge was monitored according to the number of new concepts or insights about existing concepts for each topic explained in the interviews and/or added to their concept maps. A major increase in science knowledge was identified by the addition of 4 or more new concepts or by delving into one concept in depth. A minor increase in science knowledge was identified by the addition of 2 or 3 new concepts and little or no increase was the addition of one new concept or no change. No increase in science knowledge was identified by having no changes in understanding or the addition of new concepts for each topic.

**Results**

The research question focused on any change in the preservice teachers’ science content knowledge as a result of them using the three phase framework of creating, reviewing and publishing their slowmations to a web site (Teacher Tube). Summative data from the two cohorts will be presented followed by a case study from one of the preservice teachers to demonstrate the learning process more clearly.

**Change in Preservice Teachers’ Science Content Knowledge**

Table 2 shows that in the first cohort in 2007, nearly all of the students (16/17) who were part of the study experienced an increase in scientific knowledge with 9/17 experiencing a major increase in science knowledge and 7 experiencing a minor increase. There was also an increase in science knowledge in all of the students in cohort 2 (12/12) in 2008 with 10 experiencing a major increase and 2 experiencing a minor increase.

	Major Increase in Science Knowledge	Minor Increase in Science Knowledge	Little or no increase in Science Knowledge
Cohort 1 (2007)	9	7	1
Cohort 2 (2008)	10	2	-

**Table 2:** Change in Preservice Teachers’ Science Content Knowledge

Most students increased their science knowledge during the creation phase when the students made their own slowmation, but there was also an increase in some students’ knowledge after the review phase. The same pattern occurred in the second cohort. Although it cannot be claimed that the increase in knowledge was only due to the slowmation process, interview data collected from all the students pointed to the fact that it was the three phase framework that influenced their change in science knowledge especially when they researched a topic to create the animation.

Interview data revealed that many of the participants found creating a slowmation to be a different way to learn science as they had to research their topic first in order to represent their understandings in the animation:

*Making the slowmotion extended my scientific knowledge. It made me realise that science isn't just about chemists with white coats and... Yeah, it can actually go in so many different directions and cover so many different topics, which I think is important for students trying to understand the concepts at an early age.*

Student A, Cohort 1, Final Interview

*I definitely got a lot out of it. . I ended having to do a fair bit of research. . . . I found out a lot about density and displacement of water and sort of more key things.*

Student B, Cohort 1, Final Interview

*Actually I did learn, I didn't even know what a cog was. . . . I learned about how when you changed from first gear it changes the size of the gear and you know that makes pedalling easier.*

Student C, Cohort 2, Final Interview

*Even if you're not actually putting the new knowledge into the slowmotion, you still have to know it to start with... to understand the topic first and then you can work out what parts of the topic are best suited to being presented in the slowmotion.*

Student T, Cohort 2, Final interview

*It means you have to learn it to be able to present it. It means you've done the work, you have got all the background knowledge and everything and you've gained the knowledge to do it.*

Student R, Cohort 2, Final interview

The following case study shows in more detail how one student in the second cohort developed his science knowledge using the three phase framework.

#### ***Case Study from Ross in Cohort 2***

Ross was a male in his early 20s and was allocated the topic of "Strange Plants" at the beginning of the course. He had taken biology and chemistry through in his final year of high school (grade 12) and had a positive attitude toward science. He was confident in his scientific knowledge and his technological expertise. His initial idea was from an example given by the instructor, "the first thing that sprang to mind was the only example that the instructor gave, was a thing like a Venus Flytrap" and he carried on to explain that he was unsure about what plants would fall into this category. He knew about the functions of the stems, roots and leaves and, "now I need to look at these plants and what makes them strange or unique or exotic compared to other ones."

Ross had limited background knowledge about a strange plant such as the Venous Flytrap. When asked about why the plants would be considered strange in the first place, he replied:

*That's a very good question. Maybe they're better suited for particular environments or something. I mean, around here, you don't see too many strange plants in everybody's gardens, but perhaps in other places, yes, other habitats or whatever they're better suited for or where normal plants are such – the plants are well-suited for or something. . . . It's the fact that it captures its own food, I guess.*

As part of the first interview he was asked to construct a concept map to represent his knowledge of a Strange Plant such as the Venous Flytrap (Fig. 1). When constructing his concept map, he had 4 sub concepts that he believed related to the topic as shown in Figure 1.

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

**Figure 1:** Ross’s Initial Concept Map Represent his Knowledge about a Venous Flytrap

The slowmation that Ross made about Venous Flytraps goes for 2.5 minutes and he made his model plant by taping together two plastic spoons to look like the head of the plant and coloured it in an appropriate way. He was able to prop up the model in his garden so that he could take digital still photos of the model being moved by hand. Figure 2 show a selection of three frames from Ross’s slowmation to show movement in the head of the Venus Flytrap.

		
<p>The Venus Flytrap was made out of two plastic spoons taped together</p>	<p>The trigger hairs on the surface are stimulated by a bug moving</p>	<p>The venous fly trap closes on the bug</p>

**Figure 2:** Sequence of Frames in the Venus Flytrap Slowmation

In the second interview, Ross was asked about his increase in knowledge as a result of creating the slowmation and he replied, “I learned heaps and heaps about the Flytrap because I knew what they did but didn’t know anything about how they did it. I learned a bit of history about how they got their name and that type of thing. At the start I got a broad general knowledge of all the different plants and then I learned specifics about the Venus Flytrap.”

During the second interview Ross viewed his original concept map and was able to add five new concepts as shown in Figure 3 as a result of creating the slowmation which was a major increase in science knowledge.

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

**Figure 3: Ross's Revised Concept Map during Interview Two**

Interview three was carried out after the students had reviewed two other students' videos, one about how a nuclear power plant operates and one on recycling aluminium. It also gave him an opportunity to reflect and review the science content in the other two slowmations because he checked the content by looking at other web sites that explained science concepts. Using the review process was also beneficial for Ross' increase in content knowledge:

I did actually [increase my content knowledge]... especially the power plant one. I didn't know anything about that so I did a Google search and looked up a few things. With the aluminium one as well I looked up a couple of things like how it was produced because I wasn't sure. Because I had a bit of a vague understanding of it and I just wanted to clarify things to work out if she was right or not.

He mentioned how he needed to cross check several web sites to ensure the accuracy of information as a reviewer.

## **Discussion and Conclusion**

This study showed that getting preservice elementary teachers to create, review and publish slowmations of science concepts increased the science content knowledge of 16/17 of the volunteer preservice teachers in the first cohort and 12/12 in the second cohort. Only one of the students in the first cohort experienced no increase in science knowledge as a result of participating in the three phases of the framework. These data supports the theoretical framework of constructionism (Papert, 1991) that proposes that people learn content when they design and create artifacts to represent their knowledge. Since all 48 preservice teachers in the courses were able to create a Slowmation, it provides a new form of assignment for them to use technology and engage with science content. Moreover, uploading the slowmations to TeacherTube enabled the animations to be shared for the purposes of being reviewed and displayed for others to see. TeacherTube, therefore provides a vehicle for preservice teachers all over the world to share the content of their assignments.

A limitation of this study was that the three interviews and concept maps collected are only “snapshots” of what the students had learned at a particular time. Although, this study did show that there was an increase in science knowledge in nearly all of the preservice teachers, it did not show the specific details of the knowledge-building process for each student. Further research is currently being planned involving more regular monitoring of the students’ knowledge-building process to ascertain which parts of the slowmation process enhances students’ knowledge construction. Moreover, this new study will involve tracking the preservice teachers after they graduate as beginning teachers to ascertain if they use slowmation when they are teaching science in schools. This will not only ascertain if preservice teachers download slowmations from TeacherTube to use in class, but more importantly if they encourage their own school students to learn science by constructing their own slowmations.

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