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Teaching Science Concepts in Higher Education Classes with Slow Motion Animation (Slowmation)

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Abstract: Clay animation is a form of stop motion animation but is rarely used as a teaching approach in higher education classes because it is too tedious and time consuming. "Slow Motion Animation" (Slowmation) is a simplified form of clay animation that is different in four ways and can be completed in 1-2 hour tutorial or workshop: (i) models of science concepts are made and manipulated in the horizontal plane; (ii) a range of materials can be used; (iii) the animations are played at 2-6 frames per second; and (iv) science concepts are annotated with factual text. This study demonstrates how 30 teacher education students used Slowmation to make a QuickTime animation of the life cycle of a frog in a two-hour tutorial. Slowmation is a teaching approach that is feasible for use in university classes and is a motivation for students to engage in the content knowledge of science.

Introduction

Animation is the optical illusion created by moving images of objects at high speed, usually 24 frames per second, so that the viewer gets an impression that the object is moving or alive. However, research on the use of animations for teaching educational concepts has shown that their value for student learning has been limited (ChanLin, 1998; Rieber & Hannafin, 1998; Weerawandhana, Ferry, & Brown, 2005). According to Tvertsky, Morrison, and Betrancourt (2002), who conducted a comprehensive review of literature on animation, its use as a teaching approach to promote student learning has been varied because animations are often too complex or too fast for learners to comprehend the content. They concluded that the value of animation for learning could be improved if the animations were slower and annotated with information to highlight the key educational features to be learned:

> Animations must be slow and clear enough for observers to perceive movements, changes, and their timing, and to understand the changes in relations between the parts and the sequence of events. This means that animations should lean toward the schematic and away from the realistic….It also may mean annotation, using arrows or highlighting or other devices to direct attention to the critical changes and relations. (p. 260)

Some researchers (Chan & Black, 2005) argue that the impact of animations for learning has also been limited because they are mostly made by experts for learners to use as consumers whereas animations would have more value if learners were actively as designers.

One form of animation that actively involves users in the construction process is clay animation (claymation) which was pioneered by Will Vinton in 1984 when he made a television commercial showing a conga line of raisins dancing whilst wearing sneakers (Hamilton, 1986). Although this form of animation has been used commercially in the children's television show "Gumby", and in the movies "Chicken Run" and "Wallace and Gromit", it is a very tedious process requiring each scene to be photographed after being moved and modified manually. Consequently, claymation has rarely been used as a teaching approach in higher education classes and when it has been used, it has been to promote stories or narratives rather than used to promote educational concepts.

An extensive review of literature has confirmed the lack of claymation as a teaching approach in higher education classes. A review of 10 international databases using the terms *claymation, clay animation, stop motion animation* and *stop frame animation* has produced a paucity of research publications. Of the 423 articles found, 418 were "professional articles" describing the procedures for making claymation, explaining the use of new technologies or were advertisements in magazines. Only one article argued for the value of claymation to encourage visual literacy of higher education students in teacher education (Witherspoon, Foster, Boddy, & Reynolds, 2004), and two articles argued for the use of clay animation to promote school students' literacy skills (Gladhart, 2002) and collaboration (Gamble, McLaughlin, Helmick, & Berkopes, 1995). When claymation been used in a school setting, there were difficulties in storing the clay models over extended periods of time, there was a need for adult assistance and the production process was very time consuming needing up to two school terms to complete with students worked on them at different times (Murray, Neville, & Webb, 2005; Murtagh, 2004).

Theoretically, claymation has the potential to be a valuable teaching approach in higher education classes as students are engaged in planning, designing, making models and using technology to animate them (Bransford, Brown, & Cocking, 2000). In some ways, the learning processes involved in claymation are similar to those in the making and animating of LEGO models which is underpinned by a theory of learning called "constructionism." This theory was developed by Seymour Papert in the 1980s and 1990s and is derived from the work of Piaget and Vygotsky. He argued for the educative value of students using technology to make and animate models:

> Constructionism is the idea that knowledge is something you build in your head. Constructionism reminds us that the best way to do that is to build something tangible — outside of your head — that is personally meaningful . . . if you can use technology to make things you can make a lot more interesting things. And you can learn a lot more by making them. (Papert, 1991, p. 64)

Importantly, constructionism is an active learning process as students build their own knowledge by designing and making artifacts which is similar to animation construction especially if they are shared with others to give them a real purpose and audience (Kafai, 1996).

It appears, therefore, that claymation has potential as a teaching approach in higher education, however, in its conventional form, is too tedious and too time consuming for common use. The purpose of this paper is to describe a new teaching approach that is an adaptation of claymation and is simple enough to enable the design and construction of animations in a 1-2 hour tutorial. Importantly, this form of animation encompasses recommendations from the literature that suggest that animations would be more useful for learning if they involved users in the construction process, used annotations to explain the educational concepts and were played slowly to enhance understanding (Chan & Black, 2005; Tvertsky, Morrison, & Betrancourt, 2002). This paper, however, does not substantiate the value of the teaching approach for student learning, but instead explores the feasible of this pedagogical approach for teaching science concepts in higher education classes.

Development of Slow Motion Animation (Slowmation)

From an educational perspective, claymation is a 'translation' task that enables users to represent their ideas in different ways by using clay models that can be moved and photographed (Mitchell, 2005). The process of claymation involves a multitude of connected learning processes such researching information, planning, storyboarding, designing models, taking digital photographs, using visual literacies, using technology, evaluating and most importantly, working collaboratively as a team. "Slow Motion Animation" (abbreviated to "Slowmation") is a simplified version of claymation that has been developed in over two years in science education courses at the University of Wollongong, Australia, and uses many of the same learning processes (Hoban, 2005). "Slowmation", however, is different from traditional claymation in four ways:

1. Orientation: Models are made and manipulated in the horizontal plane (on the floor or on a table) with photos taken with a digital camera mounted on a tripod looking vertically down at the models which makes the models easy to make, manually move and photograph.
2. Materials: Many materials can be used such as soft crayola dough, pictures, drawings, written text, and existing models (such as models of atoms or molecules) or toys.
3. Content: Whereas the content of claymation is usually a narrative or story, the content of a slowmation is a scientific concept that is annotated with factual text to explain or highlight features of the concept.
4. Timing: The QuickTime movies produced are played in slow motion at 2-6 frames/second (not 24 frames/second as in normal clay or computer animation) and includes static images of written text to enhance educational understanding and hence the name "Slow Motion Animation" or "Slowmation" for short.

The next section explains how 30 higher education students in a teacher education degree used the animation process in a 1-2 hour tutorial and some students voluntarily adapted the teaching approach for use in their own teaching in elementary classes.

Method

EDUS102 is a one semester subject in the Bachelor of Teaching (Primary) degree at the University of Wollongong, Australia focusing on how to teach Science in elementary schools. The subject has a one-hour lecture followed by a two-hour tutorial for the students in which they conduct hands-on activities. In 2005, 30 preservice teacher education students learned to use "Slowmation" in a two-hour tutorial. The program used to animate a science concept was QuickTime Pro which is readily available and involves putting a code into a computer's regular QuickTime program. The students participated in the tutorial to make the animation of the life cycle of a frog as described in the next section. In addition to the students designing and making the animation, two of them voluntarily used the teaching approach in the following week in their own teaching in school classes. Mayer (2003) identified the transfer of a concept or process as an indicator of learning as so it was decided to interview these two students to ascertain how they adapted or used the teaching approach.

Results

This section explains the steps involved in using the teaching approach in the two-hour tutorial as well as demonstrating the interview data from the two students who used it in their own teaching in elementary classes.

Steps in Making the Animation

Step 1. Plan and Jigsaw

The class decided on a topic involving change which was to animate the life cycle of a frog. Students were divided into four groups with each group addressing one of the four stages or episodes of a frog's life cycle: (i) adult frog lays eggs; (ii) eggs hatch into baby tadpoles; (iii) tadpoles grow legs as amphibians and; (iv) adult frogs develop. Students were able to access the internet in class to gather specific content knowledge about their particular episode.

Step 2. Storyboarding and Annotating

Once the four episodes were established, students storyboarded the movements of the models and annotated them with key scientific explanations. This was an opportunity for using group work in the class and specific roles were allocated such as model maker, content specialist (to annotate with factual text), storyboarder (to work out the movements) and background designer. Decisions were made about the backdrop as to whether the animation was going to be constructed on a blank cardboard sheet or a background such as a poster.

Step 3. Manipulating and Photographing

The students made the models and moved them in 20-40 small steps for each of the four episodes. A digital camera was mounted on a tripod and positioned over a sheet of cardboard so that pictures were taken vertically looking down at the cardboard. The students manipulated the small movements in the model manually and a photograph was taken at each step. Importantly, factual text was inserted at the appropriate time to explain the science occurring.

Step 4. Download and Import

Digital photographs were downloaded onto the desktop of a computer. QuickTime Pro was used to import the photographs to create a QuickTime animation movie because it was simple to use and the playback speed was selected at 2 frames per second.

Step 5. Making Static Images of Factual Text, Adding Narration and Music

Once the Quicktime animation movie was made, images of the factual text needed to stay longer on the screen than other photographs so the text can be read by a viewer or for a narration. This was an important step as it highlights the content knowledge of the science. A simple way to do this was to run the QuickTime movie to the appropriate photo that has the text displayed and then select "Copy" from the Edit menu and "Paste" about 10-15 times as required. This suspended the factual text on the screen so that it could be read or narrated. The final step was to adding narration. A separate QuickTime audio track was made and then selected and added to the animation.

Step 6. Show

Initially the slowmation was shown at the nominated speed of 2 frames/second to show the overall change process of the life cycle of a frog in slow motion. It was then remade and slowed down even more and shown at 5 seconds per frame to enable each group to explain the details of their episode to the rest of the class which completed the jigsaw.

Interviews with Two Students

Christine: Using "Slowmation" to Teach Stages of the Space Shuttle

Christine enjoyed using the approach so much in her teacher education class at university that she decided to use it herself when taught a grade 5 class in an elementary school the following week. She decided to use the animation process to teach the children in two lessons about the stages of a rocket taking off carrying the space shuttle. In the first lesson she taught the class about stages of the rocket launch and got the class to design five stages of the space shuttle and explained the science involved. In the second lesson the class made an animation of the space shuttle taking off, orbiting the earth and then landing back on earth again. She explained that it was relatively simple to do:

I So how easy or difficult was it for you to do?

C It was surprising easy. Before I taught it I thought it would be a difficult thing to implement but having planned it in two lessons, it was quite easy. The first lesson was basically getting them to understand the concept themselves and the second lesson involved them actually making the animation. I actually found it quite easy, especially when the children were so engaged with the whole idea of it so there were no real classroom management issues.

I Can you tell me a little bit more about the two lessons, like what you actually did?

C In the first lesson we discussed what animation was and what claymation was and I demonstrated the difference between claymation and slowmation to understand what they'd be doing and my expectations of them. And then I showed them examples of what they'd be doing. Then I drew a diagram of an oveview of the process on the blackboard and explained it as I went bit by bit into five episodes. And each time I explained one part, I showed that's the first part, and that's the second part and that's the third part. And then we went through it again with the children and I gave them groups and different roles in each. We first separated them into groups and then they all had their own group roles and then each group knowing where they were, which group they were, we then went through the whole process again so they knew where they were going, like what part they were doing of the whole process. And then we talked about what happens in that stage and what we need to make for what they'd be doing in the next stage. And from then we got onto storyboarding and each group storyboarded together what their stage should be doing for the next lesson.

I Can you tell me how the second lesson went?

C Yes that went really well. Actually it went over time a lot, it went into lunchtime but they loved it so they stayed in for about 20 minutes doing it. So you do need more than an hour for what we actually did. Something that I didn't do that I should of was actually model actually what they'd be doing, I just explained it, I didn't actually model it so I should have done that but I didn't. But what I did was have the crayola dough out the front and everyone knew what they were in charge of and they all had their storyboards in front of them and everyone just came and got the dough and brought it back and knew where they had to be. And I told them all that we'd shoot it in sequence so the first group had to do it first and so on. The fifth group was still going by the time I got to them because I just kept perfecting it and running through it and they were practising what they were going to be doing.

Russell: Using "Slowmation" to Teach Simple Machines

The second student, Russell used the approach to teach about machines to a grade 6 class over a three periods. In the following interview excerpts, he described the relative ease of using this teaching approach:

R I think it was relatively easy to do but it would depend on your class. I had a very good class. At the same time logistically there were a couple of issues, primarily because you need to focus on one thing at a time so they might only be working in one group because we were divided into six groups. That meant the other members of the class could easily get off task. Now for this activity my supervising teacher was in the classroom all the time. She was not actually keeping them on task but while I was focused on one she was dealing with the other groups because minor surface level questions were just keeping them involved. But without that input it would be quite easy to lose a bit of that focus and I think it would take longer in that instance. It is worth mentioning by the way that the students took all the photos.

I Well that's the next thing. Can you tell me how you organised this?

R We started, we did it all in half an hour we did it between lunch and recess on the Monday and the Tuesday of Week 4. But on the Friday the preceding week, that's when we planned it and I put this to them and discussed it all and we went through all the different options, what we could do for stories and why we would do it a certain way, so we had all that in background.

I So it took you three lessons more or less?

R Well the first, the middle two were about an hour, Monday and Tuesday were about an hour and a half each. That's about three and a half hours in total. But I think that was good to get it done in that time.

Conclusion

Claymation has potential to be used as a teaching approach in higher education classes because learners are involved in designing, making, manipulating and animating models. However, it its conventional form, claymation is too tedious and time consuming to be used in regular university classes. "Slowmation" is a simplified form of claymation that is much easier to perform because the models do not have to stand up because they are made and manipulated horizontally on the floor or on a table. In addition "Slowmation" involves annotating the science concept involved with factual explanations and playing the QuickTime movie in slow motion to enhance educational understanding.

Although this study did not ascertain the value of the animation for student learning, it did, however, show that a science concept such as life cycle of a frog can be made into an animation movie within a two-hour university tutorial and that the teaching approach is also adaptable for school contexts. One common feature of the teaching approach is that it is highly engaging as both the university students and school children were motivated to make an animation of a particular science concept. Since this animation was made, many others have been produced on science concepts such as planets, life cycles of different animals, seed germination, day and night, mountain building, volcanoes, magnetism, phases of the moon, mitosis, meiosis, fertilization, fuel and the digestive system. Clearly, further research is needed to develop this teaching approach and to ascertain its value for student learning.

With the rapid advances in computer technologies, animations are becoming more and more complex in the pursuit of making educational concepts appear "real" and "life like" to users. But perhaps this endeavour is counter productive if animations are beyond the capacity of teachers and learners for everyday classroom use. Perhaps it is time to respond to the requests by researchers (Chan & Black, 2005; Tvertsky et al., 2002) to simplify the use of animations so that students can be involved in the designing and making process so that they are a tool for knowledge construction. This study showed that "Slowmation" is a simple form of animation that is suitable for teaching science concepts in university and school classes and is highly engaging as a motivation for students to learn the subject matter of science.

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