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The 5 Rs: A New Teaching Approach to Encourage Student-generated Animations (Slowmations) of Science Concepts

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Abstract. “Slowmation” (abbreviated from “Slow Animation”) is a simplified way of making an animation so that students can create one as a new way of learning about a science concept. The teaching approach guiding slowmation encourages students to create a sequence of five multimodal representations (the 5 Rs) by making: (i) written notes being background knowledge from researching a topic or from direct instruction; (ii) a storyboard to design the animation; (iii) 2D or 3D models; (iv) images from digital still photographs of the models; and (v) the final animation. The 5 Rs helps students to develop understanding of a science concept by creating an animation to explain the concept.

Introduction

The world-wide explosion in personal digital technologies offers increasing opportunities for students in primary or secondary schools to create their own digital media. Twenty years ago, getting students to make a mini-movie about a science concept was unheard of because of the expense of acquiring a movie camera and a video player. Also, digital still cameras for personal use were science fiction. But times have changed. Nearly all students now have access to digital cameras (still or movie cameras), iPods™ for playing and recording sound tracks, and computers preloaded with free movie making software. It is therefore not surprising that the most popular web sites in the world, Facebook, Wikipedia, MySpace and YouTube, are all based on user-generated content because of this widespread accessibility to personal media making technology.

This exponential growth in personal digital technologies coincides with a growing body of research which suggests that getting students to create a multimodal representation of a science concept is a good way to enhance learning (Ainsworth, 1999; Prain & Waldrip, 2006; Tyler & Prain, In Press; Waldrip, Prain, & Carolan, 2006). A representation is a sign that stands for something else and can be expressed using different modes — by text, photographs, sketches, voice, numbers, graphs or models. It is through developing a sign and thinking about its meaning that learners develop a better

understanding of what it is meant to be representing. Importantly, research has shown that constructing a representation helps students to make meaning of a science concept and this is often preferential to students copying an expert-generated representation from a text book, which is a common practice in classrooms (Hubber, Tytler, & Haslam, 2010; Waldrip, Prain, & Carolyn, 2010).

Student-generated Animations

With the surge in personal media-making technologies, it is now possible for students to make a mini-movie as a new way of learning about a science concept. But even with access to the technology, making a movie to explain a science concept could be difficult for students to create, because inanimate science objects do not move by themselves unless they are motorised. On the other hand, making a mini-movie using a stop-motion animation technique is feasible because it is the creator who manually moves the objects whilst taking the digital still photos. Furthermore, having students take digital still photos one by one instead of a continuous 30 frames/second in a video allows them to manipulate, think about, discuss and reconfigure the models as each still photo is taken.

Clay animation (abbreviated to claymation) is the most common example of a stop-motion animation, but its use in school classrooms is rare. This is because it is very tedious and time consuming to make clay models and show their movement at 20-25 frames/second, which is the normal speed for animation. However, there have been several school-based action research studies in Australia using claymation to promote students' literacy skills. One project, *Clay Animation in the Primary Classroom*, was conducted at Hawthorndene Primary School and investigated the use of clay animation as a teaching and learning approach to enhance outcomes for disengaged and underachieving students (Murtagh, 2004). Titles of the fictional QuickTime movies produced include a "Zoo Trip," "Snakes", "Hamburger" and "Elephant Sandwich." The study concluded that, "clay animation as a teaching and learning tool is an exciting, time-consuming, challenging, motivational process and above all, a lot of fun. It can impact in a positive way on learning, group skills and teamwork, self-esteem, confidence and leadership skills." Another claymation project, *Student Centred Curriculum – Multiliteracies and Disengaged Learners*, was conducted at Tintinara Area School to assist year 4-6 boys to improve their literacy skills (Murray, Neville, & Webb, 2005). The

boys created a sequence of representations by writing stories with a selected theme, designing them with a storyboard, constructing clay figures and backdrop scenes, using digital photography and then completed written evaluations. In the study, the targeted group of boys became aware of the importance of planning and structuring their narratives, which suggested the need for more explicit teaching of narrative structure so that children could enhance their stories.

In both claymation projects described, however, there were difficulties in storing the clay models over extended periods of time because they dry out and there was an ongoing need for adult assistance. Furthermore, the production process was very time consuming needing up to two school terms to complete since students worked on them once a week in special literacy lessons. Moreover, both projects were using claymation to promote students' literacies and were not about representing science concepts. It appears, therefore, that there has been very little use of stop-motion animation as a teaching approach in school classes to promote student learning. Perhaps claymation in its conventional form is generally too hard or too time-consuming for teachers of science to organise or the content has not been readily applicable to animation techniques.

Slowmation: A simplified way to make an animation

“Slowmation” (abbreviated from “Slow Animation”) is a simplified way of making a stop-motion animation enabling primary or secondary students to create them as a new way of learning about a science concept (Hoban, 2005, 2007, 2009). Students can use their own digital still camera and free movie making software on their own computers to design a stop-motion animation. Creating a slowmation involves integrating features of clay animation, object animation and digital storytelling. Like clay animation (Witherspoon, Foster, Boddy, & Reynolds, 2004), slowmation uses a stop-motion technique involving the manipulation of models made out of plasticine or soft play dough as digital still photos are taken of each manual movement. Like object animation, a range of materials can be used such as plastic models, wooden, paper or cardboard cut-out models commonly found in primary classrooms to animate (Laybourne, 1998). Similar to digital storytelling (Lambert, 2002), a key part of creating a slowmation is that a narration and real-life photos can be added by the students to explain the science concept as the models are animated. In sum, a slowmation displays the following features:

- *purpose* — the goal of a slowmation is for students to learn about a science concept by making an animation to explain it. Its design can include a range of technological enhancements such as narration, music, real life photos, diagrams, models, labels, questions, static images, repetitions and characters.
- *timing* — slowmations are usually played slowly at 2 frames/second, not the usual animation speed of 20-24 frames/second, hence needing ten times fewer photos than in clay or computer animation, hence the name “Slow Animation” or “Slowmation”;
- *materials* — because models do not have to stand up, many different materials can be used such as soft play dough, plasticine, 2D pictures, drawings, written text, existing 3D models, felt, cardboard cut outs and natural materials such as leaves, rocks or fruit;
- *orientation* — models are made in 3D and/or 2D and usually manipulated in the horizontal plane (on the floor or on a table) and photographed by a digital still camera mounted on a tripod looking down or across at the models, which makes them easier to make, move and photograph; and
- *technology* — students use their own digital still cameras (set on low resolution) and free movie making software available on their computers (eg iMovie or SAM Animation on a Mac or Windows Movie Maker on a PC).

In sum, slowmation greatly simplifies the process of making stop-motion animations by manipulating 2D or 3D models often lying down on a flat surface, using accessible technology and requiring a tenth as many photos as a normal animation because they are played ten times slower at 2 frames per second.

The Teaching Approach

The process of learning involves students developing some knowledge about a science concept, breaking it down into parts or “chunks”, representing each part and then putting it back together again into a coherent whole with the animation. Research has shown that learners not only engage with content when creating a slowmation, but it helps them to develop an understanding of the content because they reflect upon it in multiple ways (Hoban, 2007; Hoban, McDonald, & Ferry, 2009). Moreover, each representation makes students think about the content in different ways, which contributes to building

understanding. As each representation raises particular questions about the concept, students are regularly “checking” the accuracy of what they are trying to represent, called the referent (Pierce, 1931) by looking on the internet, using books or discussing information with their peers or the teacher. Creating an animation involves students creating a sequence of five multimodal representations that are interrelated which is now explained in more detail:

Representation 1: Background Notes

Students need enough background knowledge before designing an animation to explain a concept. This may mean that students conduct research in order to be aware of information to identify a sequence that will involve change to be explained in the animation. Alternatively, a teacher may specifically teach students the basics of a particular concept. The representations that students usually make in summarizing this information can be in the form of notes, diagrams or graphs that collate this information.

Representation 2: Storyboard

Students design the animation using a storyboard whereby the concept is broken down into several “chunks” or “scenes” and place these in coherent sequence which involves the modalities of sketching diagrams and sometimes writing a narration. Each “chunk” then needs to be sequenced to bring the anticipated actions or explanations into a coherent story. We recommend that the students also script their narration to accompany each chunk as the modal representation of text informs the sketches and vice versa.

Representation 3: Models

As guided by the storyboard, the students make 2D or 3D models to represent the chunks or parts of the concept being represented. Existing models that are readily available in a classroom can be used or new models can be made with play dough, plasticine, and so on. This representation involves the students thinking about the chunks of the concept in concrete ways and the best way to represent the concepts is in a sequence which are brought to life through model construction. Further to this, making models also raises questions as to what the actual feature of the referent being represented looks like and often involves checking with the internet about particular features. This form of

representation often appeals to those students who are “hands-on learners” and engage in learning by making concrete materials.

Representation 4: Digital Photographs

Creating the fourth representation involved students taking digital images of the models as they are moved to simulate movement in the actual concept or referent. This representation raises questions about how the actual model moves in real life and how this can be best simulated. The usual set up or workstation involves having a digital still camera mounted on a tripod looking vertically down at the models or across at existing plastic models. This can be done at one workstation out the front of a classroom or using several workstations. If tripods are limited, digital still cameras can be taped to two rulers that are secured to a desk with tape looking down at the models on a floor. Key to the digital imaging in a slowmation is making small manual movements of the models to match the desired effect of representing movement or change according to the sequence in the storyboard.

Representation 5: The Animation

Students synthesise the previous steps in the creation of the animation as they download the photos to a computer, upload them into the software, edit them and add the narration. Finally, because the animation is easily shared by showing it on a computer or uploading to the internet, it is usually discussed by peers and the teacher or reviewed by a content expert to provide the students with feedback on the scientific accuracy and presentation of the animation.

It should be noted that the five representations previously explained are interrelated because one feeds into the next and incorporate a combination of different modalities such as text, models, photos, verbal, sketches. This combination of modes distinguishes slowmation from other one-off representational forms such as a table, a diagram or a sketch. It should also be noted that learning can be enhanced through social interaction if the animation is designed and created in a group. Constructing the final animation involves putting the concept back together into a coherent whole. It is at this stage of learning through slowmation that the creator has the opportunity to review the different levels of representation designed and portrayed. A diagram, showing the sequence of the

five interconnected representations and how meaning is created by the students thinking about the content through making a representation is shown in Figure 1. This diagram is an adaptation of Pierce’s (Pierce, 1931) semiotic triangle showing the interrelationship between three aspects — the referent (what is being represented), the representation and meaning making.

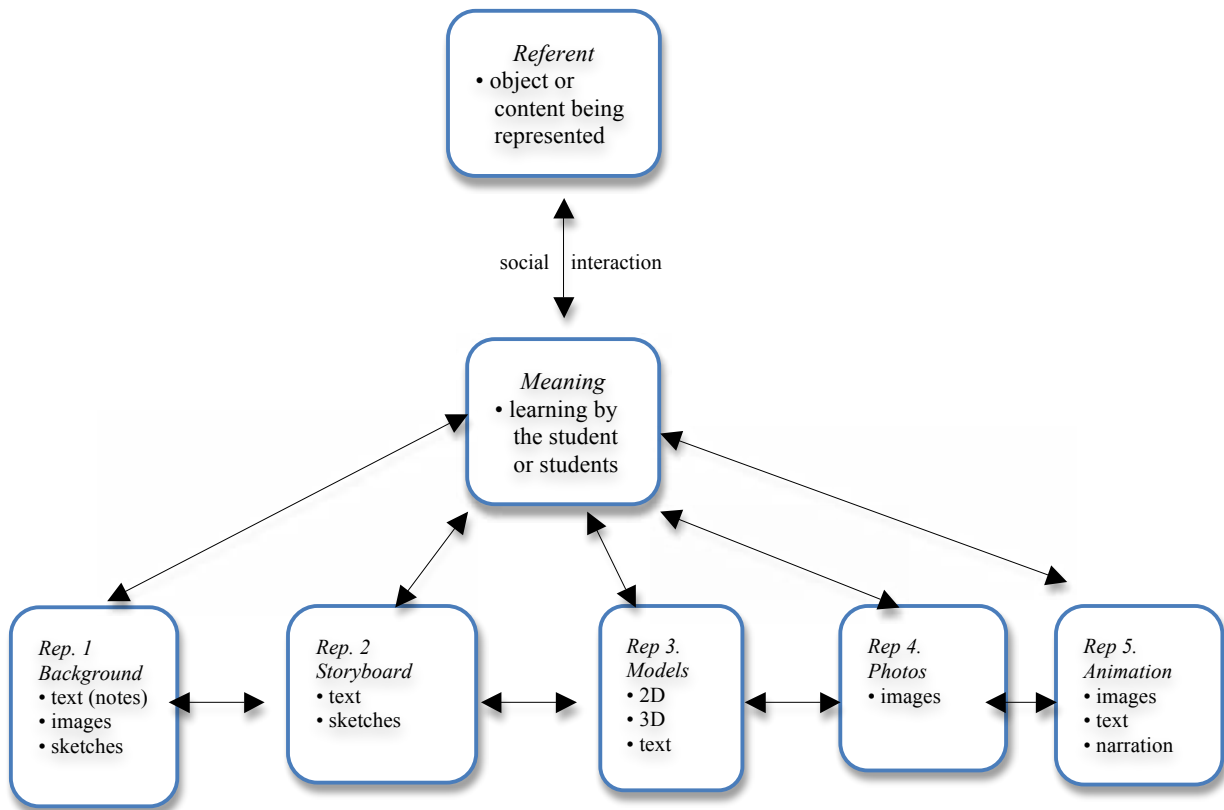


Figure 1. The 5 Rs: A Teaching Approach for Student-generated Animations (Slowmations)

Example of the 5 Rs Teaching Approach in a Primary Classroom

Over the last three years, over 600 slowmations have been made by preservice teacher education students at The University of Wollongong and Monash University through a

funded nationally research project in Australia. As a consequence of learning about this new teaching approach in their science methods classes, some of the now graduated preservice teachers are using the 5R's as a new teaching approach in school classrooms by getting school children to make animations of science concepts.

In a primary school context, the 5R's teaching approach is usually used at the end of a topic as an assessment task to ascertain what children have learned about the topic. Sometimes getting school children to represent their ideas in this way reveals their alternative concepts which are then clarified by the teacher as a result of the children showing and explaining their slowmation to the class (Keast, Cooper, Berry, Loughran, & Hoban, 2009).

One example is now provided by a primary teacher, Wendy, who used the new teaching approach in a primary school to teach the topic of life cycles to her year 2/3 class. Wendy had planned to teach the topic of life cycles over four weeks with two science lessons each week. In the unit the students covered several life cycles such as butterflies, silk worms and beans. In the life cycle of beans, the students formed pairs and each pair grew a bean seed in a cup and documented the growth of the bean seed in a diary. At the end of the topic, she organised the students as a jigsaw to make one slowmation as a class over four fifty minute lessons as a way of summarizing what the students had learned during the topic. The class was divided into five groups that represented the different parts of the bean seed life cycle: (i) seed germination; (ii) seed growth; (iii) seedlings (iv) flowering; and (v) forming seeds. The first lesson involved the students constructing a storyboard based on the documentation of results in their bean seed diary. The second lesson involved the students making models and the third lesson involved the students taking photos of the models as they were manually moved. The fourth lesson involved recording the narration as a whole class. The sequence of representations and related action by the students is shown in Table 1.

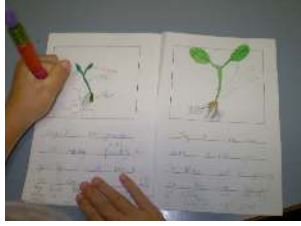




Sequence of Representations with Modalities	Action	Example
<p>Representation 1 <i>Background</i></p> <ul style="list-style-type: none"> — text — diagrams 	<p>The children kept a “bean diary” documenting the growth of the bean seeds over a period of three weeks.</p>	
<p>Representation 2 <i>Storyboarding</i></p> <ul style="list-style-type: none"> — diagrams — text 	<p>At the end of the three week period the students designed a storyboard showing the different stages of the bean seed germination.</p>	
<p>Representation 3 <i>Modelling</i></p> <ul style="list-style-type: none"> — 3D models using playdough 	<p>In a class “jigsaw”, five groups of students were allocated different parts of the bean life cycle to create models out of playdough— germination, seed growth, seedlings, flowering, forming seeds.</p>	
<p>Representation 4 <i>Photographs</i></p> <ul style="list-style-type: none"> — digital still images of the small manual movements 	<p>During one lesson, each group is called out in turn to take photos of their play dough models as they are moved manually.</p>	
<p>Representation 5 <i>Animation</i></p> <ul style="list-style-type: none"> — computer generated digital animation —narration 	<p>The teacher takes 20 minutes to download the photos onto her computer and edit them using the animation software to create the animation. The teacher then got the class to record a group narration.</p>	

Table 1. Five Connected Multimodal Representations in Creating a Slowmation

Discussion and Conclusion

Getting students to create an animation of a science concept has traditionally been too difficult to achieve in school classrooms either due to lack of equipment or the complexity of the technology. Moreover, when animation has been used, such as claymation, it has usually been for the teaching of literacy or art, not for the teaching of science. Even so, using claymation in a classroom is often too tedious and time consuming to be used as a common teaching approach.

“Slowmation” greatly simplifies the process of creating animations and so makes the use of animation as a teaching approach more feasible. Additionally, it is an approach that involves students thinking about the content in multiple ways and incorporates many connected learning processes. The 5 Rs is a new teaching approach to guide primary or secondary students so that they can create an animation as a representation of their learning in several hours. Furthermore, because the technology is easily accessible and familiar — a digital still camera and free movie making software — students can design and construct the animation in a classroom and finish it at home, or better still, make one at home and bring it to school to show the class.

The key point of this article is that creating a slowmation helps students learn about a science concept because they are constructing a sequence of five multimodal representations, which encourages them to think about a science concept in many different ways. Furthermore, asking the students to create an animation that explains a science concept engages them in learning about the concept because they need to understand it before they can explain it. Moreover, each representation can involve the use of different modalities, notes, digital images, sketches, models and voice, which can complement each other and so the process incorporates multiliteracies that are commonly used in the scientific community.

Although this article explains slowmation and gives one example of the 5 Rs in a primary school classroom, there have been many other examples in schools and in other subject areas besides science. Doing a google search on the word “slowmation” provides many different examples of animations made by students in schools. Some of these have been uploaded to YouTube as well. In a primary classroom examples have been life cycles, seasons, weather systems, night and day, etc. In a secondary classroom, some

examples have been mitosis, meiosis, phagocytosis, chemical bonding, chemical equations and gene technology.

Finally, we know from interviewing students before and after they have created a slowmation that it often results in helping them to understand a concept. What we do not know, however, is how each representation or the different modalities influence learning. Hence, further research will be needed to understand how each representation or mode influences learning. Other studies are under way to research how students learn during the actual creation process by videoing students over several hours as they create a slowmation and encouraging them to “think aloud”. We are hoping that further technological advances will make animation even simpler so that slowmation may become a common teaching approach in schools as a new way for students to engage with science content by making their own digital media products.

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