# Indigenous Science Learning Turns to Culturally Responsive 3D Animation: Process and Responses

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**Abstract:** This presentation presents the third part of a series of 3D animations for indigenous science learning called Petlaman. To our knowledge, this series of animations is the world's first 3D animated science education film to focus on indigenous culture. Petlaman means "test" or "try it" in the Atayal language. The Atayal are one of the 13 indigenous tribes in Taiwan. The Petlaman animations relate science education to indigenous culture. Additionally, the presentation also address the rationale for making culturally responsive 3D animations for indigenous science learning, the process of producing the Petlaman animations, the controversies confronting the authors in making the Petlaman animations, the responses to the animations in indigenous and non-indigenous communities, and the significance of 3D animation in science and cultural learning among indigenous people.

## Introduction

This presentation presents the third part of a series of 3D animations for indigenous science learning called *Petlaman*. To our knowledge, this series of animations is the world's first 3D animated science education film to focus on indigenous culture. *Petlaman* means "test" or "try it" in the Atayal language. The Atayal are one of the 13 indigenous tribes in Taiwan, and in terms of population is the second largest indigenous tribe, though in terms of population distribution they are distributed across the largest area including northern, eastern, and central Taiwan.

The *Petlaman* animations relate science education to indigenous culture. It is presenting science education using cultural references to attract more indigenous youngsters to science learning since the indigenous people have been underrepresented in the field of science and engineering. Additionally, the presentation also address the rationale for making culturally responsive 3D animations for indigenous people's science learning, the process of producing the *Petlaman* animations, the controversies confronting the authors in making the *Petlaman* animations, the responses to the animations in indigenous and non-indigenous communities, and the significance of 3D animation in science and cultural learning among indigenous people.

Recently, the National Science Council (NSC) of Taiwan has been encouraging various audio-visual

professionals and university professors to work together to produce informal science education films. In response to trends in promoting animation industries for informal science education and a focus on indigenous education, the NSC has been requesting proposals on 3D animation for indigenous science education. However, making indigenous informal science education animated films is a significant challenge to most audio-visual professionals as well as to most science educators because of the complicated integration among various professional fields. In the year of 2005, the author, a science educator turned producer, took the challenge and started to handles film production and administration of the *Petlaman* animations. The *Petlaman* animations are currently being produced under the support of National Science Council of Taiwan.

The *Petlaman* animations are divided in ten parts, each dealing with a separate science learning topic. Each part of *Petlaman* is 22 minutes long, and thus the ten parts comprise a total of 220 minutes. The origins of the episodes of *Petlaman* animations are a set of twenty-five science learning activities units developed by the author based on a learning framework WOLF（Worldview Oriented Learning Framework）(Fu, 1999; 2003; 2004a; 2004b; 2004c). Ten of the twenty-five units are selected to develop into the stories of the ten parts of the *Petlaman* animations (Tab. 1). The 3D animations are designed to provide an alternative means of accessing science learning based on indigenous culture primarily for indigenous students but also for others. The story and episode of the series based on the life experiences of Atayal tribal elders displays the Atayal knowledge of nature and describes interactions between Atayal culture and Western scientific culture.

| WOLF units | Animation title | Science concept |
|---|---|---|
| Time | Solar time | Time, time measurement |
| Chief's finger | Chief's finger | Length measurement & unit |
| Sharing prey | Yutas unfair | Mass & lever |
| Atayal dying & weaving | Rainbow cloth | Acid & base |
| Flying squirrel | Atayal Peter Pan at night | Bernoulli's Principle |
| Bamboo Rifle | Bamboo Rifle | Hooke's Law |
| Pickled Fish | Firefly in Water | Osmosis, Osmotic pressure |
| Acetylene Lamp | Fire from Water | Chemical reaction |
| Jew's Harp | Atayal Lovers' Harp | Sound wave |
| Hut | Secret Hut | Heat |

**Table 1: WOLF units, animation title and science concepts involved**

The presentation involves showing a part of the series of 3D animations. The part presented in this study concerns concepts of lever principle and balance. The story begins with the curiosity of the ten-year-old protagonist Tingting about Atayal tradition and natural phenomena. Initially, Tingting is concerned that his yutas (grandfather) was unfair in sharing the meat brought home by a hunting party. Eventually, after talking with a mysterious Atayal

elder, he realizes that Atayal fairness is built on compassion, caring and cooperation, rather than that can be determined quantitatively with scientific methods. The film provides Atayal children with an alternative perspective in learning traditional values and virtues while simultaneously building their scientific knowledge of lever principle and balance.

## The Rationale of Making Culturally Responsive 3D Animation for Indigenous People's Science Learning

Bruner's theory indicated that there are two essential and irreducible ingredients of human's cognition: a paradigmatic mode and a narrative mode. The paradigmatic mode deals with thinking based on principles to logically verify and to test observable phenomena or empirical experiments. The narrative mode of thinking deals with human, human-like or personal intention, action, and events. The two modes work together to constitute human way of knowing. Narrative frames and categorizes human experiences as events (Shuman, 1986). Bruner (1998) claimed narratives and stories as "the most natural and the earliest way in which we organize our experience and our knowledge." (Bruner, 1998, 121) Even scientist's way of constructing science theory is also a narrative or a storytelling process, behind which there are a series of story-like temporal action and consciousness. "The process of science making is narrative," Bruner claimed (Bruner, 1998, 126). Therefore, narrative should be a significant part of science learning experience to make the learning process a live science making.

However, school science teaching generally emphasizes paradigmatic mode of thinking and neglects narrative mode of thinking. School teachers tend to teach science as an already finished science. The narrative and storytelling of making science that Bruner indicated is neglected during most of the school science teaching. The episodes of storytelling can help learner use not only the paradigmatic modes of thinking but also the narrative mode of thinking to crystallize the whole picture of a science concept and the relations among different concepts（Orgborn, 1996）. The relations among different concepts can help learner assimilate new concepts based on what the learner already learned（Orgborn, 1996）.

The 3D animation with appropriate learning framework and episodes provide learner with scaffolding to connect learner's existing concepts to new concepts. There have been many researches about the impacts of animation to science learning since the 1990s. Those researches revealed that animation can help science learning of different levels (Baum, 1993; Greenbowe, 1994; Sanger, Phelps & Fienhold, 2000; Slish, 2000; Rodrigues, Smith & Ainley, 2001; Jacobsen & Moore, 1999; Burke, Greenbowe, & Windschitl, 1998; Sperling, Seyedmonir & Meadows, 2003; Lee, 2004.)

Most of indigenous people are underrepresented in science and technology in many countries. But the case does not indicate that indigenous people are not able to learn science. Indigenous people have different view of science. "Native science is a metaphor for a wide range of tribal processes of perceiving, thinking, acting, and "coming to know" that have evolved through human experience with the natural world (Cajete, 1999, 2). "Native

science is the collective heritage of human experience with the natural world (Cajete, 1999, 3). Human's learning cannot be divorced from culture. Indigenous people's science learning cannot be isolated from native life experiences and cultures. According to Bruner's theory about narrative of science and two modes of thought and the relevant researches about animations for science learning, making culturally responsive 3D animation for indigenous people's science learning is a way with great potentialities of helping indigenous science learning. However, there has not been a culturally responsive 3D animation produced for indigenous people's science learning.

## The Process of Making the Petlaman Animations

More than 30 consultants, including Atayal elders, scientists, science educators, teachers, cultural professionals, and government staff, collaborated with animators. As the producer, the first author has to deal with controversial issues related to learning, ethnic, aesthetics, delight, and science raised from different perspectives — cultural, scientific, educational and ethnicity-based — among the consultants of the animation project.

During the process of making the animations, the main controversial issues confronted the producer are that some scientists said there should be more science, that some science teachers said that we should teach science without spending so much time on cultural things and storytelling, that some elders said we Atayal people do not have words for those science concepts, and that the animators' and film director's insistence on visual aesthetics which sometimes are in conflict with reality. Finally, we attained a common view that this film differs from typical anthropological documentaries. We ensured that the appeal to visual aesthetics and delight could be balanced with the film's aims of teaching science and accurately depicting traditional Atayal culture.

The scientists, science educators and science teachers of the consultants focused on examining the science learning ingredient of the animations. They reviewed the animation and checked if the episodes of the animation match the framework of WOLF, if the science concepts presented correctly, and if the science concepts contents correct.

The Atayal elders and cultural professionals were in charge of examining the culture ingredient of the animations to see if the story of each part of the animation match the cultural context of Atayal tribe, if the scenes, props and characters match the cultural context of Atayal tribe, and if the sound effect, music and words match the cultural context of Atayal tribe.

## The Responses to the Petlaman Animations from Audiences

According to 1675 viewers' responses in a evaluation of the *Petlaman* animations, the audiences of the age between 12 and 17 significantly like the animation much more than those of others. The indigenous audiences like the animation significantly than non-indigenous audiences. More than 80% of the indigenous audiences agreed that

the scenes and the appearance of the characters looked like very similar to those scenes and people in tribal village. Significantly more indigenous audiences thought that the animation could be used to help science learning and native language learning. Significantly more non-indigenous audiences thought that the animation could help indigenous cultural industries, promoting indigenous cultures and indigenous cultural learning.

One Atayal teenager approached the authors after viewing the film and said: “I was born and grew up in my village. Amazingly, the scenes, characters, food, clothing and even shelter shown in the film closely resemble what we have in my village. The film has profoundly and strongly impacted me. Furthermore, the film has improved my knowledge of science by using Atayal customs and the Atayal language.” The authors believe the animations will inspire indigenous youngsters, both in Taiwan and around the world, to think about how to use 3D animation beyond entertainment making it a technology with which indigenous people can present their traditional wisdom, culture, native language and science learning.

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