Using Educational Robots as Tools of Cultural Expression: A Report on Projects with Indigenous Communities

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***Abstract*—This paper reports on the use of educational robots with indigenous people. It shows how effective educational robots are at providing tools of self expression and act as a bridge between the modern world and the traditions of Native peoples. The original work first took place with Maoris in New Zealand. A similar, independent project, run by the Native American Squaxin People of Puget Sound, a Sovereign Nation in Washington State, embraced the understandings developed in New Zealand. Following a description of the project, we will evaluate the educational effectiveness of the project using the ERA[1] Principles as an evaluative framework[1]. We will also discuss the value of ERA as a helpful tool for understanding educational robotics.**

I. Introduction

In the late 1990s, the New Zealand government implemented a project aimed at enhancing and protecting the status of the Maori language and culture within the New Zealand society. This was part of an ongoing reassertion and rebirth of an indigenous heritage, which had been under pressure for years. The problem facing the Maori nation was their children were being seduced by the dominant Eurocentric culture and were loosing touch with their roots. An educational robotic project was a small successful part of an initiative aimed at countering this trend. The robot used was the Roamer supplied by Valiant Technology.

Similar problems are faced by indigenous peoples all over the world. There are striking parallels between the experience of the Maori and Native Americans. The Squaxin Island Peoples of Puget Sound in Seattle, Washington State also used Roamer in a summer project run at their tribal centre.

This paper describes these two situations and reports the role played by the Roamer and its practical effect on the wider aims of the community. We then analyse the Squaxin project using the ERA Principles as an evaluative framework. We will then argue that the results simultaneously contribute to the verification of the value of educational robots and the value of the ERA Principles.

[1]Educational Robotic Applications.

II. Research Methods

The original Maori work is taken from Valiant Technology's unpublished historical archives. The Native American Project took the form of an unstructured case study. Observers were both participatory and non-participatory.

III. A Brief History of Maori Culture

In order to thrive the first Westerners arriving in New Zealand had to learn Te Reo (Maori language). As early as 1814 missionaries were developing a written form of Te Reo. Maoris enthusiastically adopted reading and writing their language. Throughout the 19th century the Maori and Pakeha (European New Zealanders) mixed and Te Reo was common parlance even for government officials, missionaries and other prominent people.

By 1860 English had become dominant. Te Reo was confined to Maori communities largely rural and isolated from the Pakeha majority. Some parents encouraged their children to learn English and even to turn away from other aspects of their customs. Maoris questioned the relevance Te Reo in the Europeanised world.

This process of assimilation gradually led to suppression of the Maori language and culture. Sir James Henare remembered being punished for speaking Te Reo on the school grounds. More and more Maoris learned English in order to get jobs. Before World War II only 25% of Maoris lived in cities. The lure of work enticed a migration from the country and 20 years later 60% of the Maori population lived in the cities. By 1980 less than 20% of the Maori population were considered native speakers. In the 1970s reaction to this decline started. Maori leaders recognised how language was integral to their cultural heritage. Various initiatives precipitated a gradual change until Te Reo became an official language of New Zealand in 1987 [2].

Despite this the attractions of modern life mesmerised Maori youngsters and engaging them in their inheritance was not straightforward. In the late 90s a national programme was launched aimed at encouraging Maori and non Maori children to understand Maori culture, lore, language and traditional practices.

IV. Roamer Maori Project

As part of an initiative instigated by Massey University Education dept. co-operating with staff and student teachers at Palmerston North Teachers College, John Mellsop, the New Zealand Roamer expert, was asked to provide some workshop units that focussed on training teachers (Maori and non Maori) and student teachers in effective methods using Roamer as the motivation tool for children to take self initiated interest in learning.

John and others produced a number of interactive activities based around several ancient Maori Myths and Legends bringing the fabricated characters alive using Roamer to provide appropriate (but simple) movement whilst the story was read, narrated or adlibbed by students or the tutors (Fig 1).

Fig. 1. Selection of Maori Activities

In one version of the legend of Hinemoa and Tutaneki, Hinemoa, a Maori Princess, had to swim across the lake (Rotorua) in order to secretly meet with her lover Tutaneki who lived on Mokoia, an island in the middle of the lake. This swim involved exposure to tuna (eels), Taniwha (dragons), Rapu (water weed), rats, suspicious family (iwi) and other obstacles. Fig 2 shows Roamer characters and images of the Taniwha created by Maori students as part of the enactment of the story.

A large floor map of the lake and island was drawn. Various characters and obstacles were placed on this.

The students depending on age group had a variety of objectives to consider which involved not only language but solution design, planning, mathematics and environment issues.

V. The Native American Experience

In many ways the Native American experience parallels the Maori story. It seems fewer European immigrants "went native", but certainly there came a point where the agenda focussed on assimilation. Many tribal customs were banned and what seem to be outrageous acts of cultural vandalism went on long after the Second World War when the US Congress pursued a policy of termination. This process aimed to assimilate Native Americans by terminating the separate Nation rights of the various tribes. This only stopped in 1970 [3].

Fig. 2. Roamer characters created by Maori students.

It was in the 1970s that the Native Americans started reasserting their cultural identity. By 2010, when the Roamer Squaxin Project took place, the process of revival was commonplace.

VI. Background to the Squaxin Project

The Squaxin are a small tribe, part of the Salish peoples, who form a cultural, ethnographic and linguistic sub group within Native American society.

The traditional home of the Squaxin is a small isle in the marine waterway complex (Figs 3 and 4) known as Puget Sound in the Seattle area of Washington State, USA. The thickly wooded Cascade Mountains isolated the coastal tribes of the North Western seaboard, and consequently the canoe became a major method of travel.

Fig. 3. View across the waterways of Puget Sound. Because of their connection to the sea the Squaxin were also known as the People of the water.

For centuries Squaxin used the canoe to journey to potlatch gatherings up and down the Pacific coast line. The potlatch was a festival of giving - effectively a redistribution of wealth. It involved feasting, dancing and singing. Much of this was spiritual and sacred. A single potlatch could last for weeks [4].

Fig. 4. The Squaxin tribal homeland.

The potlatch was beyond the comprehension of European American (and Canadian) people. In particular it was beyond the pale for Christian zealots aiming to "civilise the natives". Its banning and the opening of land routes saw the end of the canoe journeys.

In 1989, as part of the reassertion process the Salish Tribes restarted the canoe ceremony (Fig 5). It has now become an annual event.

Fig. 5. The traditional canoe journeys went as far south as San Francisco and north into British Colombia.

VII. Squaxin Roamer Project

Tribal Elder and the Squaxin Education Director approved this project. It was organised by James Smith from the Superintendents Office in Olympia with the support of Dave Catlin from Valiant Technology.

The event was held at the tribal centre and as it was a summer school project, attendance was not compulsory. Kenton Morrison, a local elementary school teacher and experienced Roamer user, trained students from the Gen Yes Program[2] to run the project.

As with Maoris youngsters, Squaxin students live in a world where their culture is marginalised. We will show later that this is not just a result of suppression, but a natural consequence of what is called the Circuit of Culture. The aim of this project was to engage the students in STEM rich activities linked to the traditions of the tribe. Just as with the Maoris we suggested a number of Roamer activities based on the traditional stories of the Squaxin peoples[3] [4]:

1) The Salmon Run (Fig 6)
2) The Origins of Animals
3) Hunting Activity
4) Gathering Berries

The essence of these activities would be familiar to Roamer users in New Zealand, British and American classrooms: that is, familiar in terms of what the students do and the STEM[5] content they engage in. What is different is the contextual aspects - and we will see that this is significant.

The original plan was to use the stories to familiarise the students with the Roamer. Then they would use the robot to explore:

1) The Canoe Journey
2) The Potlatch
3) Tribal Dance

Fig. 6. The students created a Salmon costume for Roamer and programmed the robot to "swim" up the river avoiding obstacles like the bear, rocks and fishermen.

The idea was for students to film these events. A bureaucratic miscommunication lost a week of the programme and the Tribal Centre was closed for two further weeks as a mark of respect for the death of two Tribal Elders. Consequently, the students only engaged with the Salmon Run activity and while a lot of the film work was done, it was never completed. Nevertheless, participants considered the project a successful excercise.

A. *Kenton Morrison's Project Report*

Students were highly motivated to work with the robots. We used some simple lessons to teach the students to program the robots. We taught them how to storyboard a story and create backgrounds and props for Roamer. This led students to an interest in their tribal art.

[2]http://genyes.org/

[3]tribehttp://squaxinislandmuseum.org/

[4]All these activities are freely available in the Roamer Activity Library: https://activity-library.roamer-robot.com/

[5]Science, Technology, Engineering and Mathematics

While working with this concept, community members began to take interest. They were able to share the importance of the tribes canoe journey. The original idea now evolved into Roamers re-enacting parts of the trip.

Students began researching the route of the journey and the tribal traditions and celebrations that occurred when the canoe arrived at each stopping point. To make this successful, we enlisted the assistance of community members that had made the canoe journey. Community members taught tribal art, music, and dance. They also provided information on the journey itself.

Students now started learning tribal dances, songs, drumming, and tribal art as they studied tribal celebrations. Students decorated the Roamers with hand-made tribal blankets and programmed them to perform tribal dances (Fig 7).

Fig. 7. Students have dressed Roamer up with the blankets they made and are ready to start the drumming and dance session.

The event cumulated in a morning activity where all students gathered to share their learning. One group had created a giant floor map of the route of the Canoe Journey. Students would program Roamers, that had been decorated to resemble canoes, to travel from point to point in the journey and discuss what happened at each point (Fig 8).

Fig. 8. The Roamer canoe enacting the Canoe journey while the story is narrated by the students.

In the end, the head of the summer school, who had been sceptical at the start, stated that he had never seen a summer where students took such an interest in their culture. Roamer became the catalyst for students to find and study areas of culture that interested them.

B. Comments from Sally Brownfield

Squaxin Education Director Sally Brownfield made the following comments about the project:

"Tribal youth experienced a deeper understanding of their language".

"Adults saw it as curriculum; this transformed and they started to see it as culture".

"I was also pleased that the students wanted to learn more about indigenous math and science used in the navigation process of the Canoe Journey. The moon, stars, and land masses created a natural navigation laboratory".

C. Comments from James Smith

James Smith from the Olympia Superintendent's office commented:

"Instructors were pleased that students wanted to learn more about their culture through the use of Roamer reproducing the Canoe Journey".

"Would they have got into this without Roamer? Yes. But they got into it quicker than they would have normally. They saw it initially as school work but recognised how school connected with culture. Recreating the journey on the floor with Roamer brought it to life for them".

VIII. Basis of Analysis

Beyond the scope of this paper our wider objective is to show how educational robots can enhance a student's learning experience in many different learning scenarios. These can be formal learning situations, where we must demonstrate to teachers that robots can support their efforts in delivering curriculum and raising the test scores. They can also be less formal objectives - like those of the Squaxin project. Political and public pressures in some education systems demand the use education methods supported by "scientific research"[6]. Such restraints apply to the tool (robots) and the application (robotic activity). So while we can analyse the activities presented in this paper we can also ask, how these findings contribute to a more general verification of educational robotics.

The ERA Principles provide a tool we can use to examine the value and effectiveness of educational robotics in a consistent way [1]. They provide a framework for designers and educators creating robots and robotic activities. They were created by Dave Catlin and Mike Blamires based on an amalgam of educational theory, the practical needs of teachers and students and the technical insights of robotics and AI. Above all they were influenced by Dave Catlin's 30 years of unpublished experience with educational robots in thousands of schools and in 30 countries on 5 different continents.

The e-Robot Project is a longitudinal research programme aimed at gathering evidence to substantiate ERA [5]. While we use ERA as a benchmark for evaluating activities, we also

[6]See the e-Robot project reference for citations relating to this claim.

use the results of that analysis in e-Robot to verify and refine ERA [7].

In general e-Robot does not aim to compare whether using robots to deliver a particular aspect of education works better than a non-robotic approach. We are working on the premise that teachers need to be able to choose methods from a range ways of engaging students in appropriate education experiences. We recognise that whats suitable for a specific teacher and group of students in a particular time and situation varies. Sometimes it will be fitting to use robots and other times it would be inappropriate. Our wider aim is to gather evidence that validates the use of robots.

We present our analysis with a formal definition and a brief explanation of a relevant ERA Principle. This is followed by comments on its significance to these projects.

IX. Analysis

A. ERA Principle: Pedagogy Principle

The science of learning underpins a wide range of methods available for using with appropriately designed educational robots to create effective learning scenarios.

This principle identifies 28 different characteristics of educational robotic activities. These traits can be thought of as the 'atoms' that combine in different ways to make educational robotic activities valuable experiences. The following analysis takes a characteristic and explains its embodiment within a specific Squaxin activity to demonstrates the value of the activity.

1) Activity: Salmon Run

Pedagogical Principle: Focussed Task
A focussed task helps the student develop a narrow skill.

In The Salmon Run to make Roamer travel along the river students have to move the robot specific distances, turn specific angles and to do this series of actions in a specific order. In doing this students get to practice estimation skills for distance and angle. Students did get the angles and distances wrong. However, they were able to refine their solutions while simultaneously honing their basic skills. This type of self correcting process is a positive learning mechanism.

Pedagogical Principle: Engagement
An aspect of the activity that clearly engages the students interest and creates a positive learning environment.

Students found it entertaining when they estimated the angle incorrectly and made the salmon swim into the mouth of the bear instead of around it. This kind of mishap endowed the activity with a spirit of enjoyment and consequently created a positive learning environment.

[7] We cannot represent the arguments supporting ERA and e-Robot in this short paper and the reader is referred to the original papers available online at http://www.valiant-technology.com/uk/pages/archives.php#researchpapers

2) Activity: Tribal Dance

Pedagogical Principle: Experience
Robot activities can provide students with experiences that provide the opportunity for implicit learning which contributes to a student's prior learning repertoire.

The dance activity involves mathematical ideas of sequence, pattern, symmetry, translations and rotations. The students involved in this activity were too young to have formally met these concepts in school. The Experience Principle claims that prior knowledge is a well established Science of Learning tenet. Moreover, much of students' prior knowledge is subconscious. It is gained through established psychological processes relating to implicit learning. We do not claim that student engagement in the Dance Activity proved or contributed to a proof of these claims. That needs to be established in a more specialised research project. If we accept the principle as a conjecture, we can claim that the mechanisms for developing appropriate experience is evident.

Pedagogical Principle: Exploration
This is using a robot to explore a situation and consciously discover the knowledge embedded in a Microworld or the environment.

Some of the students involved in the dance activity did start to recognise formal ideas and consciously use them to develop their dance. For example the notion of a pattern of movement translated to a different location. We note that this did not involve the development of formal mathematical language, though students did invent words to discuss their endeavours.

Pedagogical Principle: Modelling
Students use a robot to model an idea. This frequently takes the form of a program representing a mathematical idea.

The process of watching the dance, interpreting that as movement of the robot, then producing a program to perform that movement is an example of the students' engagement in the modelling process.

Pedagogical Principle: Creativity
Robot activities can provide the opportunity for creative thinking exhibited through the development of novel solutions to problems, imaginative use of knowledge and concepts or the development of something with artistic merit.

In this activity students could simply model what they saw. Some did that. Others showed creativity and embellished the dance movements of the robot.

Pedagogical Principle: Catalyst
This is an aspect of educational robot activities that causes students to engage in a series of tasks that do not directly involve the robot.

The Dance Activity encouraged students to engage with tasks like weaving and exploring patterns in the design of blankets. It also provided a context for learning traditional music.

3) Activity: Canoe Journey

Pedagogical Principle: Research
Students research topics and gather information necessary to successfully complete an educational robot activity.

Students had to find out about the canoe journey and apply that to the activity. Their research involved them seeking advice from more knowledgeable people (Elders) and studying publically available information.

Pedagogical Principle: Presentation
Students use a robot to present what they have learned.

Students presented what they had learned about the canoe journey using the Roamer.

B. ERA Principle: Personalisation

Educational robots personalise the learning experience to suit the individual needs of students across a range of subjects.

Both these projects are macro examples of this principle. The Maori activity of programming the Roamer to avoid the obstacles as it swam to the island, involves the development of the same mathematical skills as the Salmon Run activity. The cultural settings personalised the activities at a group level. On this level personalisation was a vital part of both projects. It was, as reported by all those involved, successful in connecting students to their culture and through their culture to elements of school curriculum. For example:

1) Reading and writing skills were engaged in presenting the canoe journey
2) Programming skills were involved in all the activities
3) The activities involved mathematical skills of measurement, estimation, pattern, sequence, symmetry, translations and rotations as well as the opportunity to practice basic arithmetical skills to solve practical problems
4) Making skills were inovled to create props and the robot characters
5) Aspects of the geography curriculum was covered in the creation of maps
6) Music skills were involved in dance activity

C. ERA Principle: Equity

Educational robots support principles of equity of age, gender, ability, race, ethnicity, culture, social class, life style and political status.

Although it was not the main focus of these projects, it was clear that curriculum was involved. Writers Gay [6] and Bouillion, L.M., Gomez [7] show the importance on the cultural situating and contextualisation of activities on the issue of curriculum Equity. Catlin and Robertson [8] explore how the Circuit of Culture relates to Equity and educational robots. They would cite the observed performance of the students in the activities, showed the ability of Roamer to adapt to the cultural and ethnic situation and reduce the cultural curriculum barriers often facing minority groups. In this context this project provides evidence supporting the Equity Principle.

Cultural expert Professor Stuart Hall points out: *Culture.... is not so much a set of things, novels and paintings or TV programmes and comics, as a process, a set of practices* [9]. This certainly attests to the significance and power of active participation in the canoe journey. He explains that shared meanings do not mean that every member of a culture has the same opinion on a topic and that culture is not simply a cognitive process: it is also about feelings, attachments and emotions. The Circuit of Culture (Fig 9) illustrates how culture creates meaning. It demonstrates the dynamism of cultures, how they self perpetuate and how they mutate in a complex process. The Squaxin canoe journey is an iconic cultural

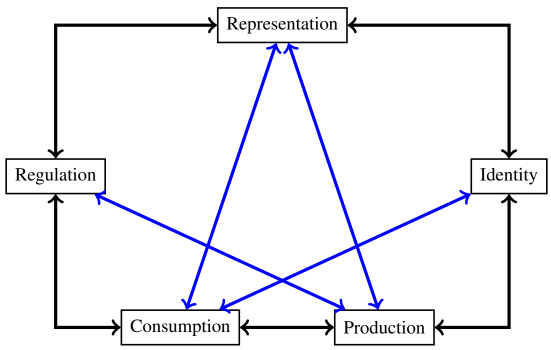

Fig. 9. The Circuit of Culture depicts the relationships between the different elements of culture.

representation - a practice of the community. The community **regulates** how, formally or informally, the modern canoe journey is organised and conducted. Of course a community **consumes** its culture, it watches the canoe journey, listens to the drum beats and hears its songs. Obviously it also **produces**; members beat the drums, sing the songs and paddle the canoes. People who participate in these various processes **identify** with them, They become members of the community.

Subgroups exist within the Squaxin community: Elders, women, men, children. The Squaxin are not isolated. They are also American. There lies the heart of the cultural problem. Squaxin youth are subjected to the mainstream American Circuit of Culture, which because of sheer number of producers, consumers and representational forms tends to drown out their participation in the Squaxin traditions. The suppression years made the situation worse, but the American Circuit of Culture predicts the inevitable distraction of Squaxin youngsters from their tribal traditions. This type diversion concerned both Maori and Squaxin Elders.

D. ERA Principle: Engagement

Through engagement Educational Robots can foster affirmative emotional states and social relationships that promote the creation of positive learning attitudes and environments, which improves the quality and depth of a student's learning experience.

This principle also plays a crucial role and interacts with Equity in a potent way. Clearly the students become involved in the projects. What initially appeared to many to be simple curriculum explorations, transformed into cultural events because of the students' engagement as active learners. Instead of passively listening and watching (**consuming**) the culture, they became **producers**. Students sought information and advice of the Elders and applied that knowledge to a modern technology. Effectively they **produced** new forms of culturally endowed **representations** for the **consumption** of their community and the reinforcement of their **identity**.

E. ERA Principle: Sustainable Learning

Educational Robots can enhance learning in the longer term through the development of meta-cognition, life skills and learner self-knowledge.

Typically educational robotic activities involve scenarios that present students with opportunities to develop life skills.

Cognitive Development	
Managing	Research
Emotional Development	
Relating	Communication Cooperation
Caring	Sharing Empathy
Social Development	
Giving	Group Contributions
Working	Presentation Teamwork
Personal Development	
	Motivation

Fig. 10. Sustainable Learning opportunities identified in the Squaxin Project

Fig 10 represents admirable human traits as classified by the ERA Sustainable Learning Principle and are evident in these projects. While it is impossible to measure whether the students actually developed these skills, we can report they were involved in situations where they had the opportunity to engage in them through practice.

X. CONCLUSION

The two projects indicated the possibilities of using educational robots as a bridge between students, the traditional culture and the modern, often dominant culture, that they experience on a day to day basis. They provided the students with the opportunity to become active learners and participants in a Circle of Culture involving their native traditions. Participation in the canoe journey is an act of cultural production. But participation is restricted to adults. Roamer allowed the students to become producers and not simply passive consumers of culture. By embracing robotics it modified the regulatory aspects of the culture. That which is seen as culturally acceptable now included a modern technology. It was clear from the responses of the Maori and Squaxin Elders that they considered the work as a help to strengthen their children's cultural identity.

The Squaxin project provided evidence of the potential for educational robotics to connect students to the curriculum via their cultural environment. It is believed the Maori project also provided this evidence, though it was not specifically noted at the time. What was evident in the Maori project is that non-Maoris also connected to the indigenous culture of New Zealand in a positive way.

We also feel that the ERA Principles provided a useful tool for evaluating the project. The process of using ERA also demonstrated the effectives of the principles.

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