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REVIEW ARTICLE

Learning Science: Pūtaiao in an Indigenous School: A Review of the Theory and Practice

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ABSTRACT

This paper presents a literature review of theory and briefly presents insight from a case study. The literature review attempts to explain what Pūtaiao is, how it is being taught, and the learning of Pūtaiao. It also investigates the Pūtaiao curriculum and the challenges currently being faced. The literature covers students from early childhood, primary, and secondary school, and in this review, it is mainly limited to Māori immersion classrooms and schools. Further work is needed focusing on teacher education and professional development of Pūtaiao teachers. Pūtaiao as a subject is facing several challenges that may be combated through more specific interventions - rather than studies investigating Kura as a whole. Despite the challenges faced, the literature overall has a positive outlook in which Pūtaiao is enjoyed by students who see it relates to their own knowledge and culture. The case study took place in a Māori medium school that caters for year 9-13 students. Two teachers from a Māori medium school (Kura) who had no background in science and their year 9 and 10 classes voluntarily participated in this research. Through support to teachers in the form of upskilling themselves and learning along with the students, teachers gained confidence and began to teach Pūtaiao. Teachers willingly learn new vocabulary to pass it on to their students. In addition, among mainstream schools, many of the studies had positive impacts by raising awareness among teachers of how to teach Māori students, and how to incorporate some of the values that are fundamental to Pūtaiao.

KEY WORDS: indigenous science; Pūtaiao; Māori medium school; science education

INTRODUCTION

Pūtaiao is a subject taught in Māori medium classrooms that can be loosely thought of as "science" although it also incorporates Mātauranga Māori (Māori knowledge) systems. The literature on Pūtaiao is a relatively small body of work, dominated by several researchers, namely, Elizabeth McKinley, Georgina Stewart, and Russell Bishop. Bishop is especially prominent in the research area of Kaupapa Māori education not only in science but also in general and has contributed, especially to the understanding of Māori Kaupapa theory.

This review of the literature attempts to explain what Pūtaiao is, how it is being taught, and the learning of Pūtaiao. It also investigates the Pūtaiao curriculum and the challenges currently being faced. The literature covers a range of students from early childhood to secondary school, and in this review, it is mainly limited to Māori immersion classrooms and schools. Since this review is concerned with the subject of Pūtaiao, the teaching and learning of science in the English medium (or mainstream) schools goes beyond the intended scope. Making a distinction between the two allows for a discussion of the differing content and pedagogical methods used in classrooms throughout New Zealand. Being a subject taught in Kura (school), Pūtaiao is underpinned by Kaupapa Māori theory. Consequently, it naturally aligns itself with cultural understandings and practices of Māori. Pūtaiao teachers face challenges in aligning Pūtaiao and a Māori worldview with the "hegemonic western perspective of science" (Rofe et al., 2015. p. 2).

WHAT IS PŪTAIAO?

Students in New Zealand have the option of attending Kura Kaupapa Māori (Māori medium schools). Kura is available from Kōhanga Reo (pre-school) through to Wharekura (high school) and Whare Wānanga (University). Kura follows *Te Marautanga o Aotearoa* (*TMoA*), the Māori language curriculum document (Ministry of Education, 2007). Within *TMoA*, subjects in the English curriculum such as mathematics, social sciences, and physical education are also included. It is acknowledged that the Māori language document is a direct translation of the English document, barring minor adjustments. This is a recent development - during the 1990s, a separate document was produced in Te Reo Māori (the Māori language) but has since been replaced with the current curriculum. *TMoA* is intended to be based in Kaupapa Māori philosophy, which is used throughout Kura. Kaupapa Māori encourages Māori beliefs and understanding and was a point of focus during curriculum development (McKinley, 1996). The Māori term Pūtaiao is translated as "science," although it encompasses slightly different aspects than the English version of the word. Georgina Stewart (2005) refers to Pūtaiao as a "superset of science" (p. 852) that includes all Western

science as well as traditional physical and spiritual Māori knowledge. In Te Ao Māori (the Māori world), the physical world is inextricably linked to concepts such as Kaitiakitanga (guardianship) and is not separate from the original story of Ranginui or Papatūānuku. Originally, as McKinley (1996) discusses, Pūtaiao was written as a separate document. As Rofe et al. (2015) explained the Wharekura curriculum is a direct translation of the English version, effectively making the Pūtaiao document redundant. Pūtaiao now exists within the New Zealand curriculum just as a translation of "science."

In *TMoA*, Pūtaiao included four strands:
- Te Ao Tūroa (natural world).
- Ahupūngao (physical world).
- Kawekawe (material world).
- Ngā Tautake Pūtaiao me ngā Kōrero-o-Mua (philosophy and history of science).

The partnering English version of the curriculum was very similar, but unlike Pūtaiao, science generally excluded the spiritual aspects or aspects seen as "unscientific" among much of the Western Scientific community (McKinley, 1996). The philosophy of science is not taught as part of the mainstream science curriculum, but Stewart (2011a) states that through a deeper understanding of the nature of science, the curriculum would be able to support a Māori viewpoint. In 2007, The New Zealand Curriculum (Ministry of Education, 2007) was mandated, and there has been a parallel *TMoA* curriculum for Māori medium schools.

The mainstream science curriculum consists of five strands:
- Nature of science strand
- Living world strand
- Planet earth and beyond strand
- Physical world strand
- Material world strand.

In this review, the word "science" refers exclusively to the Western subject taught most commonly in New Zealand mainstream schools. As science and Pūtaiao are not the same, the terms will be used separately and will refer to the teaching of the subject through different cultural lenses in different cultural contexts.

Osborne et al. (2003) conducted a Delphi study in an attempt to determine which ideas about science should be included in high school science curricula. Although a United Kingdom study, it provides an overview of the science understanding that the expert community of science have felt is important for the general population to have. The study of Osbourne et al. discussed the various concepts around "science," and the different ways of seeing the subject. When discussing Pūtaiao, the same notion applies. There are multiple ways to understand science and Pūtaiao provides an opportunity to teach science from a Māori point of view (Wood and Lewthwaite, 2008). Osbourne et al. (2003) suggest that there is no definition of "science" as such referring to the "science wars" and the debates over the level of influence society and culture has on the community's definition.

METHODOLOGY

The literature review was conducted mainly using the research tool Papers 3, which conducts a cross-database search and allows articles to be downloaded into a library. The library is then able to be sorted and categorized in different ways.

We began by selecting key terms such as Pūtaiao, science, and curriculum development. As we read each of the articles, we then tagged them with prominent themes and ideas that were common across the literature. These tags formed the basis of the work that followed grouping similar themes together. In addition, we made use of Te Waharoa, the Victoria University library database. To double check our research, we mainly used Te Waharoa when searches returned very few results. Doing so meant that we were able to check, whether it was the app that was not finding articles or if we needed to change search terms to better reflect the topic. We organized the papers into categories. The app also allows you to view certain groups in the literature, so we were able to determine the number of articles used. In total, this review covers 26 articles.

The following search terms were used most often with varying combinations: Pūtaiao, science, Wharekura, Kura, teaching, learning, and challenges. As certain academics emerged as being more prominent, we also searched their work separately, for example, Elizabeth McKinley and Georgina Stewart. Elizabeth McKinley and Georgina Stewart are well-known and acknowledged leaders within the field of Kura and Pūtaiao. Stewart's work often involves a philosophical perspective of science, education, and Pūtaiao. Other inclusion/exclusion criteria were also set to narrow the search results. Specifically, peer reviewed original journal articles form the bulk of the research included, although there is also one thesis and two reports. Book reviews, news articles, and books were excluded. Studies published from 1996 to 2016 were included because it was intended that they be as recent as possible, Pūtaiao being a relatively recent development within the main education sector. Only items written in English were considered. Titles and abstracts in the search results were read to determine whether a piece of literature was relevant to this research, and to what extent. These were considered broadly to ensure that relevant studies were not missed. With the use of the above-mentioned search terms, 60 articles were gathered but as already noted; only 26 articles were considered to be relevant to this research. The others needed to be excluded, mainly because they explored teaching Māori students in mainstream schools, rather than Pūtaiao in Kura, and because many of them were more concerned with cultural competencies, which is also a topic that relates more to mainstream schooling. The existence of the issue of Māori student underachievement has been thoroughly covered (Glynn et al., 2010; Henderson, 2013) and to emphasize this further was not the intention of this review. Consequently, while searching, we focused on research concerning solutions and teacher professional development in Māori science or Pūtaiao.

The literature that has been selected includes several studies that relate to overseas education including those of Australian

aboriginal peoples and Canadian indigenous groups. These could be used to inform similar studies here in Aotearoa. However, although similar, it is unlikely the results would be identical due to history and other influences Māori in New Zealand schools/Kura are in a different position to most other indigenous groups. In most other countries that have given some recognition to their indigenous people, New Zealand is unique in giving equal status to Māori. Educationally Kura, a state supported system, has been set up for teaching in Te Reo Māori. This would be a lot more difficult in countries such as Canada or Australia was there are many indigenous languages.

Studies within the mathematics domain (or Pāngarau) were also left in during the search process, and one remains in this review. In keeping with the assumption that mathematics and science are related subjects, these studies are included with the understanding that they have the potential to be adapted to have a science focus. The citations of some key articles were also searched to source other relevant literature. The references in one article could be used to find other articles.

To present a clear overview of the literature, the review will cover the literature in categories: What Pūtaiao is the methodology we used, and the teaching and learning of Pūtaiao. The Pūtaiao curriculum will also be discussed at the three stages of education: Early childhood, primary, and secondary. The literature that investigates the various challenges faced by educators and students of Pūtaiao are also examined. Access to articles was a limiting factor as we were restricted to the databases and literature to which Victoria University of Wellington had access.

TEACHING AND LEARNING PŪTAIAO

As noted, Georgina Stewart and Elizabeth McKinley are well-known and acknowledged leaders within the field of Kura and Pūtaiao studies (McKinley, 1996, 2005; Stewart, 2005, 2007, 2011a, 2011b, 2012). Scantlebury et al. (2001) argued that science education is inequitable, and as a domain it has promoted the Western understanding of what science is.

Woods-McConney et al. (2011) analyzed questionnaires and Programme for International Student Assessment (PISA) data to gain a deeper understanding of factors involved in indigenous (Māori and Australian) and non-indigenous student engagement in science. The article acknowledges that both Australia and New Zealand generally perform well in international comparisons (such as PISA), but that there is a recognized achievement gap between indigenous and non-indigenous students. In New Zealand, attempts are being made to increase Māori achievement in science (see, for example, Office of the Auditor-General, 2016). Woods-McConney et al. (2011) argue that science programs need to encourage student autonomy as well as be directly authentic and relevant to students' lives in order for them to engage. Woods-McConney et al. further suggest that relevant content is particularly important for indigenous students. However, not all scholars agree with this position.

Lourie and Rata (2014) argue against culture-based education. In examining the Māori curriculum, Lourie and Rata state that a curriculum based on sociocultural knowledge rather than disciplinary knowledge results in some Māori continuing to underachieve. Lourie and Rata used three types of empirical material: The Māori curriculum, degree programs from Wānanga, and vignettes representing students making subject and career choices. Highlighting the limited options a student schooled entirely in Kura Kaupapa may have for career and university, Lourie and Rata's argument relates to the challenges faced in Pūtaiao, specifically the language issues that arise (and are discussed later in this paper).

Bull et al. (2010) produced the paper Inspired by science, commissioned by the Royal Society of New Zealand and the Prime Minister's Chief Science Advisor. The paper investigates student engagement with science. Māori engagement is a common theme within the literature, and it has been argued that Kura (and Pūtaiao) offers a better opportunity for Māori students to engage in science (Woods-McConney et al., 2011). However, Inspired by Science makes very little mention of Māori students; neither does it acknowledge the *TMoA*. However, the paper does suggest a scenario for improved student engagement in science. Interestingly, parts of the methods promoted for mainstream schools align with the research for Kura kaupapa. Kura has a strong focus on using methods such as stories, and community involvement, both of which are suggested as being beneficial to boosting the engagement of all students. The paper argues that the changes they advocate are possible within the existing. The New Zealand Curriculum although teachers and schools may be required to adjust their practices. It stands to reason, then, that the successful teaching of culturally relevant science is possible within mainstream schools if teachers are enabled with adequate professional development.

THE PŪTAIAO CURRICULUM

Early Childhood Education

Te Whāriki is the New Zealand early childhood curriculum (Ministry of Education, 1996). Rather than having distinct subject areas, it is a holistic program, intended to meet the learning needs of pre-primary children. Translated into English, Te Whāriki refers to a "woven mat," a way of highlighting its interlinking design. Te Whāriki, like the other curricula mentioned above, has a complementary section in Te Reo Māori. While not identical, the "Māori Curriculum is an integral part of the document and provides a basis for bicultural early childhood education" (Ministry of Education, 1996. p. 10).

Primary

McKinley (1996) was a member of the team writing Marautanga Pūtaiao (Science curriculum), stating that "Curriculum development is inherently a political process" (p. 155). As a member of the establishing team, McKinley provided an explanation of how the drafting process was

conducted as well as a brief overview of the science curriculum in New Zealand pertaining specifically to Māori. During the 1990s, New Zealand's curricula were given an overhaul - a time that marked the first national curriculum documents that were written in Māori. Deciding on the content to include, how to write the document, and learning models recommended are all potential spaces for contest. The addition of a specifically Māori curriculum creates greater opportunity for these conflicts and others. One section caused particular conflict; the Pūtaiao curriculum had an extra strand - Ngā Tautake Pūtaiao me ngā Kōrero-o-Mua (the philosophy and history of science) - which was not considered necessary within the English version.

Stewart (2011b) looked at the inclusion of the "extra strand" within Pūtaiao compared to mainstream science. She explained the strand's recommendations were to be taught using narrative pedagogy to embrace the Māori origins. Stewart discussed the process of translation highlighting (as do others) the issues that arise when cultures meet. Because the curriculum writers were "mixing religion and science" (through the naming of the Māori creation gods or atua) (Stewart, 2011b. p. 1178), the Prime Minister's Committee ordered the revision of the Pūtaiao curriculum. This objection resulted in Stewart changing her translation from stating that "this strand is protected by the majority of familial deities," to a less explicit "this strand is metaphorically associated with the majority of the traditional familial deities" (p. 1178). Stewart explained that the previous version of the Pūtaiao curriculum specifically mentions "Māori scientific knowledge" under the heading "Māori and science" (p. 1178). By not naming the Atua, Stewart argued the curriculum has returned to cultural imperialist policies and was moving toward the suppression of Māori ontological and epistemological concepts.

The Pūtaiao curriculum, McKinley argued in 1996, was steeped in politics, and remains so today. The history of Māori education in New Zealand has resulted in a European style pedagogy becoming the dominant form of education in mainstream schools, regardless of student culture (Savage et al., 2011). Structural racism is a form of racism that is embedded within society - often unnoticed by the dominant culture. It exists within the systems of our lives, such as the health system, and the education system. Unfortunately, when working with Māori specific education, one encounters structural racism, from the policy level down to the classroom level. Individual teacher attitudes impact Māori learning, but this review is more concerned with the impact of policies, such as the guidelines provided for the development of the Pūtaiao curriculum (McKinley, 1996; Stewart, 2011b).

Hopkins (2010) conducted a study of the potential value in providing a mobile science laboratory to Kura. She argued that there was a significant lack of resources for Pūtaiao, especially if Kura wished to investigate the natural science of their local area. Kidman et al. (2013) explained how pedagogy used within the primary science classroom promotes a hidden curriculum. Their study compared experiences of indigenous students in New Zealand with indigenous students in Taiwan, discussing how definitions of knowledge and pedagogy impacted a child's attitude toward science, and consequently their success in the subject. It is necessary for literature to provide a context for the current position of Pūtaiao in order for teachers to understand how to approach the teaching of it to teach teachers and hopefully help to increase their cultural competency.

Wood and Lewthwaite (2008) conducted a study to determine the current state of Pūtaiao in Kura. Reporting on the study in stages, the article referenced here focuses specifically on the beginning aspects of a "multiphase science education development project" (p. 625). The study's aim was to pinpoint the areas of success in a science education program that "honors Māori aspirations" (p. 626) as well as identifying the barriers and support for achieving these aspirations. Wood and Lewthwaite highlight that science in the New Zealand Curriculum (Ministry of Education, 1993) specifically demanded that English medium teachers be culturally responsive when teaching Māori students. McKinley, Wood and Lewthwaite explain how the document has been criticized for attempting to fit Māori science into an English framework. Their article continues by stating that Pūtaiao as a curriculum promotes a "two world" (p. 628) knowledge system, allowing for a rich learning experience and for cultural boundaries to be crossed.

Rofe et al. (2015) conducted an empirical study using interviews with Māori teachers as an investigation tool into how these teachers conceptualize science inquiry. Their paper concludes with potential models for professional development, such as teachers from nearby the English medium schools providing support in the form of scientific teaching knowledge, with the possibility of the Wharekura teacher helping the school to support their Māori students, establishing a sustainable reciprocal program. Savage et al. (2011) drew attention to a (2007) study by Timperley et al., and Fung, which suggested that professional development would "enable teachers to respond better to the reality of diversity … rather than continuing to teach to a hypothetical mainstream" (p. 184).

Secondary

Stewart (2011a) investigated the results of Pūtaiao education, discussing whether or not Māori students' achievement in science has had the intended outcome, and whether they have begun achieving more highly since its implementation. Stewart took a positive approach, and argued that the Pūtaiao curriculum should be developed as a Kaupapa Māori curriculum. She stated that the result would be different to producing an "indigenous" science (Stewart, 2011a, p. 735) and doing so would allow Pūtaiao to be understood in a deeper manner than merely "what" it is as traditional knowledge (p. 735). Stewart provided solutions: The rearticulation of Pūtaiao using six points of awareness, and critical thinking about cultural positioning and Matauranga Māori. She also discussed the possibility of needing to create a register of Te Reo Māori for Pūtaiao and

relaxing the no English language rule in senior Pūtaiao classes. Bishop et al. (2006) also stated that "Māori medium education needs to be developed on its own terms … it is crucial that all components … be legitimate in the eyes of those who initiated the establishment and development of the system" (p. 45). Bishop et al. argued that simply translating the existing English language system into Māori does not allow for the transfer of cultural ways. As the Māori and Western worlds are based on a different understanding of the world itself, Western-based programs and curricula are unable to be simply translated into the Māori language, which is deeply interlinked with Māori culture and the Māori worldview.

THE CASE STUDY

Māori secondary school students' engagement in science is considered a barrier to their long-term interest in science. According to PISA results, Māori students perform poorly in science at national examination and the performance of students from Māori medium schools is worse than mainstream students. Some researchers, for example, Reid (2010) argued that positive relationships that support student's strong sense of being Māori may play a role in their engagement and achievement in science. This small case study provides an insight into non-science specialist Māori teachers coming out of their comfort zone to support their students to learn Pūtaiao.

Access to the Kura was gained through an existing relationship built earlier by one of the researchers. Two teachers and their respective year 9 and 10 classes participated in the study. Palmer (2009) argued that motivation was both a pre- and co-requisite to science learning. Features that arouse situational interest include personal relevance, novelty, activity level, and comprehensibility (Alexander et al., 1994; Eccles and Wigfield, 2002; Schiefele, 1999). Underpinned by these ideas, the research set out to engage students, as well as teachers, through several hands-on physics practical activities in a 2-h workshop. There was high engagement from the students and teachers and through creating situational interest we had created learner curiosity which was evident in student questions that followed. Participating students had not any formal Pūtaiao or science learning before this as the Kura was not able to attract teachers who had both a science background and fluency in Te Reo Māori.

Following the workshop, researchers and teachers met to discuss what would be most useful to support teachers for them to be able to teach Pūtaiao. Teachers said, "we don't know any science and have not taught it before." It appeared to be a confidence issues which the teachers could overcome (Rofe et al., 2015). We found that participating teachers had strong pedagogies, knowledge of students, and a common language, Te Reo Māori, and good relationships with their students.

During the year, the researchers taught 10 2-h lessons where teachers and students learnt science together through engaging in hands-on practical activities. We unpack the first session in detail to illuminate what prior knowledge students brought to the learning situation and what further learning ensued.

Investigating the Speed of a Golf Ball - An Illustrative Example

The lesson began with a video-clip of Usain Bolt winning the Olympic gold medal (https://www.youtube.com/watch?v=0PH0SV4j1Es). This was followed by a discussion about speed and the lesson was introduced. The students were told that the class would go to the school field to investigate the speed of a golf ball and they were given time to think how they could carry out the investigation. It was generally agreed that they needed to hit the ball, measure the distance it travelled, and the time it took to travel the distance.

Questions:

Researcher: How many people do we need in each group?

Student: Three, one to hit the ball, another in-charge of a stopwatch, and the third to walk the distance to work out how many meters the ball had travelled.

Students organized themselves into groups of three.

Through teacher questioning, students decided that the tape measure (200 m) would not be adequate to measure the distance travelled by the ball. The tape was laid out on the field and students counted how may steps would cover the distance of 200 m.

Teacher: Did everybody take the same number of steps?

Student: No. Well one person in each group could walk the 200 m and count their steps.

One teacher suggested that it would be better if each student in the group was able to take turns on each of the roles. Students were supported by the teachers.

Student: How can we make sure that our measurement of the steps is about the same?

Consensus was to have 10 people walk the distance and count the number of steps, then, they could add them up and divide by 10 to get an average. It appeared that this had been taught in some other context and students were able to work out the average number of steps that added up to 200 m. Student then took off to different parts of the field armed with a golf club, a stopwatch, a golf ball, and a book to record the time and distance.

Students enthusiastically went about collecting data and then returned to the class.

Back in the class, first, each group worked out the speed of their golf ball. Then, the data from all groups were collated on the board. Students copied this table into their books and then worked out the speed of a golf ball.

Students were asked to work in groups and consider their findings. This led to discussion about why they could not infer that the speed was the same for each ball.

One student said: Tom might have hit the ball very hard and Mary's ball did not go the same distance.

Another said because the balls were different they may not be "equally heavy."

Reflection

The teachers and researchers reflected on the lesson and agreed that before the class ended, through questioning, we could see whether students were beginning to develop some idea about the investigative process. With support, students had managed to plan and carry out an investigation and tried to make sense of their data.

One teacher's initial reaction was that back in the class there was a lot of "thinking" and she did not see it as hands-on. We agreed that:

- Student engagement was high and it appeared that some had played with a golf ball and club before.
- Students knew how to measure and record the data.
- They had done some exercises in maths and all groups were able to calculate the speed of their ball without any help other than a calculator.
- With support, they were beginning to think about their data in a thoughtful and critical manner.

Researchers received an email from the teachers that in the following lesson they had taken the class outside to find out the speed of a basketball by following our model lesson. After two workshops, the teachers informed us that they had begun to teach 2 h of Pūtaiao each week. We cannot say what was taught and learnt in those 2 h each week as we did not observe this teaching. What we can say is that the teachers had gained confidence to believe that they could teach Pūtaiao. In the year following the research project, one of the participating teachers took on the responsibility for the development and implementation of a Pūtaiao program for years 1-10 in this school.

We acknowledge that students and teachers were taught science in English, which was a huge compromise for the school that is committed to teaching in Te Reo Māori (for further details of the full case study see Moeed et al., 2016).

CHALLENGES IN PŪTAIAO

McKinley (2005) outlined several of the challenges faced in Pūtaiao, drawing attention to the pressure faced by the curriculum writers to parallel the English documents. Consequently, Pūtaiao has run into more challenges as the document is merely an "English translation with some minor organizational alterations and some superficial additions" (p. 235). McKinley argued that there was a need for a document that was reconceptualized for Māori education. The existing document is nonetheless agreed by curriculum developers to be the "first step" toward a Māori science curriculum.

McKinley (2005) stated that the use of Te Reo Māori as the language of instruction was a practice that was uncommon in the literature. The benefits of speaking only Te Reo Māori include enabling students to maintain a Māori identity as well as alleviating anxiety involved with learning a second language:

> The inability to recruit Māori teachers, however, who are fluent in Māori language have good cultural knowledge and are competent in the teaching of science, has been identified as crucial in the development of the science potential of children learning in Kura kaupapa (McKinley, 2005. p. 236).

McKinley (1997; 2007), Stewart (2011b) agreed, stating that there is a "vacuum of professional practice" (p. 726) due to an absence of resources, facilities, and development for teachers. Explaining the language barrier, Stewart argued that by not using international science terms, students were constantly forced to catch up with English speakers, and subsequently were less able to participate in wider science discourse.

Stewart (2011a) also draws attention to the problematic clash between Māori and the "science" worldview and knowledge. The difference between science and Pūtaiao was addressed at the start of this review, but it is appropriate to consider once again the impact that the difference may have on students. Stewart pointed out the problems associated with the National Certificate of Educational Achievement examinations in science. Students can sit the examination in Te Reo Māori, but Stewart asserts that the process these documents undergo results in neither an English nor a Māori examination. As the examination originates as an English language document, Stewart argued that the translation provides for Māori students an allowance by "language only" (p. 730), rather than Māori being able to have an input into what is examined.

The challenges faced by Pūtaiao include inadequate professional development. A lack of professional development available becomes a barrier to the improvement of Māori teacher knowledge (Hāwera and Taylor, 2011). As demonstrated in the above-mentioned literature, professional development programs and interventions can be effective ways of helping teachers learn new skills and gain more confidence. This was also evident in our case study school. We supported the teachers to gain confidence and then teach science to their students. Teacher belief and perception of having access to support led to positive outcomes for the teachers (Rofe et al., 2015). Such professional development is rarely available to teachers in Māori medium schools.

A related issue is the development of a Pūtaiao dictionary to support the teaching and learning of science in Te Reo Māori (Ministry of Education, 2009). Stewart (2007) argued and Rofe et al. (2015) agreed that this has added to the challenges to the learning of Pūtaiao in Te Reo Māori with the teachers and students having to learn a sizable vocabulary along with learning Pūtaiao, adding to their existing challenges. We have certainly found this in our case study school where both

teachers were having to learn an entire vocabulary to be able to teach science in Te Reo Māori, this added another layer to the students learning.

Despite the challenges associated with teaching Pūtaiao, the literature tends to agree that when content is not relevant to a student's culture, background, or the reality of their daily life, they are unlikely to be engaged in the learning process (for example, Bishop et al., 2006). Pūtaiao, built on Kaupapa Māori values, allows Māori students to integrate their lives with their schooling.

MAIN FINDINGS/CONCLUSIONS

Pūtaiao is taught in Māori medium schools in New Zealand. It encourages students and teachers to learn about and understand science from a Māori point of view. It has been developed as a part of *TMoA*, and researchers have stated that ongoing refining of the document will help combat challenges.

The field of Pūtaiao studies is small, but there is a gradually growing body of work becoming available. Still needed is work focusing on teacher education and professional development of Pūtaiao teachers. It was difficult to find literature related specifically to Pūtaiao within Wharekura, which was the initial purpose. The lack of literature is equally as important as discovering what does exist, and this review helps to demonstrate the pressing need for more research. Pūtaiao as a subject is facing several challenges that may be combated through more specific interventions - rather than studies investigating Kura as a whole. Despite the challenges faced, the literature overall has a positive outlook. Pūtaiao is enjoyed by students, who see it relate to their own knowledge and culture. Teachers of Pūtaiao are willingly learning new vocabulary for their students, and participating in professional development where possible. In addition, among mainstream schools, many of the studies had positive impacts by raising awareness among teachers in how to teach Māori students, and how to incorporate some of the values that are fundamental to Pūtaiao. This merging of subjects may be useful in the future, as more resources are developed for each side of the curriculum - despite highlighting the differences between Pūtaiao and science, the subjects both deal with the world we live in, and realizing that there exist multiple perspectives to understand it is a vital skill for all students in New Zealand Aotearoa.

In our view, if policymakers are concerned with raising the engagement of Māori students in science with the view of enhancing their achievement, Pūtaiao/Science needs to be taught in these schools. Policymakers need to provide professional development and support to enable Māori medium teachers to teach their students Pūtaiao/Science, who already have a strong identity as Māori, and a command on Te Reo Māori. Further research in this field is urgently needed.

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