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Whakarewarewa Thermal Village as a Living Laboratory for Indigenous Materials Science Outreach and Education

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ABSTRACT

The Māori people of Whakarewarewa thermal village have grown knowledge of their unique surroundings – New Zealand's iconic geothermal field in Rotorua – over centuries of sustainable living. More recently, this living village has welcomed visitors (manuhiri) to experience life and be exposed to the body of indigenous knowledge – Mātauranga Māori – held in the village. Whakarewarewa thermal village has now forged a partnership with The MacDiarmid Institute for Advanced Materials and Nanotechnology; a New Zealand centre of research excellence. In this partnership, we are using the physical and cultural context of Whakarewarewa thermal village as a living laboratory for materials science research, outreach and education. With a blend of traditional and modern tools, we have co-created a program that engages the local community, schools, the public, and visitors to be part of an exploration that bridges Māori and western knowledge systems. We find that modern materials analysis corroborates traditional knowledge and motivates enhanced engagement in both domains. The broad distribution in the community will add to the impact, particularly in widening the appreciation of Mātauranga Māori and scientific methods. By engaging a local guide along with schools in data gathering and knowledge sharing, including school curriculum-linked activities, the program provides meaningful experiences of mātauranga and science in practice. Underlying themes like water and air quality highlight the relevance of science to students, while Mātauranga Māori provides researchers with examples of materials science as being about the smart use of natural resources. Through this partnership, we aim to open science pathways for all students, including Māori students and others connected to the village that will ultimately benefit their communities.

1. INTRODUCTION

Whakarewarewa village ("The living Māori Village," 2019) is located in the North Island of Aotearoa in Rotorua. Its rich cultural heritage, history and unique geothermal landscape is showcased by its tourism operation, where by the village itself hosts tourists to come into the village to learn and enjoy the uniqueness of this living village. The full name of the village is Te Whakarewarewa-tanga-o-te-ope-taua-a-Wāhiao (Neilson, Bignall and Bradshaw, 2010) describing the uprising of the warriors of Wāhiao. Ancestrally the Māori people of Whakarewarewa are descendants of those who travelled to Aotearoa-New Zealand on the great canoe (waka) called Te Arawa around 1350 AD (Pohuhu et al., 1997). With them they brought a plethora of knowledge from the island whence they came located in Eastern Polynesia. Once arriving in Aotearoa, their knowledge was adapted and grown to suit the much different cooler climate. Old narratives are commonly heard to describe the great journeys of the canoes and the people that were on board. The ancestor to the people of Whakarewarewa is the high chief and tohunga, Ngātoroirangi. The descendants of that canoe that settled in the village identify as belonging to the tribe Tūhourangi-Ngāti Wāhiao amongst others.

The MacDiarmid Institute was established in 2002, as one of the first Centres of Research Excellence established in Aotearoa-New Zealand ("MacDiarmid Institute", 2019). It specializes in research into Advanced Materials and Technology and set an initial example for how Centres of Research Excellence can function as national collaborations, by combining two collaborations, centered around condensed matter physics at Victoria University of Wellington, with expertise in Nanotechnology at the University of Canterbury. From this initial basis, it has grown over the last 17 years and includes synthetic and physical chemistry expertise relevant to materials science, from across the country - including the Universities of Auckland and Otago, Massey University, and a Crown Research Institute, the institute of Geological and Nuclear Sciences ("GNS", 2019). The final formal partner in the Centre is Callaghan Innovation, a government agency dedicated to supporting science and innovation in industry. Callaghan Innovation is named after the founding director of the MacDiarmid Institute, Professor Sir Paul Callaghan, who set out from the beginning of the MacDiarmid Institute's history to create what he called Culture Change within the academic and research environment in New Zealand, in particular to encourage commercialisation and entrepreneurship amongst scientists to support economic development, without the environmental constraints associated with more traditional primary industries.

The vision of The MacDiarmid Institute is thus threefold: to create an environment in which scientists can conduct world-leading, excellent research in New Zealand; to create a culture that promotes the commercialisation of research, for example by promoting and supporting start-ups founded by our researchers and students; and finally, to engage New Zealand communities in understanding the positive role that science can play in society both through economic development, and through providing knowledge and tools that are themselves socially empowering. An example of the non-economic social impact of materials science and technology that has taken on greater importance in recent years, is the potential impact of reframing materials science as being innately based on the smart use of natural resources. It is important that the general public understands the role of chemical processes in manipulating the carbon cycle, for example, and that materials-based technologies are being developed that could help mitigate climate change.

Within the institute there has been a longstanding desire to establish meaningful collaborations and research with Māori communities, Iwi (tribes) and Hapū (sub tribes). Early relationships have been established at a personal level by previous directors of the Institute, but the relationship with Whakarewarewa has been made possible by the scientific partnership that underlies the Institute, namely the role of Geological and Nuclear Sciences (GNS) and its longstanding connection to Whakarewarewa on the basis of geothermal research.

Two and a half years ago, initial meetings were held to discuss whether a connection between The MacDiarmid Institute and Whakarewarewa Village would be able to deliver additional support to the educational and scientific aspirations of Whakarewarewa Village. The scientific collaboration that has since been established, integrating related scientific data and Mātauranga-a-iwi (tribal Māori knowledge) to better understand the formation of natural colours on rocks at geothermal vents and deposits from geothermal waters, is described in a separate paper (Natali et al., 2019).

This paper describes the engagement methods and planned activities that have thus far come from the collaboration, focusing predominantly on the education and outreach activities which are planned to commence in late 2019 and early 2020.

2. EDUCATION ENGAGEMENT

Education engagement and outreach has become increasingly important across the science landscape in Aotearoa-New Zealand. Over the past 5 years initiatives by the government have increased the number of outreach programmes being conducted across the country which is largely due to the introduction of A Nation of Curious Minds - te Whenua Hihiro i Te Mahara Fund (Curious Minds, 2019). The aim of this fund is to encourage New Zealanders to engage in science and technology. A particular aim of this fund is to reach 'hard to reach' groups. Māori youth are considered one of these groups, thus a number of outreach programmes have been developed and implemented with the help of this fund. Importantly also it should be noted that there has also been a broader cultural shift across the science sector which recognizes the importance of engaging with Māori in a more respectful and substantial way. This shift is due to many factors including higher order directives coming from government and funders to engage. In addition scientific organisations have also taken a broader scope in recognition of their responsibility to support students to see themselves as able to become scientists. In a world in which most PhD researchers do not end up in academic research jobs, the science community needs to take greater responsibility for communicating with students, and their parents and teachers, about the different pathways that studying science can enable.

The higher order directives from government that encourages and expects engagement is framed within the context of the Vision Mātauranga policy (Vision Mātarauranga, 2007), which was developed in 2005 by Professor Charles Royal at the Ministry of Research, Science, and Technology (now the Ministry for Business, Innovation and Employment, MBIE). This framework aims to address the need to actively engage Māori and Māori knowledge with Research Science and Technology. The objective of Vision Mātauranga is to act as a guide to unlock the potential of Māori knowledge, resources and people (ibid), thus enabling the opportunity to engage with Māori communities and people to develop and realise Māori aspirations and potential. There are four themes in Vision Mātauranga (ibid):

1. Indigenous Innovation: Contributing to Economic Growth through distinctive research and development.

2. Taiao: Achieving Environmental Sustainability through Iwi & Hapū Relationships with land & sea.

3. Hauora/Oranga: Improving Health and Social Wellbeing.

4. Mātauranga: Exploring indigenous knowledge and research, science and technology.

Although these higher order directives have increased the need, want or desire to engage with Māori, for some institutions there has been a self-directed drive to engage. Since 2017 The MacDiarmid Institute is one such institution that has been engaging in a relationship with Whakarewarewa, in which they have been discussing how to collaborate most effectively to deliver the aspirations of Whakarewarewa Village. Three main areas have thus far been identified, the first being a research collaboration (see Natali et al, 2019), followed by community engagement, both to open the process of science to community inspection but also to educate scientific researchers about the needs and interests of local communities. The third goal is to deliver direct educational support to local schools, based both on Mātauranga Māori (Indigenous Knowledge) and scientific research. This threefold set of goals has required a large timeframe in order for the collaboration to grow through knowledge sharing and relationship development (a crucial part of collaboration with Māori that at times is underestimated) known to Māori as whakawhanaungatanga. Through this development we see that the initial scientific partnership will provide knowledge, and support the development of narratives based both on science and on Mātauranga Māori, which will be enriched through the programme of engagement and finally, support collaboration with and outreach to schools.

The initial scientific engagement with Whakarewarewa has focused on understanding the formation of natural colours on rocks at geothermal vents and deposits from geothermal waters. This project takes into account the realities of living with natural hazards and adapting to this environment. It is expected that within this collaborative research, the mutual benefits that will arise will be the development of both Māori and scientific understanding of frontier materials science, corroboration of historical knowledge and identifying new research opportunities. The research team contains experts who share an interest in exploring synergies between the two knowledge systems; in particular, as The MacDiarmid Institute has an interest in learning about how to most effectively frame materials science as being about the smart use of natural resources, in the context of sustainability. Research outcomes will be communicated at meetings (hui) and conferences, and we will aim at publishing our research findings in international journals.

To deliver on our engagement and education goals, the development of an education laboratory has been the main focus of development in 2019. Currently the laboratory is a collaboration between GNS and Whakarewarewa and contains examples of research that is being conducted by GNS.

A combined and agreed new vision is outlined in the following section.

2.1 The Lab - Te Mātāpuna o Papatūānuku

The Lab is a small building located within the Whakarewarewa Village with a floor size of approximately 80 m^2. The facility is known as facility Te Mātāpuna o Papatūānuku..The building is separated into three areas, with two main entrances into rooms 1 and 2. The first entrance currently takes you into a large room (Room 1) with rocks displayed in cabinets and other scientific information on the walls. The room then transitions into another room (Room2) that houses a television screen with GNS scientists talking about their research. On the walls there is also information shown which includes traditional narrative about the area, as well as scientific information. Within this second room there is a window and a door that leads into Room 3. Room 3 is a small room that houses scientific research equipment to measure air particulates outside the building. Room 2 then has a second access point to outside. The current configuration of the lab and its contents was a collaboration between Whakarewarewa and GNS Science. The current configuration is shown in Figure 1.

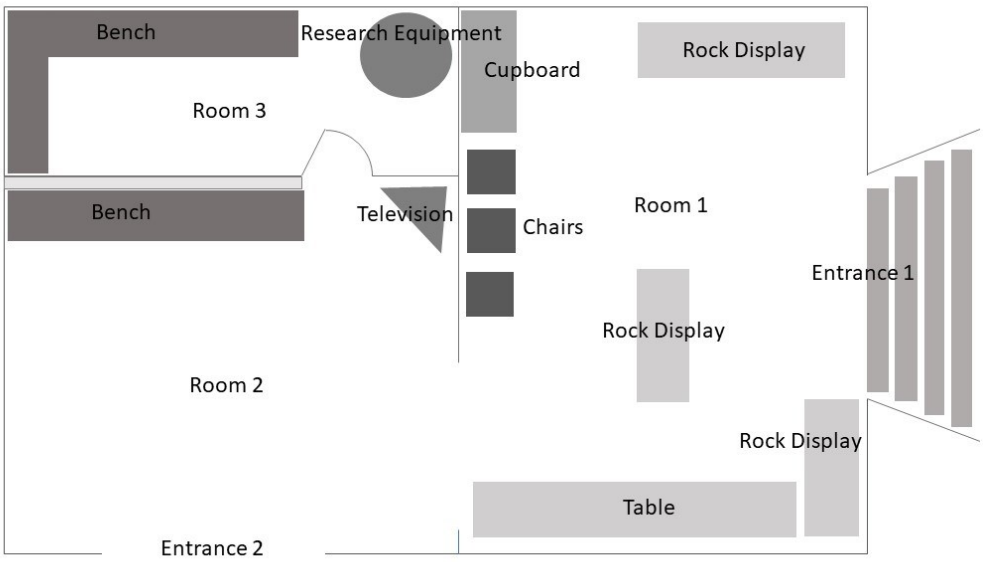

Figure 1: The current layout of The Lab at Whakarewarewa. Posters display information on traditional Maori narrative and western scientific information throughout on the walls.

Within the new design what was critical is that it should be accessible to all visitors (manuhiri), including Māori, and domestic and international tourists coming into The Lab. Research that is highlighted currently is highly technical, thus a shift to making the research accessible and understandable to the local tribe, residents and visitors (all manuhiri) is essential. The first phase is currently underway, where current research material in its technical form is being gathered to be rewritten into accessible / understandable language. Upon completion, the next step will be to create a variety of dissemination platforms. These platforms will be a mixture of permanent poster forms and videos showcasing the research.

In order to make it accessible, it is also essential that the indigenous language of Aotearoa-New Zealand is also used. Thus it is expected that all written material in The Lab will be in both the Te Reo (Māori) and English. This is not uncommon, and examples of how this is done on a large scale is at the national museum in Wellington Aotearoa-New Zealand called Te Papa Tongarewa, whereby all information is bilingual in Te Reo (Māori) and English. A key priority is also to build on the current narrative already displayed on Māori knowledge of the area and geothermal phenomena. Traditional understandings, observations and practices within the Village will be displayed upon negotiation and permission by the Whakarewarewa Board. What and how this is to be undertaken is currently in discussion.

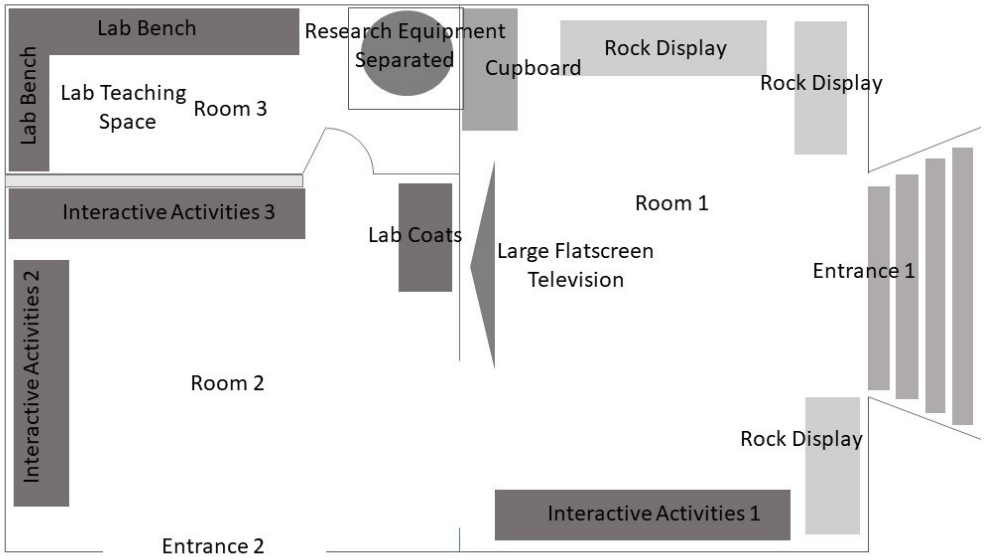

Figure 2: Future laboratory layout sporting a new large screen television, interactive activities and lab space for school students.

The project is currently in the 'activity design phase', whereby a set of interactive activities that visitors (manuhiri), including Māori, and domestic and international tourists, the community and school children can come in and interact with the activities. Through many discussions between the collaborators, various considerations have been identified. When considering activity design, and engagement the main factors thus far are to ensure that the activities factor in differing parameters, including, but not limited to:

- Cultural appropriateness
- Balanced perspectives
- Difficulty levels
- Age
- Height
- Language
- Ways of learning
- Accessibility issues
- Fun and interactive engagement methods
- Tactile learning techniques

Activities need to be culturally appropriate and relevant and consider different ways of learning (Harris, 2017). This is to ensure that audiences, in particular Māori are engaged in a meaningful way that they can relate to. Also tactile interactive activities are particularly important when engaging youth. In terms of content, we value the need to develop a balanced perspective between Mātauranga Māori and western science in a way that aligns to the aspirations of the village. Content also needs to be at an appropriate academic level, which will be challenging given the large age range and different cultures that come into the village. Particular importance will be given to language as outlined above. Also to be considered are accessibility challenges whereby those disabled will be able to access and engage in the activities. In Figure 2 this is thus far addressed with the large open space in both Rooms 1 and 2, however access to the laboratory space is limited and more thought needs to be given around this.

The design of the activities is currently being conducted. Currently we are envisioning a functioning laboratory for school children, which will have such things as Māori designed lab coats, and computers in Room 2 to conduct analysis and in room 3 a space to do fun and interactive experiments relevant to geothermal science. How and by whom the functioning lab will be taught by is still being discussed but it is envisioned that future support by GNS and The MacDiarmid Institute, that will see a part time education specialists able to facilitate the teaching. Much will need to be considered as we design the activities. The large screen television in Room 2 will replace the television in Room 1 which currently plays programme and film content, of GNS scientists talking about their research.

In the redesign of The Lab, a set of videos will be developed that will showcase both locals (including Māori) and scientists talking about their understandings and research of the geothermal features. Māori scientists will also be showcased, when appropriate on the videos to talk about geothermal concepts to add a layer of positive role modeling that we hope to inspire the Māori youth that will watch. These videos will also include archival video footage that will showcase past documentaries of the area, along with scientific research that has been undertaken within the Whakarewarewa Geothermal Valley and the wider Rotorua Caldera.

These videos will be professionally filmed and edited to give a high quality finish and extensive discussion will be conducted with all parties in order to produce a meaningful and quality delivery. The collaboration between Whakarewarewa, The MacDiarmid Institute and GNS brings together significant expertise that will enable the design of a unique cultural experience for the domestic and international tourists, while also being an educational and teaching tool for all youth, (including Māori) that will be both relevant and engaging.

2.2 Education Programme

Although in its infancy, here we mention an upcoming development is the design and implementation of an education and education outreach programme which will be available to all youth around the region of Rotorua and further afield. Ongoing discussion with Whakarewarewa about their education aspirations culminating in the idea of an outreach programme. Whilst education programmes can be done in a variety of ways from large scale expos to small scale programmes (Harris, 2017). Educational outreach needs to be something that works for both the wider community and the collaborating institutions. For this reason planning has begun to hold three wananga (knowledge sharing events) with, 15 to 20 students that are nominated from schools from around the region. These wananga will run for two full days and will involve interactive activities related to Mātauranga Maori, geothermal science and material science that is culturally relevant.

Suggested locations are those related to the history of the formation and creation of the Village itself. Whereby traditional narrative explains the formation of volcanoes and geothermally active areas by two goddesses whom travel in the earth surfacing at various points including Whakarewarewa (Neilson et al., 2010). It is thus appropriate that the locations of any wananga for local Māori align with these places so closely linked with the Village to frame and position the programme within the relevant landscape connected to Whakarewarewa. Development of the programme and activities will take place from late 2019, into early 2020.

3. RELATIONSHIP DEVELOPMENT

Relationships between research organisations and indigenous communities have been fraught with bad experiences. Indigenous peoples have become accustomed to the swiftness of researchers to swan in and swan out without any return to the indigenous peoples who are the target of the research (Smith, 1999). With the increasing amount of engagement by researchers with Māori by research institutes it is important to understand the way research and collaborations need to be conducted in order to make them meaningful and genuine. For this most Māori researchers will utilise and implement kaupapa Māori methodology (Smith, 1997; Pihama et al., 2002). This methodological approach diverges appropriately from that of standard anthropological practice. Kaupapa Māori research is connected to Māori philosophy and principles (Smith, 1997), is culturally safe (Irwin, 1994) and inherently recognises the validity and legitimacy of Māori and Māori knowledge (Smith, 1997).

There are a number of key elements of Kaupapa Māori theory (ibid), which have been further developed by others (Pihama et al., 2002; Rangahau, 2019). We here outline some of these and describe how they are implemented in the Whakarewarewa, MacDiarmid and GNS collaboration.

The first, Tino Rangatiratanga is based on the principle of self-determination, whereby Māori have control over what they determine to be important and what they aspire to. The second, Taonga tuku iho – The Principle of Cultural Aspiration describes how Māori knowledge is at the core of the research and that cultural ways must be adhered to. The third, Ako Māori – The Principle of Culturally Preferred Pedagogy, acknowledges the unique ways in which Māori teach and learn. Fourthly, Kia piki ake I nga raruraru o te kainga – The Principle of Socio-Economic Mediation ensures that communities will benefit from the research in some way. The fifth principle is of the Extended Family Structure or Whanau (Family), which acknowledges the relationships within the Māori world and the importance of how these are established and maintained. The sixth, Kaupapa, ensures that the research is part of the collective vision of the communities being researched. The seventh, based on the Treaty of Waitangi, affirms the status of Māori as the first people of the land in Aotearoa-New Zealand and the last principle, called Ata, relates to the building and nurturing of relationships and ensuring the continued wellbeing of these (ibid).

Within the current collaboration these principles of Kaupapa Māori have been applied and adhered to as much as possible. We here summarise how some of these principles were implemented within the project:

- Tino Rangatiratanga: this is implemented by giving the collaborators autonomy over the research, education programmes and lab development. It is them that determines how the these outputs are realised from the outset. For example, does the collaborator want the outcomes of the knowledge to be published publicly; or only aspects or not at all; do they want educational resources made such as small publications or teaching resources; or is there some other type of resource that they wish to be made.

- Taonga Tuku Iho, the principle of cultural aspiration: Here Māori knowledge, language and laws take front and centre asserting them as the central pillar of the collaboration. The validity of these is more than acknowledged it is inherently known.

- Ako (Learning) Māori, acknowledges teaching and learning practices that are unique to Māori. Within the context of the lab and outreach programmes, we acknowledge the unique ways of learning and teaching that are needed to make the programmes relevant to Māori and thus a success. These might be for example teaching chants relevant to geothermal phenomenon in the wananga setting or creating activities that combine both mātauranga Māori and western science together to make them culturally relevant.

- Whanau (Family) Principle, acknowledges the importance of the relationships between the collaborators and researchers. The collaboration understands the importance of continued relationship that is long term and maintained.

- Ata Principle ensures that the relationships that are developed are genuine. The relationships will also have negotiated boundaries and interaction protocols that are appropriate in a Māori context and are respectful.

- Kaupapa or topic, that the research is to the benefit of the community (Taiepa, 1998) and that what is to be researched, designed or developed, is a collective vision for the purpose of the Māori community.

By implementing these elements of kaupapa Māori methodology the collaboration will continue to be respectful, genuine and beneficial to all.

4. SUMMARY

Māori have a proverb 'he waka eke noa' meaning we are all in this canoe together. The interpretation of this can describe the collaboration between the Whakarewarewa village, MacDiarmid and GNS, that is a collaboration where we row together as a collective with a common vision. In this paper we have discussed some of the collective vision of this collaboration which thus far has focussed on three goals centred around research, the development of an education lab and the design of an outreach programme. This paper focussed on the latter two and the engagement methodology used during the collaboration based on Kauapapa Māori Methodology. Although this collaboration has three main goals, there are more outcomes that result. These are invaluable relationships made between the three organisations and individuals, the new knowledge that is created between both knowledge systems and the transformation of Māori youth when engaging with a Māori Lab and outreach programme. It is an exciting space that breaks away from the business as usual collaborations that scientific research institutes are used to, to create a long standing relationship that is both meaningful and inspirational.

REFERENCES

GNS. (2019, 30 July). Retrieved from https://www.gns.cri.nz/

Harris, P.: Portable Planetariums in the Teaching of Māori Astronomy, in H. Whaanga, T. T. Keegan, & M. Apperley (Eds.), *He Whare Hangarau Māori - Language, Culture and Technology.* Hamilton: University of Waikato, (2017).

Irwin, K.: *Māori research methods and processes: An exploration*. Sites, 28, (1994) 24-43.

MacDiarmid Institute. (2019, 30 July). Retrieved from https://www.macdiarmid.ac.nz/

Neilson, G., Bignall, G., & Bradshaw, D.: Whakarewarewa a living thermal village–Rotorua, New Zealand. *Proceedings, World Geothermal Congress* (2010).

Natali, F., Warbrick, J., Harris, P., Huata, R., Kennedy, J., Bradshaw, D., Millar, B, Markwitz, A., Miller, M., & Paasi, K.: Exploring Synergies Between Māori Knowledge and Western Science on the Formation of Natural Colours. *Manuscript submitted for publication* (2019).

Pihama, L., Cram, F., & Walker, S. Creating methodological space: A literature review of Kaupapa Māori research. *Canadian Journal of Native Education*, 25(1), (2002,) 30 - 44.

Pohuhu, N., Smith, S., Whatahoro, H., & Te Matorohanga: The lore of the Whare-wānanga, or, Teachings of the Māori college on religion, cosmogony and history / written down by H.T. Whatahoro from the teachings of Te Matorohanga and Nepia Pohuhu, priests of the Whare-wānanga of the East Coast, New Zealand ; translated by S. Percy Smith. *(Memoirs of the Polynesian Society v. 3-4)*. Hamilton, N.Z.: University of Waikato Library (1997), 147.

The Living Māori Village – Whakarewarewa. (2019, 30 July). Retrieved from https://whakarewarewa.com/

Rangahau. (2019, 30 July). Retrieved from http://www.rangahau.co.nz/research-idea/27/

Smith, G. H.: The development of kaupapa Māori : theory and praxis. *Thesis* (1997). Auckland University Cited by Pihama, L., Cram, F., & Walker, S. (2002).

Smith, L.T., *Decolonizing Methodologies: Research and Indigenous Peoples*. Zed Books:London. (1999)

Taiepa, T.: Collaborative Management-Enhancing Māori Participation in the Management of Natural Resources, in Pūmanawa Hauora (ed) *Proceeding of Te Oru Rangahau Māori Research and Development Conference.* School of Māori Studies, Massey University: Palmerston North (1998)

Vision Mātauranga. Ministry of Research, Science and Technology. (2007). Retrieved from https://www.mbie.govt.nz/assets/9916d28d7b/vision-mātauranga-booklet.pdf