THE SITUATED ROLE OF TECHNOLOGY IN ENHANCING THE ACADEMIC PERFORMANCE OF INDIGENOUS STUDENTS IN MATHEMATICS LEARNING: APPLICATION WITHIN A MAORI CULTURAL CONTEXT IN NEW ZEALAND

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Date Received: 12/04/2018 Date Revised: 29/05/2018 Date Accepted: 24/06/2018

ABSTRACT

This paper looks at benefits of technology inclusion in global indigenous students' learning. Critical meta-analysis was undertaken of fifteen articles. It was found that Indigenous students learn better through a Culture inclusive curriculum. Technology can be an effective tool in creating a collaborative environment, where students can share their learning and build their knowledge from what they already know. This allows informal learning as well as classroom learning possible. Students are also able to bring their background knowledge into the classroom to learn better. However, this is only possible if students do not get distracted during its use. The type of assessment used will also determine mathematical achievement as for indigenous students' context of the question needs to be familiar for them to understand it better.

Keywords: Educational Technology, Inclusive Curriculum, Indigeneous Students' Learning.

INTRODUCTION

Mathematics is one of these subjects where indigenous students are underachieving (Averill, 2012; Abrams, Taylor, & Guo, 2013; Sterenberg, 2016; Grootenboer & Sullivan, 2013; Philpott, Sharpe, & Neville, 2009). Underachievement in mathematics could be due to many different factors, including the nature of this subject itself (Wong, 2002; Meaney, 2002), its pedagogy (Seah, 2002; Wong, 2002; Meaney, 2002), and/or how it is assessed (McKinley, 2001 cited in Abrams, Taylor, & Guo, 2013). Teaching mathematics needs to be taught not just as rules or algorithms, but in such a manner that students could actually understand and find it meaningful in their lives (Wong, 2002; Seah, 2002; Meaney, 2002; Tuinamuana, 2007).

An effective classroom tool could be the use of technology as it could allow collaboration amongst students. In the context of New Zealand's indigenous population called Maori, technology could be effective in Maori students' learning since working in collaboration is a cultural norm for them (Datt, Donald, & Carter, 2011; Wright, 2010) and other indigenous societies like the Canadian Aboriginals students (Philpott, Sharpe, & Neville, 2009).

Due to whanau (community) responsibilities, most of these low achieving Maori students have very poor attendance too and thus have big gaps in their understanding of mathematical concepts. Using technology to enhance learning could be a flexible and collaborative study option for these students as they could balance their personal lives and the educational demands (Datt, Donald, & Carter, 2011). Learning would happen anywhere and at any time suitable for these students (Kwon & Lee, 2010) and this could mean personalized learning experiences. Learning would

become more engaging due to timely feedback and could improve their academic achievement (White & Hudson, 2014). Socio-economic status of a child and their family are important factors (Bishop, Berryman, Wearmouth, & Peter, 2012; Hall, Hornby, & Macfarlane, 2015), but cannot be changed as straightforwardly as pedagogy.

1. Purpose and Significance of this Study

This study looks at the learning needs of global indigenous students and why they are underachievers in the education sector, especially in the subject of mathematics. Formal education is regarded by indigenous students as not relevant to them since it contains what the colonizers of the land thought was important attributes to have in the workforce. This historical factor is still evident in the current education system, which is examination driven even though this style of teaching has been already criticized (Tuinamuana, 2007).

Maori students work better through a culture inclusive curriculum (Averill, 2012; Averill & Clark, 2012; Bennett & Barbour, 2012; Bishop & Berryman, 2009). This could be achieved through various ways of teacher care mentioned in the "Te Kotahitanga principles" (Averill, 2012; Averill & Clark, 2012; Bishop & Berryman, 2009; Bishop, Berryman, Wearmouth, & Peter, 2012) and it highlights the importance of having a positive relationship. Technology use in the classroom could support this need further as it increases interactions between students and teachers and allows equal opportunities for both parties to learn in collaboration with each other (Bennett & Barbour, 2012; Wright, 2010). This could increase students' motivation (Zurita & Nussbaum, 2004) and engagement on tasks and improve achievement (Wright, 2010; White & Hudson, 2014).

This study will locate and analyse relevant literature which identifies benefits of technology inclusion in education for indigenous students globally and which has incorporated it successfully into the mathematics curriculum. Then construct an understanding about indigenous students' mathematical achievement using technology as an effective 21st century tool particularly for New Zealand Maori. In this study, the following questions would be answered.

2. Research Questions

- How well do indigenous students perform academically in mathematics, particularly within a New Zealand context?
- How can e-learning/ m-learning benefit indigenous secondary students' mathematical learning, particularly within a New Zealand context?

3. Methodology

3.1 Search Process

Different databases, such as ERIC, Google Scholar, ProQuest, WorldCat, EBSCOhost, ScienceDirect, SAGE Journal Online, JSTOR and professional publishers Science Direct Elsevier, Springer Link, and Wiley were accessed and searched for. Keywords such as "e-learning", "indigenous students' achievement", "mathematics achievement for secondary students", and "Maori achievement in mathematics" were used to conduct the searches. The bibliographies of the chosen articles and reports were used to identify other relevant materials and original sources for some chosen ideas. Additional search terms: collaborative learning, individual learning, Te Kotahitanga, Maori achievement, pedagogy, and technology were added to the original keywords to refine the search.

3.2 Selection Criteria

Selected articles were read thoroughly to look at its contents and then its suitability was determined. These studies had to be on:

- Indigenous students' mathematical learning
- Indigenous students' learning needs and styles
- Mathematics teaching and learning
- Inclusion of any type of technology into teaching and learning
- Use of technology in mathematics
- Indigenous students and technology
- Articles from 2000 to 2016

3.3 The Coding Process

An annotated bibliography was done and tabulated on selected articles (See Appendix Table 1). Then the selected studies were coded using the following criteria (Appendix Table 2): students (St), teachers (T), indigenous (I), Other Ethnicities (OE), Maori (MR), Primary (P), Secondary (S), Mathematics (Mt), using technology (T), or Other Subjects (OS). Research methods used in the study was coded as Mixed (M), Quantitative (Qn), or Qualitative (Q).

4. Overview of the Selected Studies

Overall, this study looked at fifteen independent studies and existing meta-analysis. Five of these studies either did not mention the sample, how it was chosen or did not include enough detail about it. Meaney (2002) and Abrams, Taylor, & Guo's (2013) articles did not mention their chosen sample for the study. However, both articles were about indigenous students' learning. Sterenberg (2016) mentioned grade 9 students, but not the sample size and Cobb (1988) stated the names and grades of the two chosen students and very briefly how one of these students was chosen. Grootenboer & Sullivan (2013) mentioned that although their sample size was small, it was a good representation of the students of the age group. Li & Ma (2010) stated that they had limited data from their chosen sample and thus could not determine student attitude towards mathematics using Computer Technology (CT) and how changing technology could impact change in the use of CT in the classroom.

To add on, the data collection methods of four of the studies were not mentioned properly and this means these studies cannot be replicated precisely or could even be biased. In Meaney (2002) and Abrams, Taylor, & Guo (2013), it was not specified at all. Sterenberg (2016) did mention it, but needed more detail like types of questions asked and student responses during the two planned lessons. Similarly, in Philpott, Sharpe, & Neville (2009), the individual and focus group interview questions, reasons for choosing those questions, and percentage of students who responded are missing.

Five studies had only one researcher thus they had to increase the reliability and validity of their studies. Wong (2002) included the student questionnaire reliability using the "Cronbach alpha reliability scale (Grade 6: 0.71, 0.59, 0.70; Grade 9: 0.73, 0.69, 0.75; Grade 10: 0.72, 0.71, 0.78; Grade 12: 0.73, 0.69, 0.76)" (Wong, 2002, p. 18) and teacher questionnaire used was stated as being validated by Perry. All the ideas of Sterenberg (2016) have been checked by the classroom teacher, Bryony. Averill (2012) had two cultural advisors, one Maori and one Pasifika, throughout the study and Cobb (1988) had four other reviewers for his article. However, Meaney (2002) did not mention any other person who reviewed the study or use of any reliability tool that was used.

All selected articles did a through discussion on its findings except Abrams, Taylor, & Guo (2013) who discussed some issues in methodology that occurs when conducting studies with indigenous people. These issues could affect the validity of the data collected. All the chosen articles have used either mixed methods or qualitative methods to data collection except Li & Ma's (2010) article, which has used quantitative method as it has calculated effect sizes of all its 10 chosen independent studies.

There are many different forms of technology being used in education today. Sometimes the particular technology is used due to the different features of the device itself like e-learning or m-learning. These allow learning to be ubiquitous since learning could happen anywhere and when needed. Two of the selected readings, Wright (2010), and Hsu & Ching (2015) are about learning opportunities due to the device. Wright's (2010), article is about benefits of using technology in the classroom and how students could benefit from it. This article also mentions different learning needs of indigenous students and how technology could address these effectively to meet the key competencies mentioned in the New Zealand Curriculum. Hsu & Ching's (2015) article is about different learning opportunities made possible due to portable devices. These learning opportunities are context aware learning, seamless and ubiquitous learning, mobile social learning, mobile computer supported collaborative learning, and game based learning.

Moreover, in some instances, a particular software makes the difference such as in Li & Ma's (2010) article.

Computer Technology (CT) includes software that could be different programs like Tutorial, communication tools, exploratory environment, range of tools, and programming language. Tutorial includes computer assisted instruction and could be used for drill and practice. Communication tools allows communication and makes information sharing possible through e-mail, videoconferencing, and the internet. This has been used in three of the selected studies, Bennett & Barbour (2012), Simonovits, Mcelroy, O'Loughlin, & Townsend (2013), and Philpott, Sharpe, & Neville (2009). Exploratory environment is active learning through inquiry, for example, the Logo mathematics project. Tools, such as PowerPoint, virtual manipulatives, and learning objects (Kay & Knaack, 2008) makes learning entertaining and effective. Programming languages include specific computer programming languages like C++ (Lou et al., 2001; Li & Ma, 2010).

Most articles chosen used semi structured interview as their instrument for data collection while one article used a structured interview. This article was by Grootenboer & Sullivan (2013), which used a one to one task based structured interview to give every student the same chance as everyone else to show their prior knowledge. Semi structured individual interviews were used for students and teachers in Averill (2012) and for e-students in Bennett & Barbour (2012). Averill & Clarke (2012) have used semi structured individual interviews for teachers and for students' focus groups. In Philpott, Sharpe, & Neville (2009) for students and teachers, both individual and focus group interviews, were semi structured.

The next common instrument used for data collection in the selected articles were structured or semi structured questionnaires mostly using Likert scale. Wong (2002) used structured 5 point Likert scale for both students and teachers' questionnaires. Averill (2012) used a structured/semi structured questionnaires with both students and teachers. Averill & Clark (2012) used semi structured questionnaires with Likert scale. Bennett & Barbour (2012) used semi structured online survey. Simonovits, Mcelroy, O'Loughlin, & Townsend (2013) used a semi structured questionnaires with 5 point ranking scale and open ended questions. Kay & Knaack (2008) used structured survey with 5 point Likert scale to rate student comments and 7 point for teacher comments. The other methods utilized were lesson observations (Averill, 2012; Averill & Clarke, 2012; Bennett & Barbour, 2012) and case study (Cobb, 1988; Sterenberg, 2016).

5. Discussion of Key Findings

5.1 Indigenous Underachievement in Mathematics

Educational achievement of indigenous students is low. This pattern is the same for the subject of mathematics for Maori learners (Averill, 2012), Australian indigenous students (Abrams, Taylor, & Guo, 2012), Canadian Aboriginals (Sterenberg, 2016) and for indigenous students in general (Grootenboer & Sullivan, 2013; Philpott, Sharpe, & Neville, 2009).

Australian indigenous students are behind in the NAPLAN test of numeracy and literacy than all the other ethnicity students at school years 5 and 7 (Department of Education Employment and Workplace Relations 2011 cited in Owens, 2014). These students also scored the lowest in Mathematics on the 2009 Program for International Student Assessment. In 2007, American Indian natives scored lower than the White students in the National Assessment of Educational Progress testing in Mathematics in the 4^{th}, 8^{th}, and 12^{th} grades (National Center for Education Statistics, 2010a, b, c cited in Abrams, Taylor & Guo, 2013). In the United States, fewer indigenous students' are in Mathematics related careers (US Department of Education, 2010 cited in Abrams, Taylor, & Guo, 2013). Similarly, mathematical achievement rates and low secondary education completion rates are an issue for Canadian Aboriginal students (Sterenberg, 2016; Philpott, Sharpe, & Neville, 2009) even after revised educational policies (Battiste, 2002). 56% of seven year olds and 100% of 15 year olds are behind in education and this trend worsens into higher education (Philpott, Sharpe, & Neville, 2009).

Maori and non-Maori students have a significant achievement gap in the New Zealand educational sector (Baskerville, 2009). In 2009, school retention rate until the age of 17 years for Maori students was 45.8% compared to 72.2% for the other students (Ministry of Education,

2010b cited in Bishop, Berryman, Wearmouth, & Peter, 2011). In the year 2010, probability of Maori students' leaving school at the age of 15 was twice the probability for 'Pakeha' students (Ministry of Education, 2011 a cited in Bishop, Berryman, Wearmouth, & Peter, 2012). This means their university entrance rate is low. "In 2009, 23% of Maori boys and 35% of Maori girls achieved university entrance compared to 47% and 60% for their non-Maori counterparts (Ministry of Education, 2010a cited in Bishop, Berryman, Wearmouth, & Peter, 2012, p. 50).

Being low achievers in a country leads to other related problems. Maori students are three times more likely to be suspended, enrolled in behavioral courses and in low stream classes. A higher number of the Maori population are unemployed, in low paid employment and are part of the poverty data and these create differences in their social, economic, and political stance (Bishop, Berryman, Wearmouth, & Peter, 2012).

5.2 What Works for Indigenous Students?

Policymakers need to look for effective solutions for raising the achievement level of indigenous students, especially by minimizing cultural issues (Averill, 2012). However, this should not happen at the expense of losing their culture, but through a culture inclusive pedagogy (Owens, 2014). The school curriculum, pedagogy, and assessment methods should acknowledge indigenous knowledge to make it relevant for indigenous students (McKinley & Stewart, 2009 cited in Abrams, Taylor, & Guo, 2013). To be treated equally in education, they need to achieve in standard mathematics (Grootenboer & Sullivan, 2013). Students should be able to learn school mathematics and be able to use that knowledge in their cultural settings (Owens, 2014). A culturally responsive curriculum values students' prior knowledge, allows collaboration in small groups and encourages positive relationships, and could prove to be effective for addressing underachievement.

Schools need to partner up with their local communities to make their curriculum relevant (Department of Education Employment and Workplace Relations, 2008, 2009; NSW Department of Education and Community, 2008; Slack-Smith, 2008 cited in Owens, 2014). Whanau (Bishop, Berryman, Wearmouth, & Peter, 2012; Hall, Hornby, & Macfarlane, 2015) and community involvement is important (Owens, 2014). This could motivate and engage indigenous students on tasks and could improve their achievement as curriculum would be relevant to them. Culture inclusive pedagogy such as 'placed based approach' (Sterenberg, 2016; Abrams, Taylor, & Guo, 2013) and 'Ethnomathematics' (Meaney, 2002; Owens, 2014) could be used. Community involvement could show indigenous students that their culture is valued since they respect their elders and this could provide equity in education for them (Kaur, 2012).

In order to have a culturally responsive curriculum, a school reform for the Australian Aboriginal students known as the Stronger Smarter Learning Communities (SSLC) has been formed. It emphasizes on having high expectations for indigenous students' learning, valuing their cultural backgrounds, having community involvement, and having effective staffing (Bishop, Berryman, Wearmouth, & Peter, 2012). The focus is directed back on the curriculum rather than students' unwanted behavior (Owens, 2014).

According to Piaget's theory of Cognitive Development, children show different level of understanding at different ages and that they follow through the four stages in the same order. Piaget's four stages of sensori-motor, pre-operational, concrete operations, and formal operations were used worldwide for mathematics curriculum development. Thus teaching mathematics became about what was thought to be appropriate at a certain age instead of starting from students' prior knowledge. "Children from non-western cultures are often considered as lagging behind their western counterparts" (Meaney, 2002, p. 174) as their prior knowledge is different. Since these four stages of Piaget's theory were not part of the indigenous culture, they meant to have the same prior knowledge at entering schooling as others, where indigenous children's home cultures needed to be modified to western home cultures. This means losing indigenous cultural identity.

A solution to this problem is recognizing that indigenous children do have prior knowledge, but it is different from

western children's prior knowledge as it is based on what their communities regard as important at their age. Meaney (2002), Sterenberg (2016), Grootenboer & Sullivan (2012), and Abrams, Taylor, & Guo (2013) state that teachers should try to activate prior knowledge of their students and build on it rather than try to start teaching on ideas that are thought to be appropriate in the school curriculum at that particular age.

A culturally responsive pedagogy is using students' prior knowledge in their learning. All students including indigenous students learn and retain information better if it is related to their prior experiences (Grootenboer & Sullivan, 2013; Battiste, 2002; Abrams, Taylor, & Guo, 2013). It helps them understand concepts better as students actively accommodate new knowledge onto their existing knowledge. Indigenous students struggle with mathematical problems that have foreign contexts since it is unfamiliar to them (Grootenboer & Sullivan, 2013). Using students' prior knowledge will show indigenous students that their culture is valued and could build positive relationships (Bishop et al., 2003 cited in Averill, 2012).

Another culturally responsive pedagogy is working in collaboration on activities. Students can share, create, and build on their knowledge (Bennett & Barbour, 2012; Philpott, Sharpe, & Neville, 2009; Wright, 2010) through collaborating on activities. These activities are student centered and thus becomes motivating and engaging for these students due to interacting with their peers (Wright, 2010; Datt, Donald, & Carter, 2011) and promotes higher order thinking skills (Zurita & Nussbaum, 2004).

Embedding technology to support indigenous students' learning Technology inclusion could promote increased interaction between students and teachers (Abdullah, Hussin, Asra, & Zakaria, 2013) and with other students and this means attending to their individual learning needs better. However, students could get easily distracted as they lack knowledge on using technology effectively in their learning.

Wright's (2010) article states portable device would allow Maori students to bring their cultural knowledge into the classroom and learn from using their prior knowledge. "Context-relevant learning information, such as weather conditions, historical sites information, or ecology systems can be automatically downloaded on mobile devices. Learners will be notified based on their locations and access the information for analysis and learning in an authentic context (The New Media Consortium, 2004 cited in Hsu & Ching, 2015).

Hsu & Ching's (2015) article mentions mobile social learning opportunities due to the learners' ability to be connected with others on social network sites like Facebook and Twitter. Wright (2010) backs this idea of using Web 2.0 tools in the classroom including Facebook as it has potential for maximizing learning opportunities in education. Features of these tools allow formation of videos or images for feedback rather than students being passive learners. Being socially connected means collaborating and sharing of these resources to create learning opportunities and promote informal learning opportunities (Kong et al., 2014).

Students are already using these social sites for educational purposes. In Simonovits, Mcelroy, O'Loughlin, & Townsend (2013), students used Web 2.0 tools, Facebook and Skype, to communicate with their partners and build on their knowledge on the mathematical topic of Trigonometry. In Bennett & Barbour (2012), students and teachers are using these tools for face to face interactions. Equally, students could use it to reflect on their learning, share tasks and assessment requirements and to give emotional support to each other if not accessing for content or contextual knowledge (Wright, 2010).

Conversely, Wright (2010) indicates the problem of students not being able to use technology wisely in their education. "Some students did not consider it serious learning due to the media they used (not published books or articles) and the environments (not school)" (Hsu & Ching, 2015, p.4). In Philpott, Sharpe, & Neville (2009), Facebook and MSN access are mentioned as an organizational issue, which needs to be limited as it is distractive for the students' learning. Lack of online supervision by e-teachers lets students "fool around or

talk" and not work on their activities (p. 9).

This creates the need for schools to "firewall" social sites. The potential of these social sites in education even though having the features to collaborate and to allow learners to be active still has not been realized. There are very limited research on Web 2.0 tools for social learning in education compared to research on m-learning devices in educational context. According to Hsu & Ching (2015), mobile technology could assist social learning through allowing both formal and informal learning to happen in and out of class which makes learning relevant and meaningful.

A solution to the problem of firewalling could be teachers facilitating effective use of these tools in the classroom (Greenhow & Robelia, 2009 cited in Wright, 2010). "The evidence is mounting that teachers are critical to good learning, regardless of whether or not e-Learning tools are integral features in these classrooms" (Wright, 2010, p. 21). Teachers could plan lessons to allow students to collaborate and use these digital tools effectively for their classroom learning.

Bennett & Barbour (2012) states that many of the above Web 2.0 tools were new for the students. However, they were supported by their e-teachers in using them. Nevertheless, this support is not only the responsibility of the e-teachers. According to Table 1, Facebook is still yet to be used effectively for students' learning. Students did mention that they are open to the idea of their e-teachers using other tools to engage them further.

Web 2.0 tools	Percentage of Student Respondents
LMS	39.1
YouTube	34.8
Facebook	-
Wiki	21.7
Blog	4.3
Skype	21.7
Google documents	21.7
None of the above	13.0
Other	4.3

Table 1. Web 2.0 Tools used by Students and Teachers for Learning

5.3 Musing Technology to Assist Learning of Mathematics

Technology inclusion in mathematics teaching and learning (Simonovits, McElroy, O'Loughlin, and Townsend, 2013, p. 442) could address key competences like:

- Using computers as tools to generate multiple representations of mathematical concepts.
- Communicating mathematical ideas in writing and orally, using mathematical language and symbols.
- Using problem-solving to investigate and understand mathematical concepts.

Higher improvement was seen in younger than in older students' mathematics achievement (Li & Ma, 2010; Simonovits, Mcelroy, O'Loughlin, & Townsend, 2013; Kay & Knaack, 2008; Wright, 2010). This may be due to the fact that technology allows features to be visual, hands on (Li & Ma, 2010) and interactive (Taleb, Ahmadi, & Musavi, 2015; Simonovits, Mcelroy, O'Loughlin, & Townsend, 2013) for the younger students to work with effectively.

However, it has been pointed out that if students are motivated and engaged on mathematical tasks, their achievement could increase (Wright, 2010). This is true for indigenous students as well. Technology is a motivating and engaging tool (Simonovits, Mcelroy, O'Loughlin, & Townsend, 2013; Taleb, Ahmadi, & Musavi, 2015) and allows hands on learning approach (Li & Ma, 2010). Thus could lead to mathematical achievement. Nevertheless, there are other factors that needs to be considered that affects mathematics achievement of indigenous students (Philpott, Neville, & Sharpe, 2009).

Grootenboer & Sullivan (2013) mention that some forms of assessment works better with indigenous students than other forms. For example, in a two part study, students were found to answer contextual questions better using open ended task based questioning method rather than using NAPLAN test. Both forms of assessments were assessing the same criteria, but the results in NAPLAN test was not good due to its questions unfamiliar contexts and thus students mostly guessed their responses. Assessment procedures could be a form of oppression for indigenous students (McKinley, 2001 cited in Abrams, Taylor, & Guo,

2013).

Thus mathematics achievement also depends on the validity of the assessment tool being used. Teachers should know their students individually (Averill, 2012; Averill & Clark, 2012) as sometimes these tests are not very accurate in measuring their academic capabilities (Sterenberg, 2016). This could be a reason why indigenous students are reported as underachievers in national standard assessments, but in fact the assessment tool itself maybe not reliable. Wong (2002) states that examination culture influences the types of assessment questions. Closed ended and low level questions are included for CHC mathematics learners, which could restrict their thinking abilities (Lam et al., 2001 cited in Wong, 2002).

Previously learning was individualized to suit students' different prior knowledge, interests and learning styles so that students could work at their own pace. However, due to large class sizes, this may not be always possible (Abdullah, Hussin, Asra, & Zakaria, 2013). Working in smaller groups using CT shows positive effect on mathematics achievement than working individually (Lou et al. 2001; Li & Ma, 2010). Schools are using collaborative learning strategies for addressing individual learning. Working in teams at workplaces and the rapid technological advancements are too much for individuals to understand alone. Collaborative activities nurture individual learning (Reychav & Wu, 2015) as students are able to develop their communication and social skills (Kong et al., 2014) while actively constructing their own knowledge. Collaborative and problem solving activities, allows students to do higher order thinking (Zurita & Nussbaum, 2004) and chances are that knowledge would be retained for longer (Wright, 2010).

Collaborative activities increases learner confidence and creativity and assists students' learning abilities (Sultan, Sarwat, Kanwal, & Khurram, 2011). Collaborating on activities increases students' motivation and participation (Wright, 2010) on mathematical activities (Taleb, Ahmadi, & Musavi, 2015; Simonovits, Mcleroy, O'Loughlin, & Townsend, 2013; Wright, 2010) as it forms communities of inquiry (Philpott, Sharpe, & Neville, 2009; Bennett & Barbour, 2012). Collaborative learning allows students to see their group members as the tool holders (source of knowledge) and from whom they could build on their existing knowledge from. Competition is not seen as helpful in these learning situations since team work, social skills, and achieving common learning goals are more important. This in turn increases the students' self-esteem (Philpott, Neville, & Sharpe, 2009) since they become active learners by building on their own knowledge rather than absorbing ready-made passive knowledge. Thus learning becomes enjoyable (Mandryk et al. 2001 cited Zurita & Nussbaum, 2004).

Conclusion

In order to minimize the achievement gap between indigenous and non-indigenous students around the world, a culture inclusive pedagogy is suggested. This means students' culture is valued while having a positive relationship with their teachers. School reforms like Te Kotahitanga, 'Ka Hikitia', managing for success and Stronger Smarter Community of Learning (SSCL) emphasize on various ways to do this. The use of different media makes learning interactive and engaging. Increase in engagement, motivation, and participation on mathematical activities could lead indigenous students to achievement (Wright, 2010). Technology use makes learning ubiquitous, situated, collaborative, and authentic. This means learning could happen anywhere and at any time using real life situations making it more relevant and meaningful. GPS and wireless connectivity of devices which could allow learners to learn from anywhere. Situated learning is indigenous way of learning while involved on a collaborative task and allows better concept retention.

However, some difficulties could still be present. These could be the irrelevant assessment tools used to assess indigenous students' achievement. Task based interviews have been found to be effective in assessing Australian indigenous students' understanding of measurement concepts that were not able to be measured effectively using the NAPLAN assessment tool. Also while using culture inclusive pedagogy respect and careful thought needs to

be given to indigenous knowledge system. This knowledge system has its own rules of who could possess and receive it and how it should be used. Despite the many benefits of technology in education its usage is still limited. This could be increased by improving teachers' pedagogical knowledge through professional development.

Technology incorporation together with a culture inclusive curriculum could benefit indigenous students' mathematical learning. It allows collaboration and improves online student teacher relationships due to increased interactions. It could allow student centered learning, where students can learn at their own pace through one to one interactions. Moreover, its features make learning flexible, interactive, engaging, and thus could improve motivation, self-esteem, and achievement.

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Appendices

Author Codes	Indigenous/MR/ Other (MR/I/OE)	Student/Teacher/ Other Participants (St/T/OP)	Maths/Other Subject/ General (Ma/Os/G)	Qualitative/ Quantitative/ Mixed (Q/Qn/M)	Technology/ Not (T/N)	Primary/ Secondary/ Tertiary (P/S/T)	Online Course Type
Averill (Av)	I/OE/MR	St/T	Ma	M	N	S	
Averill & Clark (AC)	I/OE/MR	St/T	Ma	M	N	S	
Bennet & Barbour (BB)	I/MR/OE	S	G	Q	T	P/S	Virtual learning network
Grootenboer & Sullivan (GS)	I	St	Ma	M	N	P	
Sterenberg (S)	I	T	Ma	Q	N	S	
Wong (W)	OE	St/T	Ma	Q (St), M(T)	N	P/S	
Philpott, Sharpe & Neville (PSN)	I	St/T/OP	G	Q but got Qn as marks	T	S	Web based learning
Meaney (M)	I	-	Ma	-	N	-	
Hsu & Ching (HC)	-	-	-	-	T	-	e-learning environment
Kay & Knaack (KK)	OE	St/T	Ma	Q	T	P/S	Learning objects
Li & Ma (LM)	-	St	Ma	Qn	T	P/S	Computer technology
Abrams, Taylor & Guo (ATG)	I	-	Ma/Os	-	N	-	
Wright (Wr)	I/OE	-	G	Q & Qn	T	-	e-learning
Cobb (C)	-	St/T	Ma	-	N	P	
Simonovits, Mcelroy, O'Loughlin & Townsend (SMT)	OE	St	Ma	M	T	yes	Moodle 2.2 & M@th Desktop software

Table A1. Meta-Analysis 1

Author(s) /Date	Purpose of study	Result
Cobb (1988)	To explain how students actively construct knowledge due to instructional constraints	The findings indicated that students and teachers actively construct meanings of each other's words and actions. Students build on their knowledge when they encounter inconsistencies in their existing knowledge. Thus negotiation in teaching is important than transmission of knowledge. Teachers' role is important to create constraints in instructions in order for students to learn.
Meaney (2002)	To examine perceptions of mathematics, sequences of student learning, teaching and learning mathematics and languages of instruction to address areas of conflict for indigenous students.	This article states mathematics and its teaching is culture inclusive. 1) Mathematics in the school and community- perceptions of other parties could affect teaching and learning. These parties could be parents, teachers and students culture. 2) Sequence of students' learning- learning happens in a sequence. Some concepts are learnt before others could be understood. Indigenous students have different prior knowledge so learning should build on what they know and not what the curriculum thinks they should know. 3) Teaching and learning mathematics- teachers interaction with indigenous students is important for their learning. Ethnomathematics -familiar context for students to understand problems and make connections with real world. 4) Language of instruction- learning mathematics in another language could be another reason for difficulty. Community input could overcome this.
Wong (2002)	To investigate CHC students' and teachers' conceptions of mathematics in Hong Kong and Mainland China.	Findings suggest that mathematics teaching and learning in the Chinese CHC culture, is affected by both teacher and student perceptions. Students look for rules in solving problems. Even teachers thought that maths needs calculations and some reasoning. Thus these students possess restricted understanding of maths and are good at solving closed ended questions better.
Kay & Knaack (2008)	Impact of learning objects (LO) in secondary school mathematics through assessing teaching strategies, teacher attitudes, students' attitudes and learning performance.	The findings suggest that LO are not as successful for overall learning as was thought. Students thought it is not challenging enough but was easy to use and better engaging than other teaching methods due to visual features.

Philpott, Sharpe & Neville (2009)	To -contextualize problems of Aboriginal communities of coastal Labrador -examine the effectiveness of web- based learning courses -examine perspectives of students, educators and parents currently involved with web-based courses in Aboriginal communities	The results showed: (i) E-learning as an Essential Component-important for career opportunities and helpful due to unavailability of courses. (ii) Success in E-learning- noticed academic success in web courses and being compared with provincial students improved self-esteem of e-students. (iii) Developing Personal Skills-like time management, computer literacy, collaboration, independence and enhanced work ethic (iv) Teacher Support-readily available, clear, knowledgeable and effective methodology. Giving timely feedback and increased personal connection due to fax, phone and e-mail. Good for shy students could question privately. (v) Web Course Delivery Processes-- features like web course structure, recorded classes, ready access from any computer performance alerts etc. Students still needed supervision or distracted as teacher loaded Areas to improve service are organizational, communication, motivational and contextual.
Wright (2010)	To inform the development of e-learning policy and projects intended to support students' learning through out their schooling. 46 studies	The key findings of this report is e-learning benefit for the students: i) Motivation and engagement- using social networking sites suits Maori and Pasifika students through Web 2.0 tools. ii) Independence and personalized learning Increases students motivation and engagement as they could access help when needed. Also they have access to other students shared work and if they do not have their work available due to some reason their learning could still be possible. Web 2.0 tools makes learning personalized and improves relationships. iii) Critical thinking and multiliteracies Student centered learning allows deep thinking as students could collaborate and use their prior knowledge while working on multiple texts. iv) Access to information, experts and resources Information is readily available, thus students can use these resources in their own way depending on their individual needs. v) Collaboration in different context including international ones This motivates students and could enhance numeracy and literacy skills as well. vi) Some conditions for positive outcomes are the role of the teacher, the types of pedagogy and its accessibility. Effective leadership is important such as time tabling, professional development for teachers and technical support are a few.
Li & Ma (2010)	To examine the impact of Computer Technology (CT) on mathematics education in K-12 classrooms through a systematic review of existing literature (10 random chosen from 46 studies between 1990-2006)	The key findings of this Meta –analysis includes no significant effect of Computer Technology (CT) on maths achievement was noticed due to different gender, racial groups or SES. But effect difference of CT on maths achievement between mainstream and special needs students were noticed. Also elementary students benefitted over secondary schools in using CT for better maths achievement due to visual and hands on approach. To add on, using constructivist approach and CT showed improvement in maths achievement when compared to behaviorist approach. Shorter technology interventions are more effective in promoting mathematics achievement than longer technology interventions. Different programs, communication tools, exploratory environment and a range of tools had same effect on achievement and results on non-standardised tests were greater than standardised tests. Mathematics achievement depends on technology, its implementation and different learner characteristics.
Averill (2012)	To examine which factors contribute to teacher care in urban mathematics classrooms and which effective pedagogies and behaviours are needed for developing and maintaining caring teacher-student relationships in multi-ethnic mathematics classrooms.	Finding showed that most caring teacher practices showed greater student engagement, confidence and most student led interactions. Less cared students were off task, disruptive, unresponsive and had challenging behavior and displayed negative body language. Also no culturally linked mathematics teaching was observed or valuing student heritage, but some students could be embarrassed if it was as they lacked cultural and language understanding. Thus teachers chose the safe path. However, not all one to one interactions could be heard properly to be sure of this.
Averill & Clark (2012)	To look at teacher behaviours and practices in New Zealand that senior secondary mathematics students and teachers believe contribute to respectful classroom relationships	This study is about some teacher behaviours considered as respectful for Maori and Pasifika students' motivation and achievement. These foster positive student teacher relationship. i) Focussing on learning- both students and teachers think teachers should listen, be approachable, hold high expectations and provide opportunities for students to figure out their own solutions to problems. ii) Responding sensitively to student errors- students' view is teachers treating errors positively and provide individual feedback.

		iii) Challenges- both teachers and students think difficult student behaviour, negative attitude and curriculum pressure are barriers for teachers to show respect. iv) Planning ahead and listening- according to a teacher, practices like questioning promotes active learning. v) One to one connections- knowing students names, greetings, short informal conversations, giving individual assistance are some ways. Both students and teachers perceptions- teachers were respectful if well prepared, provide feedback on answers and errors and are punctual. Also using their first names, being humorous and informal is good. Students' different perception was teachers should be approachable which means student teacher relationships. Students' cultural diversity was a challenge for some teachers, if eye contact is appropriate or not. Students' different views of marking. Lenient marking is not respectful.
Bennett & Barbour (2012)	Perceptions of Mori students in the Virtual Learning Network (VLN) of effective strategies for engaging them in online learning.	The findings mention: i) Main reason for taking up VLN courses was that it was not offered at school. Students like working online and dislikes were mentioned as minor. ii) Teachers were already using a range of Web 2.0 tools but could engage students further by introducing other ones. Students needed support with tools on one to one basis by e-teachers and they acknowledged that their teachers were learning with them. Majority of e-students felt they were supported with technology use. iii) Communication and relationship- Students were better engaged as they had more equal relationship with e-teachers online and relationship is important for online learning. No different treatment was noticed by Maori students and e-mail was the main form of communication.
Grootenboer & Sullivan (2013)	To explore if remote Australian indigenous students' mathematical learning build upon their prior knowledge, their understandings and their identities	The study found that students did better in task based interview (2nd part) than NAPLAN test (1st part). NAPLAN test may not be good tool to measure achievement of indigenous students. Use one on one interview in early school year. 6% could not read train schedule but 2nd part same students could read TV schedule as familiar context. Teachers should know students better than through assessment only. 1st part both groups may have guessed responses to NAPLAN test so limited knowledge on measurement for teacher to build from Year 3-5 tape measure used to measure length but one student didn't know quarter to nine on digital watch. Year 6-7 Students could read calendar but also poor performance on NAPLAN test 2nd part -Some well-developed and some underdeveloped concepts for both groups. Calendar section students could not read or get information from it even in familiar context as thought question are ridiculous.
Simonovits, Mcelroy, O'Loughlin, & Townsend (2013)	To allow high school students from different European countries to collaborate using technology on small selected mathematics topic involving technology, student mobility and English language competency.	This study's findings report on curriculum aim should be to apply maths in real life context. Students enjoyed working with their foreign partners using technology. This improved their ICT skills and they learnt to work in collaboration.
Abrams, Taylor, & Guo (2013)	To look at knowledge and resources of indigenous students and examine classroom structures that can enhance or diminish their learning.	This study talks about national and international underachievement of indigenous students in science and mathematics. It mentions that indigenous knowledge systems different from western knowledge and that teachers should become familiar with indigenous culture. Mathematics learning is contextual and on many occasions students have to compromise their culture.
Hsu & Ching (2015) 17 articles	To review and synthesize models and frameworks on mobile learning	It is about different learning environments possible through technology use. This makes learning more relevant. Context aware learning (location awareness) due to GPS capability. Seamless and ubiquitous learning due to portability so learning can happen on the move. Game based learning happens in game scenarios. Mobile computer supported collaborated learning mCSCL is when students work in collaboration and form questions, discuss ideas, come to a solution and then reflect on it. Mobile social learning happens through social networking sites.
Sterenberg (2016)	To investigate a teacher's approach to integrate indigenous and western knowledge together.	It is not easy to integrate the two curriculums together especially not by using any concept. Land is sacred for indigenous people and thus is a concept that could be used. This could be done through placed based pedagogy but findings of this study should not be generalised for other Aboriginal communities.

Table A2. Meta-Analysis 2

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